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DIRECTORY OF GRAPHITE AVAILABILITY

SECOND EDITION

JULIAN GLASSER AND WILLIAM J. GLASSER

CHEMICAL AND METALLURGICAL RESEARCH, INC.

TECHNICAL REPORT AFML-TR-67-113

AUGUST 1967

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AIR FORCE MATERIALS LABORATORY
RESEARCH AND TECHNOLOGY DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

This directory was prepared by Chemical and Metallurgical Research, Inc., Chattanooga, Tennessee, under U. S. Air Force Contract No. AF 33(615)-3430, The Ohio State University Research Foundation Project No. 2165, Request No. ML-39. This Contract was initiated under Project No. 7381, "Materials Application," Task No. 738102, "Materials and Process Evaluation." The work was administered under the direction of the Materials Engineering Branch, Materials Applications Division, Air Force Materials Laboratory, Research and Technology Division, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, with Mr. C. A. Pratt (MAAE) as Project Engineer.

The work in preparing this directory covered the period September 1966 through February 1967. The manuscript was released by the authors in March 1967 for publication as a technical report.

The authors especially wish to acknowledge the contributions and cooperation of the 19 suppliers of graphite products who are listed in this directory.

This technical report has been reviewed and is approved.

Albert Olevitch

ALBERT OLEVITCH, Chief
Materials Engineering Branch
Materials Applications Division
Air Force Materials Laboratory

ABSTRACT

This directory was prepared for the purpose of assisting development, application, and design engineers in the rapid identification of graphite materials and sources of supply. This is a revision and updating of the first directory published in 1963 and it is expected that continuing revision, supplements, or new editions will be needed.

A total of 262 graphite products, available from 19 suppliers, are characterized by type, manufacturing methods, analyses, and properties. For each of these products, supplier's availability on grades, sizes and shapes, price, rate or capacity of production, and delivery times are shown. An indexing system allows for the convenient finding of information on suppliers, sizes and shapes, unique characteristics, compositions, and properties.

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DIRECTORY OF GRAPHITE AVAILABILITY

INTRODUCTION

In September, 1963, the first "Directory of Graphite Availability," ASD-TDR-63-853, was published. The first revision brings data and information up to date for the purpose of satisfying a continuing need of development, application, and design engineers for rapid identification of graphite materials and sources of supply.

This new edition includes further information with regard to new commercially available products. It should be noted, however, that the new product numbers do not correspond to those of the old directory unless by coincidence. The method of collecting and treating the necessary information was generally the same as before.

The directory presented herein is not intended to replace the technical handbooks and literature currently available from manufacturers. On the other hand, its intent is to assemble in one place a list of all graphite products commercially available, together with approximate property values. Finally, the information collected is presented in such a manner that it would allow easy updating and constant surveillance.

Since the first edition of the directory, it was found that the range of values for the property data is too broad. This has been solved by using average values where they are available. Also, it was found that (because of wide range of testing methods) the data presented had little meaning unless a test method is indicated for each property. Therefore, the product sheets show (where available) how the data were obtained.

An innovation in this edition is the inclusion of thirty-four figures (graphs), which illustrate high temperature properties to about 5000°F for specific graphite products. These figures are supplemental to the characterization sheet for the corresponding graphite product number.

SUMMARY OF TRENDS

Significant advancements have been made with respect to commercial availability and technology for graphite products since 1963, when the first edition of the directory was prepared. This directory identifies 262 commercially available graphite products, which is about 30% more products than shown in the 1963 edition. Furthermore, the data sheets in the directory were recast to properly reflect advancement in new technology and make them more useful to the Air Force requirements.

Specific trends in availability for each class of graphite products are shown in Figure 1. As can be expected, the largest increase in availability was experienced by the more conventional and the higher tonnage classes which are the bulk graphites, molded and extruded. The only other large volume class, composites, experienced virtually no change.

The specialty smaller quantity graphite products, namely hot worked, pyrolytic, fibrous, flexible, alloyed, and foamed remain relatively small in quantity. However, the fibrous and flexible classes are finding new applications and appear potentially highly attractive for military needs. The other specialty classes, such as pyrolytic, have gained more acceptance through familiarity; but more time will be required before they can be considered as conventional off-the-shelf items for military systems design engineers.

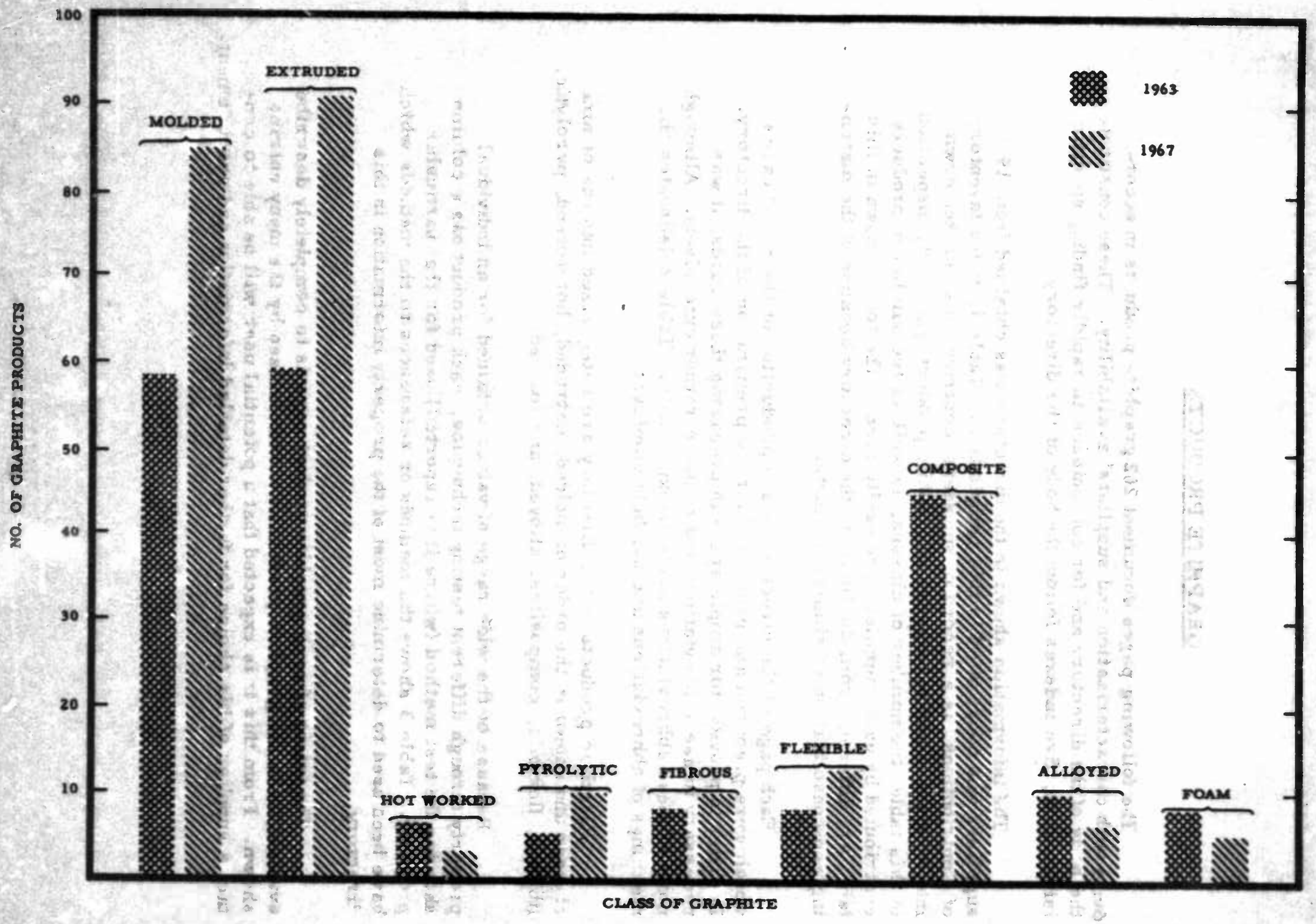


FIG. 1 DISTRIBUTION OF GRAPHITE PRODUCTS BY CLASSES FOR 1963 and 1967

GRAPHITE PRODUCTS

The following pages document 262 graphite products in accordance with characterization and suppliers' availability. These constitute the body of the directory and for convenience in rapidly finding specific information, five indexes follow the body of the directory.

The information shown in the directory was obtained from 19 suppliers who cooperated in this compilation. Table 1, titled Inventory of Contributions, is a record of suppliers' contributions, broken down into 20 classes and subclasses of graphite product types. By inspection of this table, the number of classes, as well as the number of products contributed by each supplier, are easily seen. The totals shown in this table are different from the totals in the directory because of the matching and consolidation of similar products.

Each page of the directory is a reproduction of the 5 x 8" cards which were prepared and processed for the preparation of the directory. In order to provide for ample space in preparing these cards, it was necessary to use abbreviations and symbols rather extensively. Although most of these abbreviations are self-explanatory, Table 2 delineates the meanings of abbreviations and symbols employed.

Graphite products in the directory are categorized into one of nine classes and shown in the order of molded, extruded, hot worked, pyrolytic, fibrous, flexibile, composites, alloyed, and foamed.

Because of the wide range of values obtained for an individual property through different testing techniques, each product has a column showing the test method (where it is reported) used for that particular property. Table 3 shows the methods or references to the methods which have been used to determine most of the property information in this directory.

The intent of each graphite product page is to completely describe availability of the graphite product as characterized by the many entries shown. From this it is expected that a potential user will be able to contact a supplier of his choice for further detailed information and procurement.

TABLE 1

INVENTORY OF CONTRIBUTIONS

Symbol	Description	Atomergic Chemetals	Duramic Products	Gen. Elec. Detroit	Gen. Elec. Schenectady	Graphite Prod. Division, Carborundum	Great Lakes Carbon	HITCO	3 M Company	Ohio Carbon	Poco Carbon	Pure Carbon	Raytheon	Space Age	Speer Carbon	Stackpole Carbon	Super-Temp	Union Carbide	U.S. Graphite	Vitreous Carbon	TOTALS
	GRAPHITE PRODUCT TYPE (Class and Subclass)	NUMBER OF CONTRIBUTIONS BY																			
1a	Molded, fine grained		3		2	1	2			6	3	8			56	5		8	1	1	96
1b	Molded, medium grained						2											7			9
2a	Extruded, fine grained					6	1								16	2		4			29
2b	Extruded, medium grained					3	21								13	2		15			54
2c	Extruded, coarse grained					2	3								2			1			8
2d	Extruded, very coarse grained					1	1														2
3a	Hot worked-very high density																	1			1
3b	Hot worked-high density		1															1			2
4	Pyrolytic	1		2									1	3			2	1			10
5a	Fibers					1		1	2									1			5
5b	Yarns					2		1	1									4			8
6a	Woven cloth					2		1	2									6			11
6b	Nonwoven cloth							1										1			2
6c	Pyrolytic tape																	2			2
7a	Microcomposites							1				4									5
7b	Macrocomposites			1	6							6			5	11		5			34
7c	Gross composites				3							3									6
8a	Metallo-pyrolytic	1																			1
8b	Graphite-boron															1	1	2			4
	Graphite foams													3				3			6
	TOTALS	2	4	3	11	18	30	5	5	6	3	21	1	6	92	21	3	62	1	1	295

TABLE 2

ABBREVIATIONS AND SYMBOLS

Abbreviation or Symbol	Meaning
av.	Average
blk.	Block
Cap.	Capacity
cyl	Cylinder
C. Str.	Compressive strength
C. Exp.	Coefficient of thermal expansion
Del.	Delivery
Flex. Str.	Flexural strength
H. T.	High temperature
lg	Long
M	Thousand
Oxid.	Oxidation
pipe	Pipe and tube (1 to 3 ratio)
plt	Plate
Std. Dev.	Standard deviation
S. Res.	Specific resistance
thk	Thick
T. Str.	Tensile strength
Therm. Cond.	Thermal conductivity
Y. Mod.	Young's modulus
>	Greater than
<	Less than

TABLE 3

TEST METHODS

Property	Units	Method	Reference
Young's Modulus	psi	Sonic	
		Stress-Strain	ASTM-D-790-61
Tensile Strength	psi	Stress-Strain (Dog Bone)	ASTM-C-190-59
		Stress-Strain (cyl 1/4" dia)	WADD-TR-61-72 Vol. XXXV
		Gage dimension	
Compressive Strength	psi	Cubic Compression	ASTM-C-109-545 ASTM-D-695 ASTM-C-39-56T
Flexural Strength	psi	4 Point loading(1)	ASTM-C-78-59
		Single Point(2)	NEMA
Density	g/cc	Wt/Volume	ASTM-C-134-41 NEMA Standards
Coefficient of Thermal Expansion	1/°C	Expansion Measurement	ASTM-B-95-39
		Expansion bar 5/16"x5/8"x6"	WADD-TR-61-72 Vol. XXVI
Thermal Conductivity	cal-cm/sec cm^2 °K	Calculated from Electrical Conductivity	---
		(cyl 1-1/2" dia x 6" lg)	WADD-61-72 Vol. XXVI
		Value at 1300°F	Guarded Hot Plate
Specific Resistance	ohm-cm	Volt/amps	NEMA Standards
		Kelvin Bridge	NEMA Standards
		Voltage Drop on bar 1-1/4"x1-1/4"x7"	WADD-TR-61-72 Vol. XXVI
Hardness	---	Indentation	---
		Scleroscope	---

(1) 4 Point Loading is the actual loading for the Third Point Method
(2) Single Point Loading is conventional terminology for 3 Point Loading

Molded Graphite Products (Nos. 1 through 85)

In the molded class, 85 graphite products are shown. This is one of the most popular classes (together with extruded and composites). Graphite products in some of the other classes, such as composites and alloyed graphites, might well be included in the molded class because many of them are indeed characterized by this manufacturing method; however, for the sake of avoiding repetition, they are not shown in the molded class.

The classification of "molded" was selected, not because of the unique manufacturing method, but because this manufacturing method imparts unique characterization to graphite products. For example, anisotropy or orientation properties are greatly influenced by forming methods, including molding. When coke is crushed or milled, the individual particles tend to have one dimension larger than the other and, in forming, the long axes of the particles tend to take a preferred orientation, and the final graphite product retains the same pattern of grain orientation as well as grain size. In the case of the molded class, orientation is perpendicular to the direction of molding.

Grain size has a profound effect on the properties of molded graphite and this is why the molded class is subdivided into two subclasses* in accordance with maximum grain size. In general, the medium-grain stock is more uniform in all directions (less anisotropic) than the fine-grain stock, and the molded class exhibits less anisotropic properties than any other class.

From the point of view of familiarity and long experience, the molded class is outstanding. Historically, this is the oldest class of graphite products produced and the leading suppliers manufacture larger quantities of this class than any other. In the past, most of the applications have been in the broad field of metallurgy; however, every opportunity should be taken for applications in military usage because of the very high degree of manufacturing capability and depth of familiarity.

---

*Fine grain - 0.015" max (Nos. 1-76)
Medium grain - 0.015" to 0.12" max (Nos. 76-85)

GRAPHITE PRODUCT NO. 1

Characterization

TYPE: molded, fine grained; high strength; good electrical and thermal conductor; high density; used for molds, jigs and fixtures, rocket nozzle inserts, casting dies, sintering boats, and crucibles

MFG: calcined petroleum coke; graphitized over 2500C; impregnated; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES: Typical	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.84					
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	ER-83	various rectangular and round stock	$1-10/lb		

GRAPHITE PRODUCT NO. 2

Characterization

TYPE: molded, fine grained; low coeff. therm. exp.; used for jigs and fixtures, heater elements, support material in furnace brazing & heat-treating, and susceptor in induction heating furnaces

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ni	Ca	Fe	Si	Al	Co	Na	Ti	Mo
Av. value	200ppm	200ppm	100ppm	75ppm	75ppm	25ppm	100ppm	10ppm	10ppm

Also available in purified grade 50ppm total impurities

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	15	1.1	15	1.4	1.9
T. Str. (10^3psi)	(2)	2.1	20	2.0	20	2.1	5.9
C. Str. (10^3psi)	(3)	8.4	20	8.0	20	8.8	12.8
Flex. Str. (10^3psi)	(4)	4.2	20	4.0	20	4.3	7.3
Density (g/cc)		1.75	5				
C. Exp. (10^{-6}/°C)		3.4	5	3.3	5	4.1	
Therm. Cond. (cal-cm/sec cm^2°K)		.35	15	.34	15		
S. Res. (10^{-4}ohm cm)		13.0	1	13.5	1		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Duramic Products	D-775	blk up to 18" x 7" x 4" max	$1-10/lb	<10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-565-65T
(3) ASTM-C-528-63T
(4) ASTM-C-328-56T

GRAPHITE PRODUCT NO. 3

Characterization

TYPE: molded, fine grained; low cost; used for jigs and fixtures, support material in furnace brazing & heating treating, and heater elements

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ni	Ca	Fe	Na	Si	Al	Co	Ti	Mo
Av. value	400ppm	400ppm	200ppm	200ppm	150ppm	150ppm	50ppm	20ppm	20ppm

Also available in purified grade 50ppm total impurities

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	15	1.3	15	1.6	2.1
T. Str. (10^3psi)	(2)	3.3	20	2.8	20	3.0	6.3
C. Str. (10^3psi)	(3)	8.6	20	10.5	20	9.0	13.0
Flex. Str. (10^3psi)	(4)	4.4	20	4.0	20	4.5	7.5
Density (g/cc)		1.65	5				
C. Exp. (10^{-6}/°C)		4.0	5	5.1	5	3.3	4.1
Therm. Cond. (cal-cm/sec cm^2°K)		.350	15	.330	15		
S. Res. (10^{-4}ohm cm)		12.7	1	14.0	1		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Duramic Products	D-657	blk up to 24"x20" x 9"	$1-10/lb	< 10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-565-65T
(3) ASTM-C-528-63T
(4) ASTM-C-328-56T

GRAPHITE PRODUCT NO. 4

Characterization

TYPE: molded, fine grained; high purity; used for jigs and fixtures, susceptor in induction heating furnaces, heater elements, and crucibles

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ni	Ca	Fe	Na	Si	Al
Av. value	3ppm	3ppm	2ppm	2ppm	1ppm	1ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	15	1.4	15	1.4	2.0
T. Str. (10^3psi)	(2)	1.8	20	1.79	20	1.8	4.9
C. Str. (10^3psi)	(3)	8.0	20	7.9	20	8.6	13.0
Flex. Str. (10^3psi)	(4)	4.0	20	3.9	20	4.1	7.6
Density (g/cc)		1.55	5				
C. Exp. (10^{-6}/°C)		5.7	5	5.6	5	6.6	
Therm. Cond. (cal-cm/sec cm^2°K)		.39	15	.38	15		
S. Res. (10^{-4}ohm cm)		36	1	37	1		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Duramic Products	D-555	blk up to 15" x 6" x 3"	$10-100/lb	<10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-565-65T
(3) ASTM-C-528-63T
(4) ASTM-C-328-56T

GRAPHITE PRODUCT NO. 5

Characterization

TYPE: molded, fine grained; low porosity; used primarily for carbon brushes and certain mechanical electrical specialties

MFG: raw materials may be combinations of the following: resin, metal inorganic salt, calcined petroleum coke, lamp black, coal tar pitch, petroleum pitch, natural and artificial graphite; graphitized over 2500C; 100-2000 lb batch size

ANALYTICAL:	Ash	Fe	V	Σ
Av. value	.1-.5%	<.05%	<.005%	>1ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		2.5	<10				
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		5-10	5-10				
Density (g/cc)		1.65-1.8					
C. Exp. (10^6/°C)		2-10					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)		10-50	5-10				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	L.T.
GE - Schenectady	ME 14	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	100-3M T/yr	3 mo

GRAPHITE PRODUCT NO. 6

Characterization

TYPE: molded, fine grained; high strength; high hardness; used for mold stock and rocket nozzle inserts

MFG: graphitized over 2500C; Acheson electric furnace; 1-20T batch size

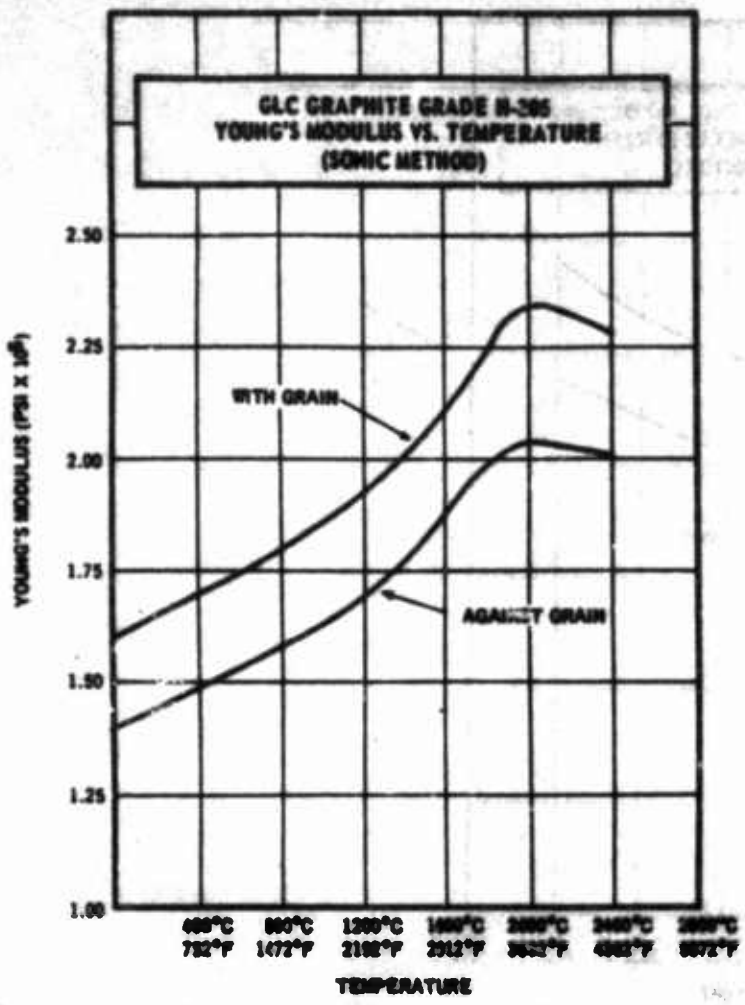
ANALYTICAL:	Ash	Ni	Ca	Fe	Na	Si	Al
Av. value	0.25%	0.04%	0.04%	0.02%	0.02%	0.015%	0.015%
Std. dev. (%)	<50	<50	<40	<40	<40	<50	<40

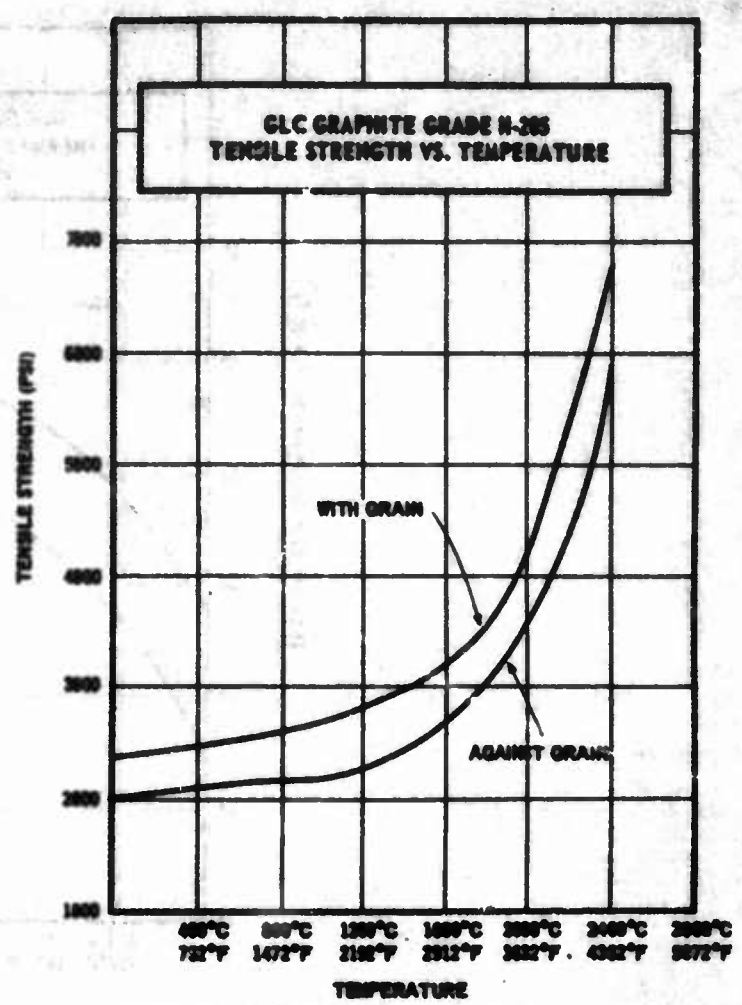
PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.6	10	1.4	10		
T. Str. (10^3psi)	(2)	3.2	10	2.8	10		
C. Str. (10^3psi)	(3)	8.5	10	10.0	10		
Flex. Str. (10^3psi)	(4)	4.5	10	4.0	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	3.9	5	5.0	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.35	10	0.33	10		
S. Res. (10^{-4}ohm cm)	(8)	12	10	14	10		
Hardness-Brinell-136 Kg Load-10mm ball				15.0	10		
Permeability (D'Arcy)		0.2	10	0.004	10		

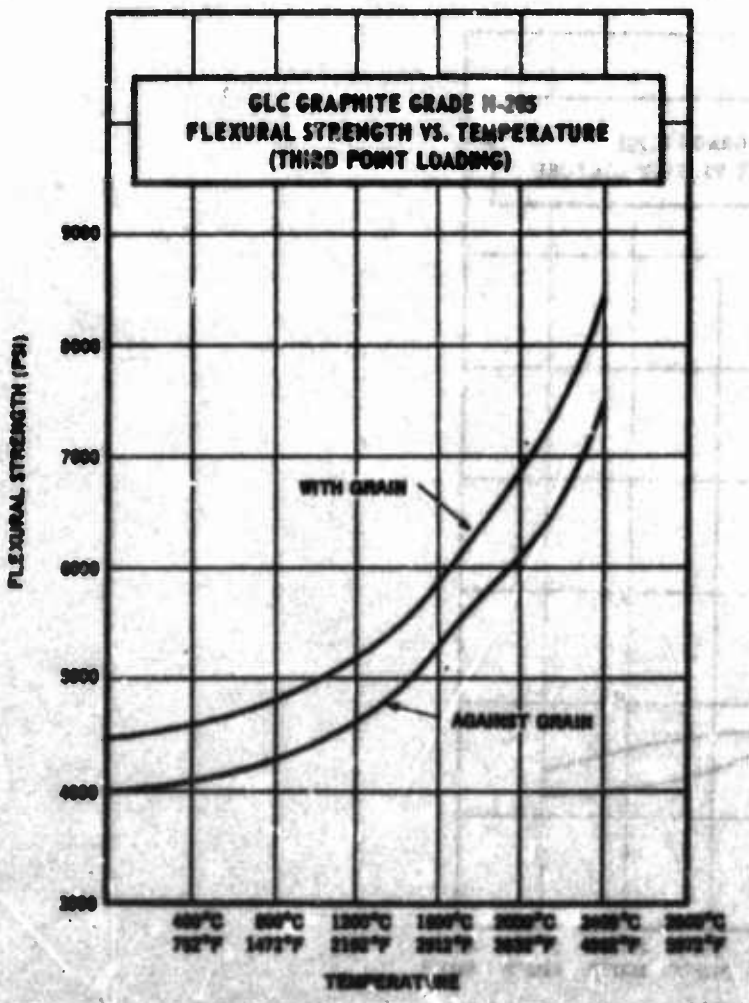
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	H205	cyl 10-22"	<$1/lb	3 M-30 M T/yr	3 mo
		blk 9" x 20" x 24"	$1-10/lb		

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75 °C
(7) Thermal diffusivity
(8) Volt/amps







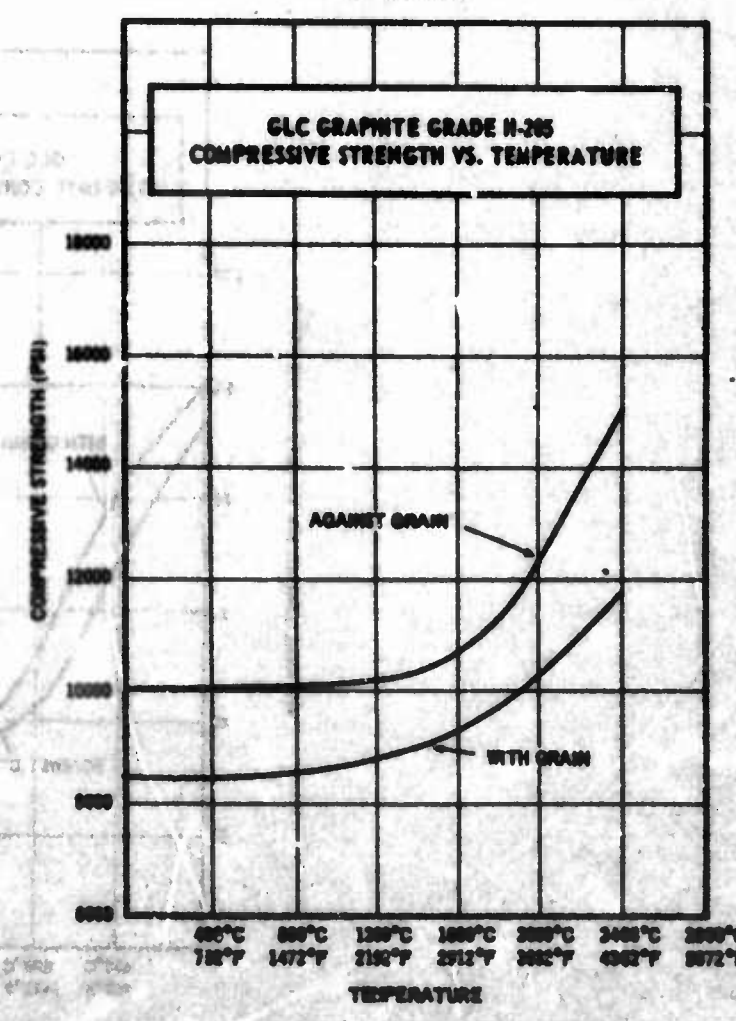
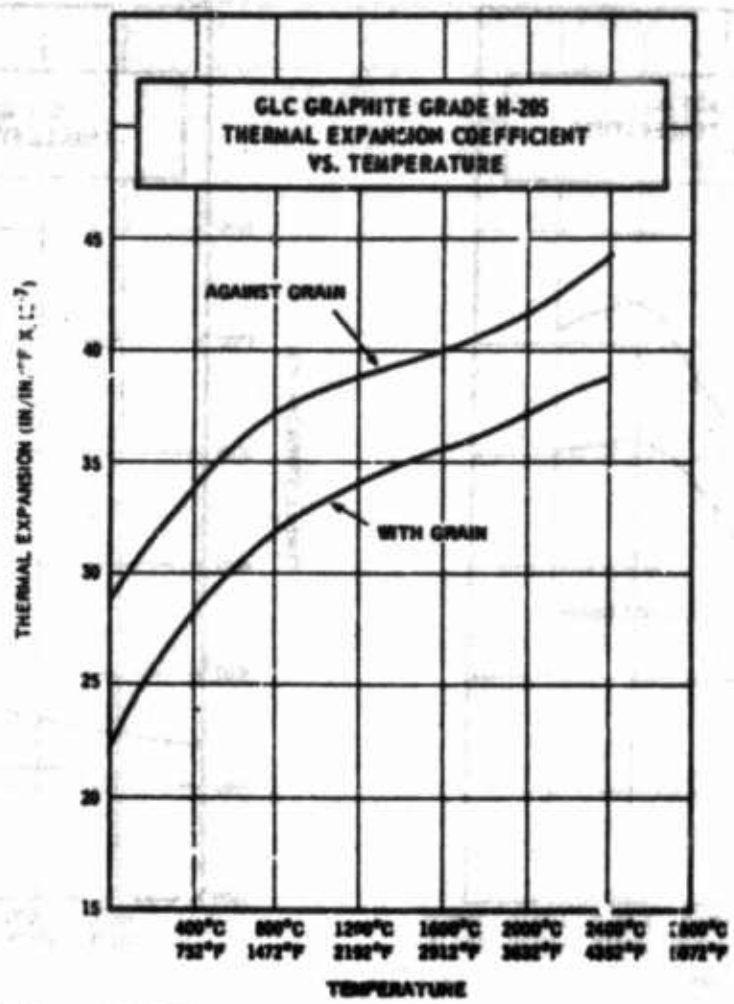


FIGURE 2 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 6
(Furnished by Great Lakes Carbon)



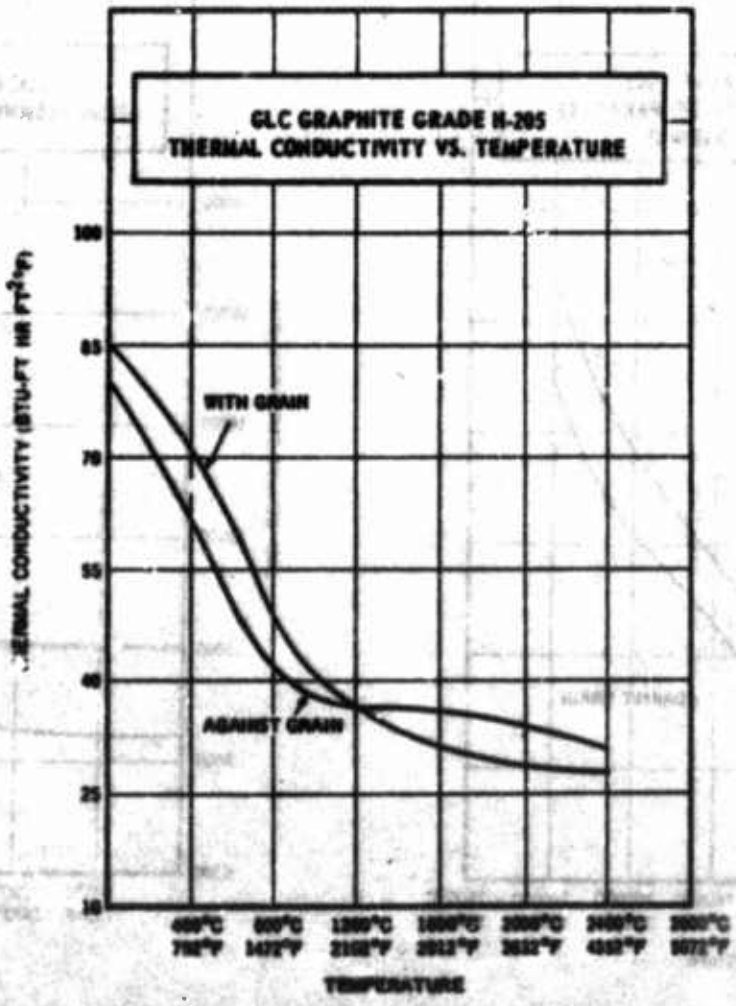


FIGURE 3 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 6
(Furnished by Great Lakes Carbon)

GRAPHITE PRODUCT NO. 7

Characterization

TYPE: molded, fine grained; high strength; high density; high hardness; used for mold stock, rocket nozzle inserts, sintering boats, and crucibles

MFG: graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:	Ash	Ni	Ca	Fe	Na	Si	Al
Av. value	0.25%	0.04%	0.04%	0.02%	0.02%	0.015%	0.015%
Std. dev. (%)	< 50	< 50	< 40	< 40	< 40	< 50	< 40

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7	10	1.5	10		
T. Str. (10^3psi)	(2)	3.5	10	3.0	10		
C. Str. (10^3psi)	(3)	10.0	10	12.0	10		
Flex. Str. (10^3psi)	(4)	4.7	10	4.3	10		
Density (g/cc)	(5)	1.81	2				
C. Exp. (10^6/°C)	(6)	41	5	50	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.37	10	0.35	10		
S. Res. (10^4ohm cm)							
Hardness-Brinell-136 Kg load-10mm ball				18.0	10		
Permeability (D'Arcy)		0.006	10	0.001	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	H205-85	cyl 10-22" blk 9" x 20" x 29"	< $1/lb $1-10/lb	3 M-30 M T/yr	3 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity

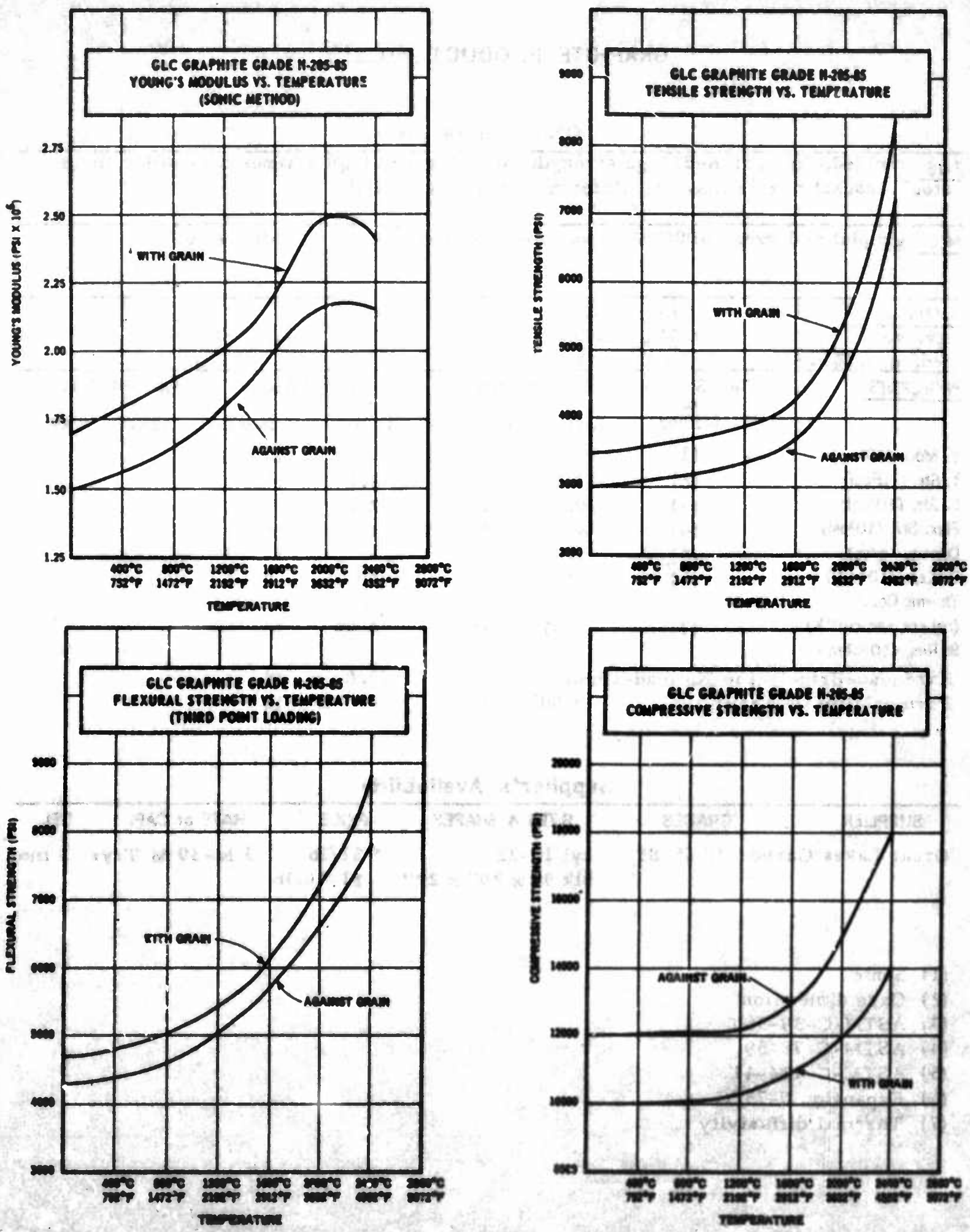
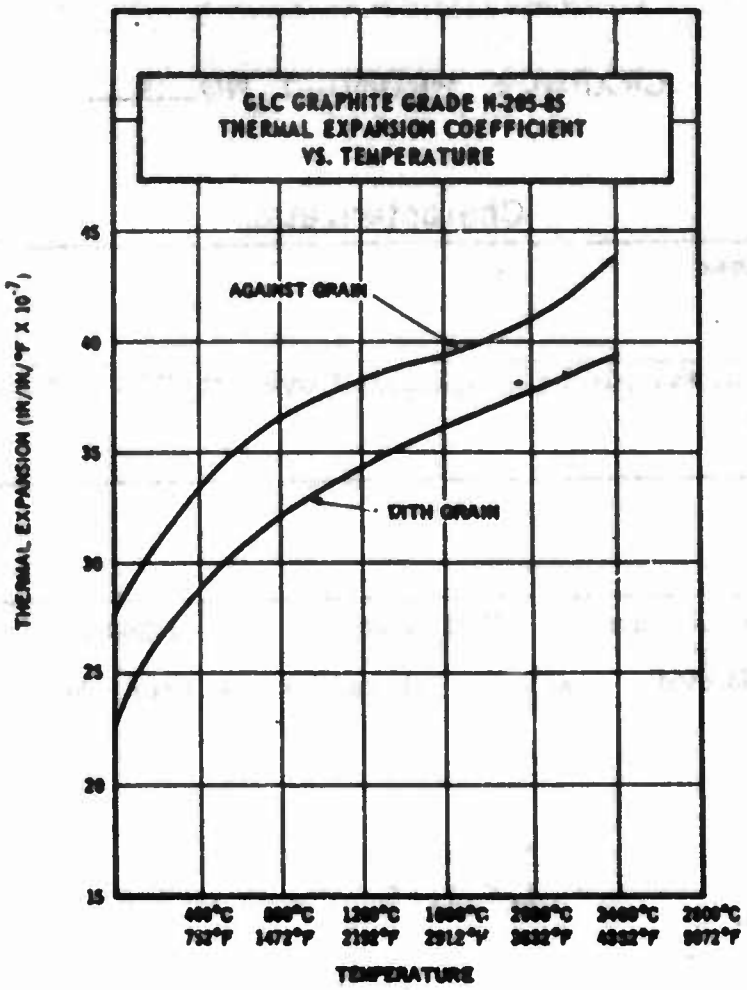


FIGURE 4 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 7
(Furnished by Great Lakes Carbon)



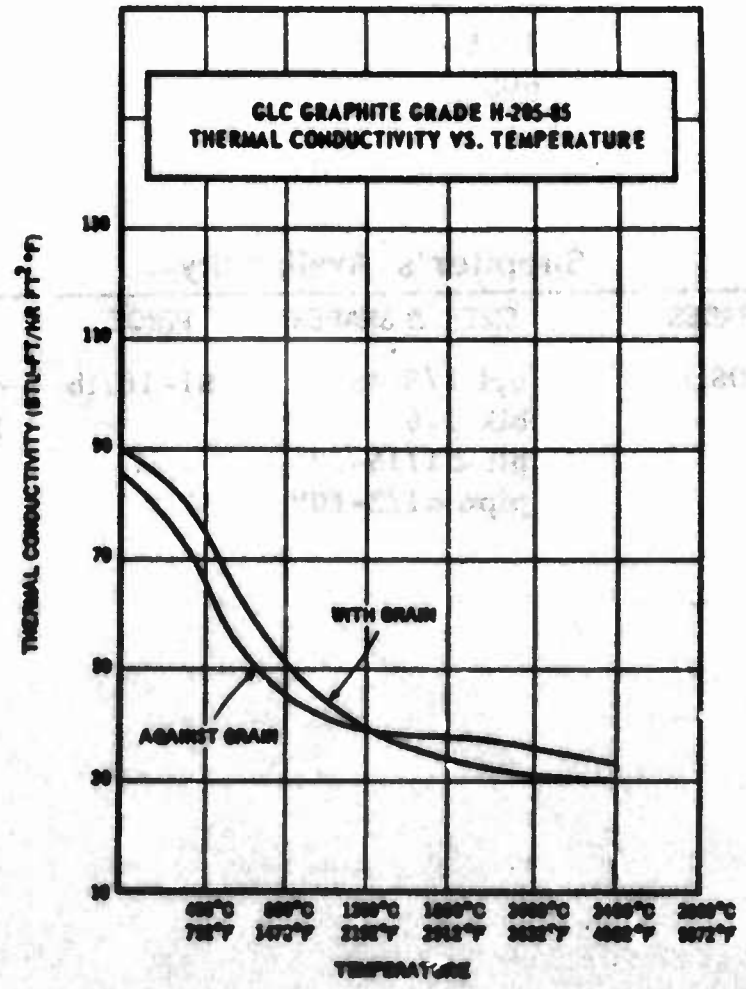


FIGURE 5 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 7
(Furnished by Great Lakes Carbon)

GRAPHITE PRODUCT NO. 8

Characterization

TYPE: molded, fine grained

MFG: lamp black and coal tar pitch; graphitized over 2500C; ground and machined; 100-2000 lb batch size

ANALYTICAL:

	Ash
Av. value	.1-5%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		2.5					
Density (g/cc)		1.5-1.65					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		10-50					
Hardness		60S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Ohio Carbon	2D8D	cyl 1/8-45" blk 1-6" plt < 1/16-1" pipe <1/2-10"	$1-10/lb	< 10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 9

Characterization

TYPE: molded, fine grained; basically used for brush applications

MFG: lamp black, calcined petroleum coke and coal tar pitch; graphitized over 2500C in Acheson electric furnace; ground and machined; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value .1-.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)		5-10					
Flex. Str. (10^3psi)		5-10					
Density (g/cc)		1.5-1.65					
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^4ohm cm)		10-50					
Hardness		65S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Ohio Carbon	2D9B	cyl 1/8-45" blk 1-6" plt < 1/16-1" pipe < 1/2-10"	$10-100/lb	<10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 10

Characterization

TYPE: molded, fine grained

MFG: coal tar pitch and artificial graphite; processed in a fuel fired furnace; machined and ground; batch size 100-2000 lb

ANALYTICAL: Ash
Av. value >.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1-5					
Density (g/cc)		1.5-1.65					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		10-50					
Hardness		60S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Ohio Carbon	B1A	cyl 1/8-45" blk 1-6" plt < 1/16-1" pipe < 1/2-10"	$1-10/lb	<10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 11

Characterization

TYPE: molded, fine grained

MFG: coal tar pitch, natural graphite, metal; processed in a fuel fired furnace; machined and ground; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1-5					
Density (g/cc)		>2.2					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		1-10					
Hardness		35S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Ohio Carbon	ME	cyl 1/8-45" blk 1-6" plt < 1/16-1" pipe < 1/2-10"		< 10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 12

Characterization

TYPE: molded, fine grained; high strength; high hardness

MFG: calcined petroleum coke, natural graphite and coal tar pitch; processed below 2500C; ground and machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	>.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)		10-50					
Flex. Str. (10^3psi)		5-10					
Density (g/cc)		1.65-1.8					
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^4ohm cm)		10-50					
Hardness		80S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Ohio Carbon	W97	cyl 1/8-45" blk 1-6" plt < 1/16-1" pipe < 1/2-10"	$1-10/lb	< 10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 13

Characterization

TYPE: molded, fine grained; high strength; high electrical resistant; high reproducibility; low porosity; chemical resistant; abrasion resistant; small sizes; isotropic; used for jigs and fixtures, seals, bearings, rocket nozzle inserts, rupture discs and crucibles

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ash
Av. value	< 0.1%
Std. dev. (%)	< 30

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8	>20	1.6	>20		1.5
T. Str. (10^3psi)	(2)	9.4					10.2
C. Str. (10^3psi)	(3)	20.0	5-10				
Flex. Str. (10^3psi)	(4)	10.0	10-20	10.0	10-20		
Density (g/cc)		1.80-1.88					
C. Exp. (10^{-6}/°C)	(5)	9.0					
Therm. Cond. (cal-cm/sec cm²°K)		.1-.5		.1-.5			.06
S. Res. (10^{-4}ohm cm)	(6)	14-16					
Hardness (Scleroscope)		78					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Poco Graphite, Inc.	AXF	rod 1/8-5/8" cyl 8" max blk 4" x 8" x 18" max plt < 1"	$10-100/lb	100-3 M T/yr	3 mo

(1) 4 Point bending
(2) Air bearing
(3) 1/2" x 1" L
(4) 4 Point loading
(5) RT-1000°C
(6) Kelvin Bridge 1/2" x 1" L

GRAPHITE PRODUCT NO. 14

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; small sizes; used for molds, jigs and fixtures, seals, rocket nozzle inserts, rupture discs, sintering boats, crucibles, and continuous casting dies

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ash
Av. value	< 0.1%
Std. dev. (%)	< 30

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7		1.6			1.40
T. Str. (10^3psi)	(2)	9.4					9.5
C. Str. (10^3psi)	(3)	16.0					25.0
Flex. Str. (10^3psi)	(4)	8.0					
Density (g/cc)		1.70-1.79					
C. Exp. (10^{-3}/°C)	(5)	8.0					
Therm. Cond. (cal-cm/sec cm²°K)		.1-.5		.1-.5			
S. Res. (10^{-4}ohm cm)	(6)	16-22					
Hardness		70S Typical					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Poco Graphite, Inc.	AXM	rod 1/8-5/8" cyl 8" max blk 4" x 8" x 18" max plt < 1"	$1-10/lb	100-3 M T/yr	1 mo

(1) Compressive
(2) Air bearing
(3) 1/2" x 1" L
(4) 4 Point loading
(5) RT-1000°C
(6) Kelvin Bridge 1/2" x 1" L

GRAPHITE PRODUCT NO. 15

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; small sizes; used for electrolytic anodes, jigs and fixtures, sintering boats, crucibles, and susceptor in induction heating furnaces

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ash
Av. value	< 0.1%
Std. dev. (%)	< 30

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)	(1)	0.75		0.85		.9	
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	9.0				9.5	
Flex. Str. (10^3psi)	(3)	6.0					
Density (g/cc)		1.50-1.59					
C. Exp. (10^{-6}/°C)		7.0					
Therm. Cond. (cal-cm/sec cm²°K)		.1-.5		.1-.5			
S. Res. (10^{-4}ohm cm)	(4)	28-34					
Hardness	Scleroscope	57 Typical					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Poco Graphite, Inc.	AXZ	rod 1/8-5/8" cyl 8" max blk 4" x 8" x 18" max plt < 1"	$1-10/lb	100-3 M T/yr	1 mo

(1) Compressive
(2) 1/2" x 1" L
(3) 4 Point loading
(4) Kelvin Bridge 1/2" x 1" L

GRAPHITE PRODUCT NO. 16

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high purity; good nuclear properties; high reproducibility; low friction; low porosity; chemical resistant; high temperature oxidation resistant

MFG: calcined petroleum coke, coal tar pitch, and artificial graphite; graphitized over 2500C; Acheson electric furnace; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:

	Ash
Av. value	10ppm max

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		5					
C. Str. (10^3psi)		20					
Flex. Str. (10^3psi)		10	15				
Density (g/cc)		1.8	>2				
C. Exp. (10^{-6}/°C)		4					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		18					
Hardness		75S	10				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	DS13	cyl 1/8-8" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-8"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 17

Characterization

TYPE: molded, fine grained; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; long experience; low hardness; primarily used for brush applications

MFG: graphite and resin; processed below 2500C; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	> 2.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	>20				
Density (g/cc)		<1.5	>2				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		30	15				
Hardness		18S	16				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	G-9	cyl 1/8-6" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-6"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 18

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; used for brushes, rupture discs, sintering boats, crucibles, and susceptor in induction heating furnace

MFG: lamp black, graphite and pitch; graphitized over 2500C; Acheson electric furnace; finishing operations as required; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value .5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	15				
Density (g/cc)		1.55	1.5				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		75	75				
Hardness		50S	6				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	G-88-C	cyl 1/8-6" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-6"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 19

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; long experience: used for mechanical applications

MFG: lamp black, graphite and pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.3%
Std. dev. (%)	>50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		<1					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	15				
Density (g/cc)		1.60	1.5				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		75	7.5				
Hardness		52S	<5				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	L-55	cyl 1/8-6" blk 1-6" rod .01-1/8" plt <1/16-1" pipe <1/2-6"	$1-10/lb	100-3 M T/yr	3 mo

GRAPHITE PRODUCT NO. 20

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; high temperature oxidation resistance; abrasion resistant; long experience; used for mechanical applications

MFG: lamp black, graphite and pitch; graphitized over 2500C; Acheson electric furnace; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash	Fe	Si
Av. value	<.1%	<.05%	10ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		4					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		7.5	15				
Density (g/cc)		1.60	1.5				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2-°K)							
S. Res. (10^{-4}ohm cm)		30	15				
Hardness		64S	< 10				
Admittance (H^2/sec, He)		10^{-2}					
Abrasion Res.		4 Hr/mil					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	L-56	cyl 1/8-12" blk 1-6" rod .01-1/8" plt<1/16-1" pipe < 1/2-10"	$1-10/lb	100-3M T/yr	3 mo

GRAPHITE PRODUCT NO. 21

Characterization

TYPE: molded, fine grained; carbon-graphite; high strength; high reproducibility; good electrical and thermal conductivity; low porosity; low friction; long experience; high production; low coeff. therm. exp.; used for mechanical applications

MFG: graphite, pitch; not graphitized; no secondary processing; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		7.5					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		7.5	15				
Density (g/cc)		1.75	15				
C. Exp. (10^6/°C)		6					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)		75					
Hardness		76S	10				
Abrasion		4 Hr/mil	50				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-9	cyl 1/8-19" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-10"	$1-10/lb	100-3 M T/yr	2 mo

GRAPHITE PRODUCT NO. 22

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; low porosity; long experience; high temperature oxidation resistance; good mechanical properties

MFG: graphite and pitch; graphitized over 2500C; Acheson electric furnace; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		<1					
T. Str. (10^3psi)		3					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		7.5	15				
Density (g/cc)		1.60	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		30	15				
Hardness		46S	10				
Abrasion Res.		8 Hr/Mil	50				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-3W	cyl 1/8-12" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-10"	$1-10/lb	100-3 M T/yr	2 mo

GRAPHITE PRODUCT NO. 23

Characterization

TYPE: molded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; low friction; low porosity; long experience; high temperature oxidation resistance; good mechanical properties

MFG: graphite and pitch; graphitized over 2500C; Acheson electric furnace; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		5					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		10	15				
Density (g/cc)		1.8	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		30					
Hardness		78S	10				
Abrasion Res.		30Hr/mil					
Oxid. rate in air							0.3%/hr(1000F)

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-03	cyl 1/8-8" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-8"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 24

Characterization

TYPE: molded, fine grained; high purity; high reproducibility; high temperature oxidation resistant; long experience; used for molds, jigs, fixtures, heater elements, crucibles, electronic tube anodes, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Fe	V	B	Si	Ca	Al	Mg
Av. value	< 10ppm	1ppm	<1ppm	10 ppm	< 10ppm	5ppm	< 1.0ppm

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)	(1)	0.87		1.18			
T. Str. (10^3psi)	(2)	1.8		1.6		2.2	3.8
C. Str. (10^3psi)	(3)	6.8		7.2		7.0	9.8
Flex. Str. (10^3psi)	(4)	3.6		3.1		4.2	7.0
Density (g/cc)	(5)	1.68					
C. Exp. (10^6/°C)	(6)	3.3		4.4			
Therm. Cond. (cal-cm/sec cm^2°K)	(7)					0.15	
S. Res. (10^4ohm cm)	(8)	9.6				9.1	10.7
Scleroscope Hardness		37					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9RL	cyl 10" max	$1-10/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded Hot Plate
(8) Volt/amps

GRAPHITE PRODUCT NO. 25

Characterization

TYPE: molded, fine grained; high strength; high purity; high reproducibility; high temperature oxidation resistant; long experience; used for molds, jigs, fixtures, sintering boats, heater elements, crucibles, and electronic tube anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash	Fe	V	B	Si	Ca	Al	Mg
Av. value	50ppm	<10ppm	1ppm	<1ppm	10ppm	<10ppm	5ppm	<10ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1500F	2000F
Y. Mod. (10^6psi)	(1)	1.5					
T. Str. (10^3psi)	(2)	1.8		1.6		2.2	3.8
C. Str. (10^3psi)	(3)	6.4		6.8		7.0	9.8
Flex. Str. (10^3psi)	(4)	3.7		3.2		4.2	7.0
Density (g/cc)	(5)	1.65					
C. Exp. (10^6/°C)	(6)	3.3		4.4			
Therm. Cond. (cal-cm/sec cm^2°K)						0.12	
S. Res. (10^4ohm cm)	(7)	8.6				7.1	11.7

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	39RL	blk <12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 26

Characterization

TYPE: molded, fine grained; high strength; abrasion resistant; long experience; high hardness; used for jigs, fixtures, seals, and bearings

MFG: calcined petroleum coke and coal tar pitch; processed below 2500C; machined; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 3.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.0					
T. Str. (10^3psi)	(2)	1.6		1.5			
C. Str. (10^3psi)	(3)	10.0		11.0			
Flex. Str. (10^3psi)	(4)	3.5		2.9			
Density (g/cc)	(5)	1.63					
C. Exp. (10^{-6}/°C)	(6)	4.3		5.4			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	55.9					
Rockwell Hardness		78					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Sy[illegible] Carbon	350	blk 12" x 6" x 2" individually molded items	<$1/lb	10-100 T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 27

Characterization

TYPE: molded, fine grained; high electrical resistance; used for brushes

MFG: artificial graphite; processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.0					
Density (g/cc)	(2)	1.68					
C. Exp. (10^{-6}/°C)	(3)	4.4		5.7			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	33					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	357	blk<12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 28

Characterization

TYPE: molded, fine grained; high electrical resistance; used for brushes

MFG: lamp black; processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	4.5, 3.5					
Density (g/cc)	(2)	1.52, 1.43					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	58.4, 76.2					
Scleroscope Hardness		80, 70					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	521	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	< 10 T/yr	1 mo
Speer Carbon	990	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	< 10 T/yr	1 mo

*First number refers to first product

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 29

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; long experience; used for brushes

MFG: processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	5.6	14				
Density (g/cc)	(2)	1.90	1				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	22.6	3				
Scleroscope Hardness		20.6	14				
Rockwell Hardness (L)		45					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Spear Carbon	610	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 30

Characterization

TYPE: molded, fine grained; used for brushes

MFG: natural graphite; processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	4.0, 3.5					
Density (g/cc)	(2)	1.95, 1.88					
C. Exp. (10^{-6}/°C)	(3)	-, 1.3		-, 5.6			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	30.5, 8.9					
Scleroscope Hardness		10, 18					
Rockwell Hardness		-, 83					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	614	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	700	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

* First number refers to first product

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 31

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: artificial graphite; processed below 2500C; machined, 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	6.9	11				
Density (g/cc)	(2)	1.80	2				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	45.2	10				
Scleroscope Hardness		36.7	8				
Rockwell Hardness (L)		75					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	619	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 32

Characterization

TYPE: molded, fine grained; high electrical resistance; long experience; used for brushes

MFG: artificial graphite; processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	5.43	17				
Density (g/cc)	(2)	1.72	1				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	2166	16				
Scleroscope Hardness		47.8	9				
Rockwell Hardness (M)		87					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	621	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 33

Characterization

TYPE: unmolded, fine grained; high electrical resistance; long experience; used for brushes

MFG: natural graphite; processed below 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prep. 1300F	Typical H.T. Prep. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	0.9	21				
Density (g/cc)	(2)	1.40	1				
C. Exp. (10^{-6}/°C)	(3)	1.9		9.4			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	25.7	27				
Scleroscope Hardness		14.9	10				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	702	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 34

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; long experience; high production; used for rocket nozzle inserts, continuous casting dies, sintering boats, heater elements, crucibles, and mechanical applications such as seals and bearings

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.03%

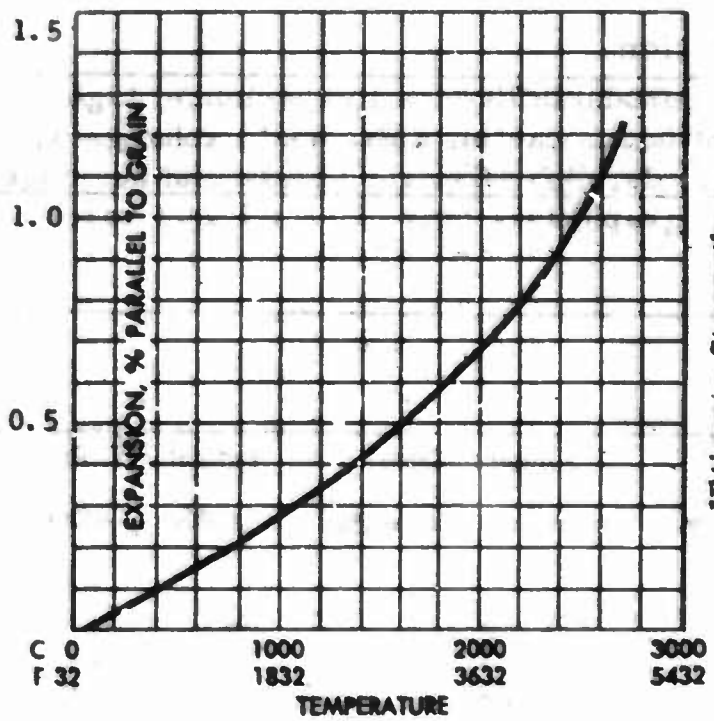
PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5					
T. Str. (10^3psi)	(2)	1.8		1.6		2.2	3.8
C. Str. (10^3psi)	(3)	6.4		6.8		7.0	9.8
Flex. Str. (10^3psi)	(4)	3.7		3.2		4.2	7.0
Density (g/cc)	(5)	1.65					
C. Exp. (10^{-6}/°C)	(6)	3.3		4.4			
Therm. Cond. (cal-cm/sec cm^2°K)	(7)					0.12	
S. Res. (10^{-4}ohm cm)	(8)	8.6				7.1	11.7
Scleroscope Hardness		36					

Supplier's Availability

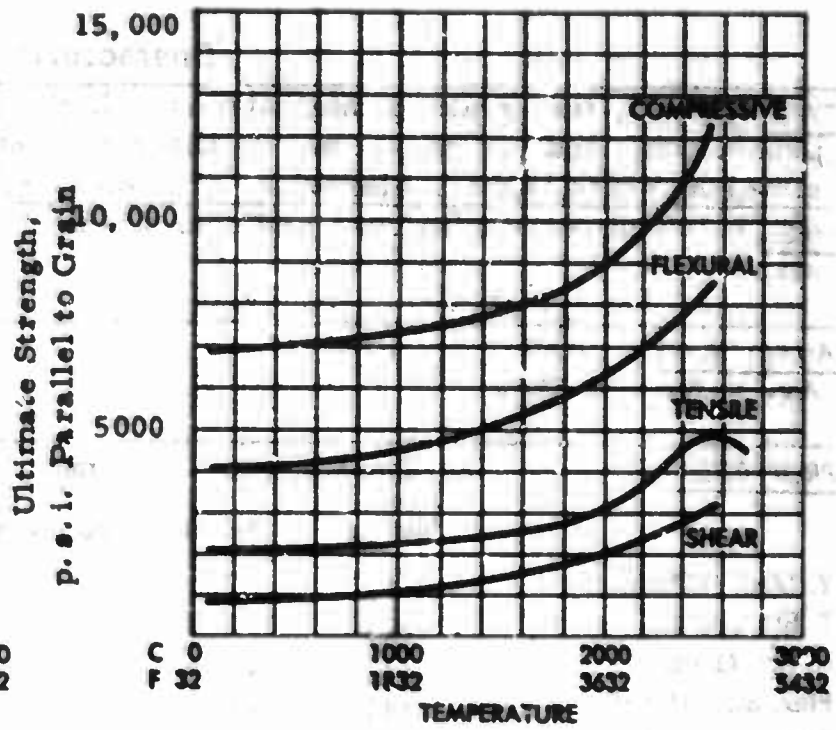
SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	3499	blk 12" x 12" x 5"	$1-10/lb	100-3 M T/yr	0-3 mo
General Electric Schenectady	ME11[1]	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	100-3 M T/yr	3 mo

1 Hardness - 40S

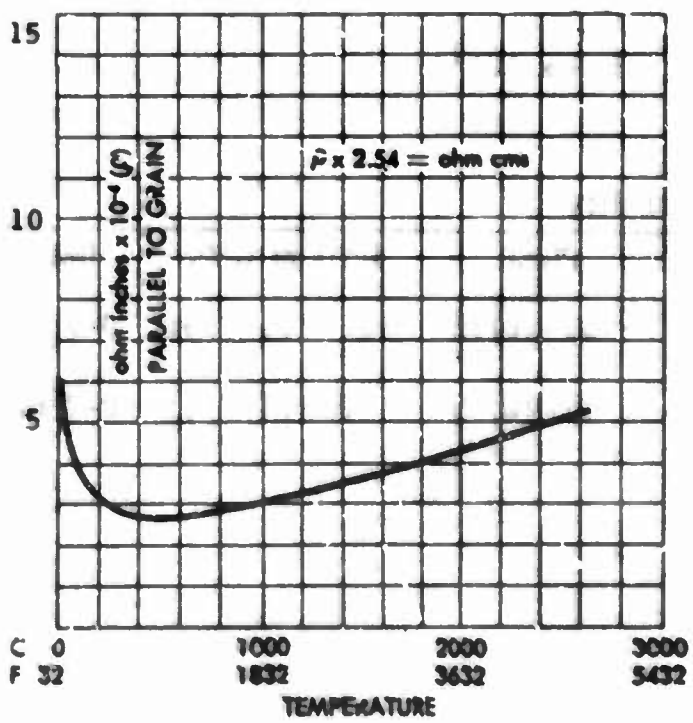
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded Hot Plate
(8) Volt/amps



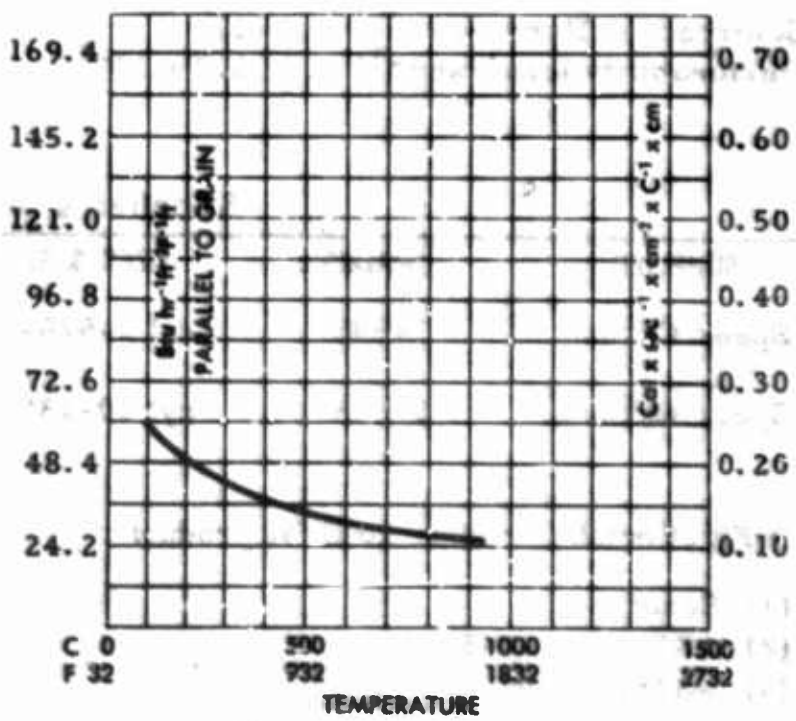
Thermal Expansion vs. Temperature
Grade 3499



Ultimate Strength vs. Temperature
Grade 3499



Electrical Resistivity - Grade 3499



Thermal Conductivity - Grade 3499

FIGURE 6 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 34
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 35

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; long experience; high production; used for rocket nozzle inserts, continuous casting dies, heat exchangers, sintering boats, heater elements, crucibles, molds, jigs, fixtures, seals and bearings

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.03%

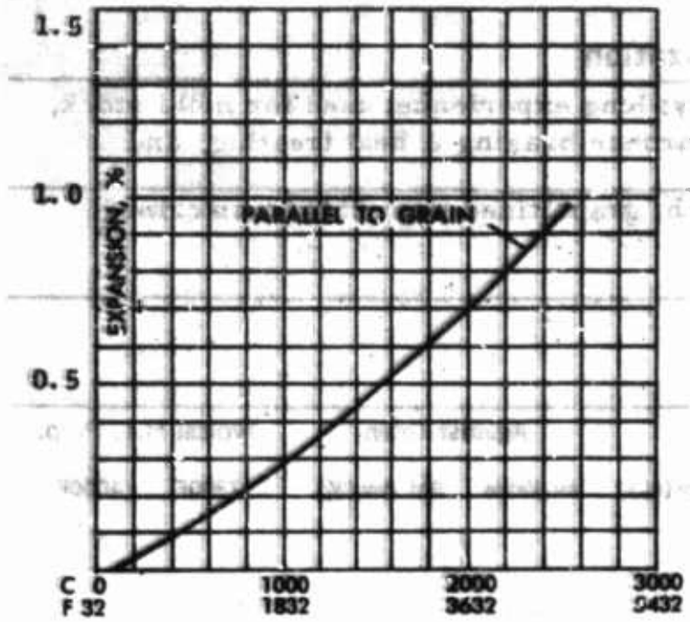
PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)	(1)	.87, -		1.18			
T. Str. (10^3psi)	(2)	1.8, 1.6		1.6, 1.4		2.2	3.8
C. Str. (10^3psi)	(3)	6.8, 6.0		7.2, 6.5		7.0	9.8
Flex. Str. (10^3psi)	(4)	3.6, 3.0		3.1, 2.8		4.2	7.0
Density (g/cc)	(5)	1.68, 1.61					
C. Exp. (10^6/°C)	(6)	3.3		4.4			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					.15	
S. Res. (10^4ohm cm)	(8)	9.6, 10.2				9.1	10.7
Scleroscope Hardness		37					
Permeability (cm^2/sec^{-1})		6.0×10^{-1}		5.8×10^{-1}			

Supplier's Availability

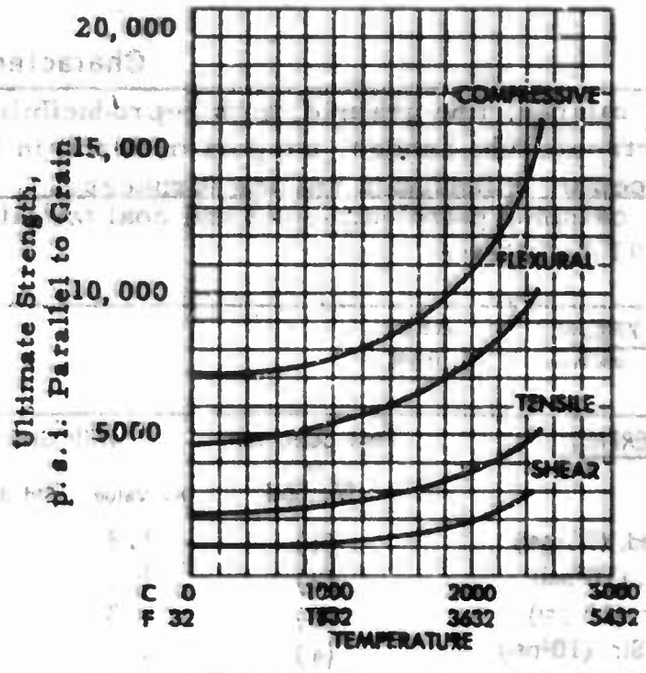
SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	3499S	cyl 2-5/8-8"	$1-10/lb	100-3M T/yr	0-3 mo
Speer Carbon	3499S	cyl 10-13"	$1-10/lb	100-3M T/yr	0-3 mo

* First number refers to first product

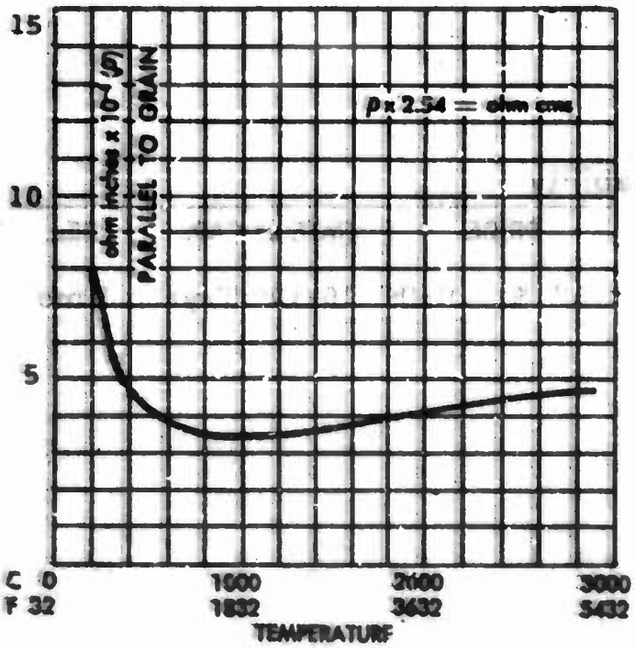
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps



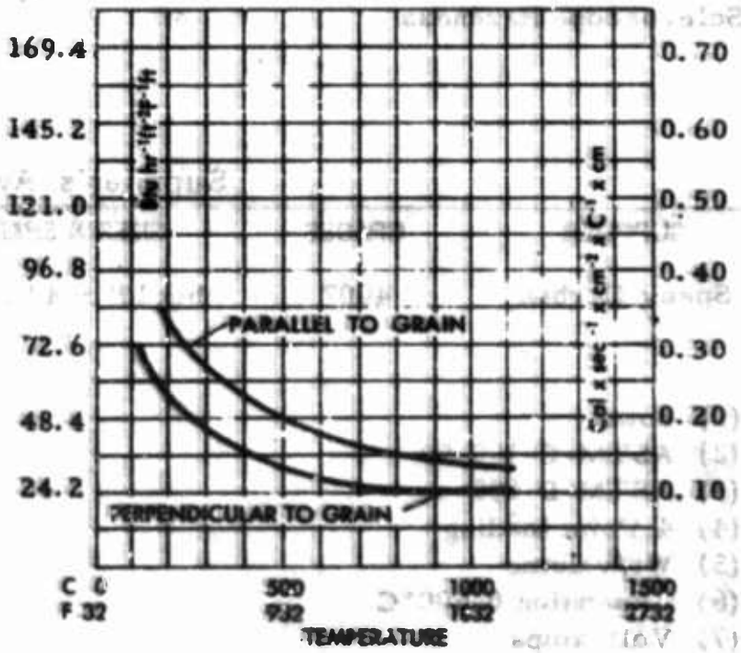
Thermal Expansion vs. Temperature
Grade 3499S



Ultimate Strength vs. Temperature - Grade 3499S



Electrical Resistivity - Grade 3499S



Thermal Conductivity - Grade 3499S

FIGURE 7 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 35
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 36

Characterization

TYPE: molded, fine grained; high reproducibility; long experience; used for mold stock, electronic tube anodes, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

	Ash
Av. value	0.03%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3					
T. Str. (10^3psi)	(2)	1.5					
C. Str. (10^3psi)	(3)	6.3		6.5			
Flex. Str. (10^3psi)	(4)	3.2		2.1			
Density (g/cc)	(5)	1.68					
C. Exp. (10^{-6}/°C)	(6)	2.7		4.1			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	8.9					
Scleroscope Hardness		40					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	4007	blk 10" x 4" x 2-1/2"	$1-10/lb	10-100 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 37

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.12%

PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	1.9, 2.6, 2.9, 4.4	13				
Density (g/cc)	(2)	1.5, 1.5, 1.5, 1.6	2				
C. Exp. (10^{-6}/°C)	(3)	5.9, 6.0, 6.1, 6.1		6.0, 6.2, 6.0, 6.0			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	61.0, 50.8, 57.9, 52.1	7				
Scleroscope Hardness		46.0, 47.9, 53.5, 75.9	7				
Rockwell Hardness (K)		65, 60, 75, 110					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	4029	blk <12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	1 mo
Speer Carbon	E-35	blk <12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	1 mo
Speer Carbon	E-28	blk <12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	1 mo
Speer Carbon	E-34	blk < 12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	1 mo

All grades fabricated brushes only.

* First number refers to first product

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 38

Characterization

TYPE: molded, fine grained; low friction; high temperature oxidation resistant; abrasion resistant; long experience; used for mold stock, jigs, fixtures, seals, bearings, continuous casting dies, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1900F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	1.9		1.9			
C. Str. (10^3psi)	(2)	6.7		6.5			
Flex. Str. (10^3psi)	(3)	4.0		3.8			
Density (g/cc)	(4)	1.73					
C. Exp. (10^{-6}/°C)	(5)	3.3		4.4			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(6)	10.2					
Scleroscope Hardness		35					
Rockwell Hardness (L)		63					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	4110	cyl 13" blk 12"x12"x2-1/2"	$1-10/lb	3M-30M T/yr	1 mo

(1) ASTM-C-190-59
(2) ASTM-C-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Volt/amps

GRAPHITE PRODUCT NO. 39

Characterization

TYPE: molded, fine grained; high reproducibility; low friction; high temperature oxidation resistant; abrasion resistant; long experience; used for mold stock, jigs and fixtures, seals, bearings, continuous casting dies

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	5.7					
Density (g/cc)	(2)	1.80					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	8.1					
Scleroscope Hardness		35					
Rockwell Hardness (R)		90					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	7110	cyl 13" blk 12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	1 mo

(1) 4 Point loading
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 40

Characterization

TYPE: molded, fine grained; good thermal insulator; high reproducibility; low density; abrasion resistant; long experience; high production; used for jigs and fixtures, sintering boats, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; processed under 2500C; machined; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 0.15%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.0					
T. Str. (10^3psi)	(2)	0.9					
C. Str. (10^3psi)	(3)	6.8			7.7		
Flex. Str. (10^5psi)	(4)	1.9			1.9		
Density (g/cc)	(5)	1.37					
C. Exp. (10^{-6}/°C)	(6)	4.6			6.2		
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	76.2					
Scleroscope Hardness		50					
Rockwell Hardness (L)		59					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	7716	blk 12" x 12" x 5"	<$1/lb	10-100 T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 41

Characterization

TYPE: molded, fine grained; high strength; low friction; low porosity; chemical resistant; abrasion resistant; long experience; small sizes; high hardness; used for seals, bearings, and pistons

MFG: calcined petroleum coke and coal tar pitch; processed under 2500C; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	4.0					
C. Str. (10^3psi)	(2)	2.5					
Flex. Str. (10^3psi)	(3)	6.0					
Density (g/cc)	(4)	1.78					
C. Exp. (10^{-6}/°C)	(5)	4.0					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							
Scleroscope Hardness		80					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	8645	Individually molded items < 6" dia	$1-10/lb	10-100 T/yr	0-3 mo

(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C

GRAPHITE PRODUCT NO. 42

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; abrasion resistant; long experience; high production; used for jigs and fixtures, rocket nozzle inserts, continuous casting dies, and crucibles

MFG: calcined petroelum coke and coal tar pitch; graphitized over 2500C; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 0.04%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4		1.2			
T. Str. (10^3psi)	(2)	2.4		2.1		4.0	5.7
C. Str. (10^3psi)	(3)	9.2		9.6		10.5	14.8
Flex. Str. (10^3psi)	(4)	4.4		4.1		6.0	11.3
Density (g/cc)	(5)	1.79					
C. Exp. (10^{-6}/°C)	(6)	3.0		4.7			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.2	
S. Res. (10^{-4}ohm cm)	(8)	11.4				8.4	7.6
Scleroscope Hardness		48					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9135 9139	Finished shapes only with < 3" wall thickness	<$1-10/lb	100-3 M T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps

GRAPHITE PRODUCT NO. 43

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; abrasion resistant; long experience; high production; used for jigs and fixtures, rocket nozzle inserts, continuous casting dies, and crucibles

MFC: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 100-2000 lb batch size

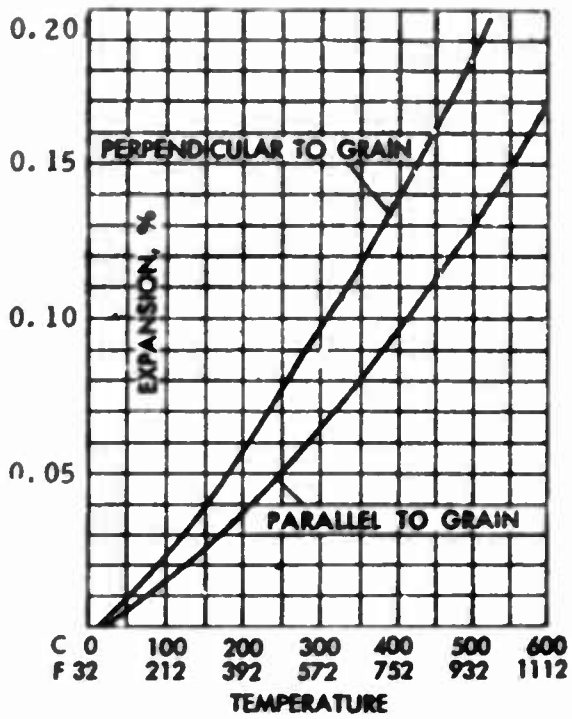
ANALYTICAL:	Ash
Av. value	0.04%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)			1.1			
T. Str. (10^3psi)	(2)	2.2		2.1		3.2	4.8
C. Str. (10^3psi)	(3)	8.1		8.4		9.7	13.2
Flex. Str. (10^3psi)	(4)	4.2		3.6		5.8	9.3
Density (g/cc)	(5)	1.70					
C. Exp. (10^{-6}/°C)	(6)	3.2		4.5			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.2	
S. Res. (10^{-4}ohm cm)	(8)	9.1				7.6	10.2
Scleroscope Hardness		44					

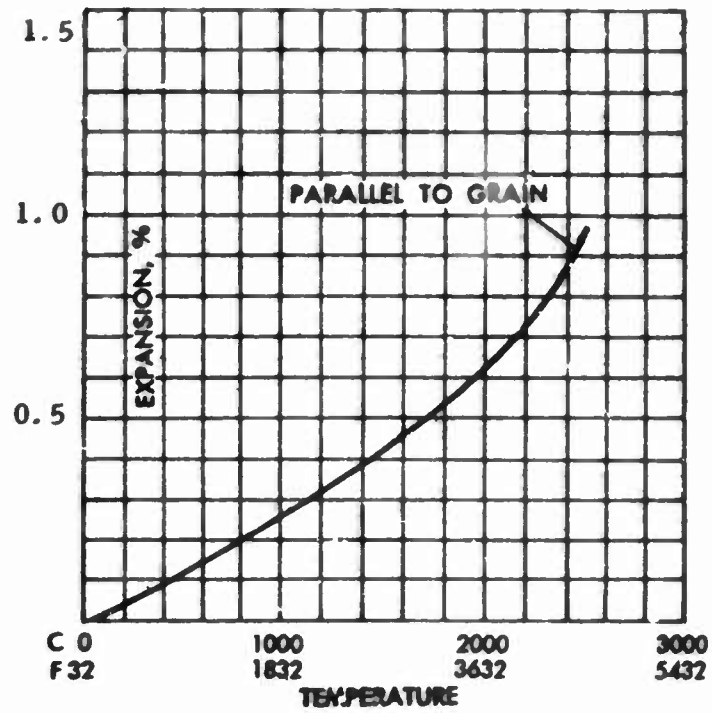
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9134	Machined shapes only up to 13" dia with < 3" wall thickness	$1-10/lb	100-3 M T/yr	0-1 mo

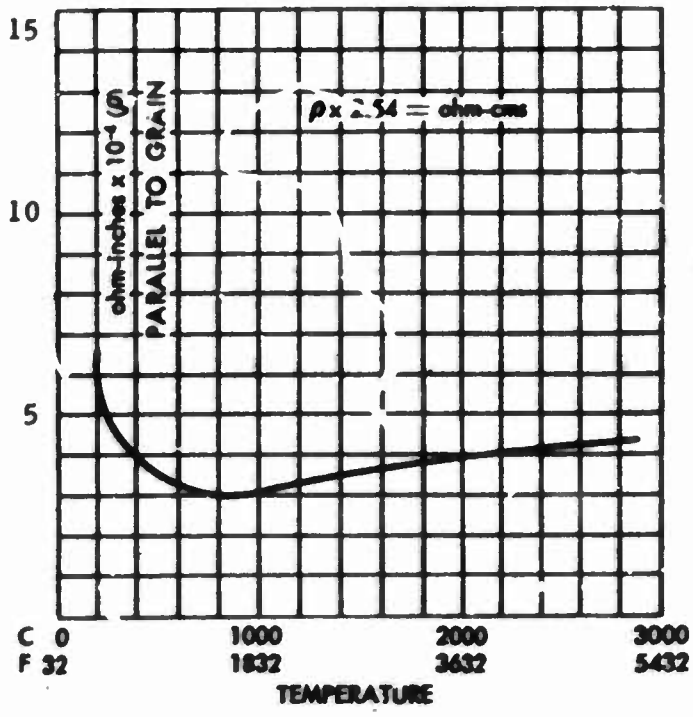
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps



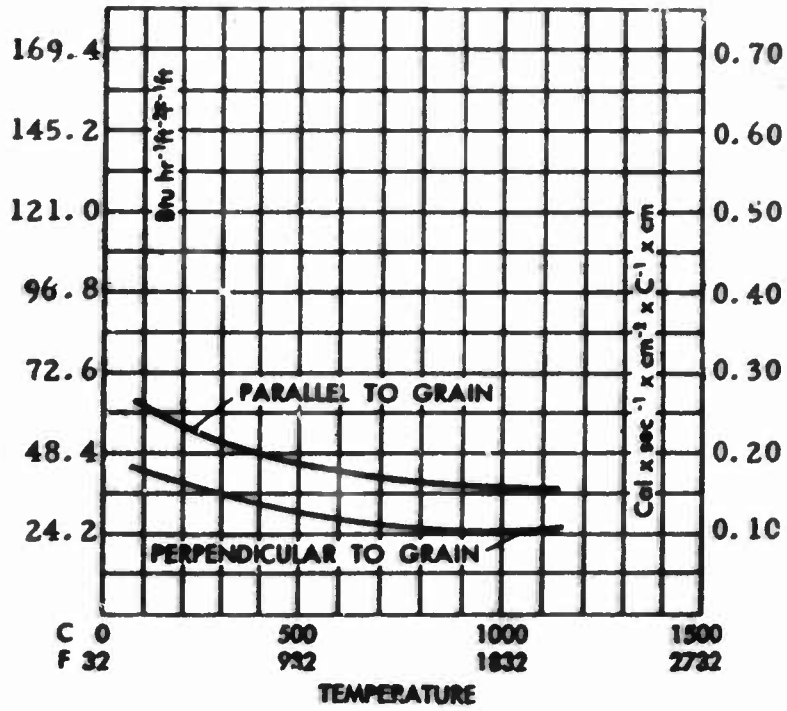
Thermal Expansion vs. Temperature - Grade 9134



Thermal Expansion vs. Temperature Grade 9134

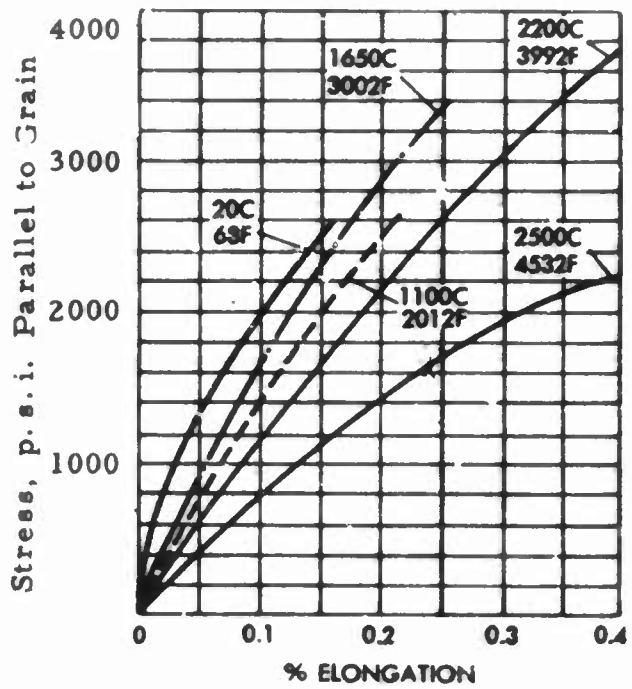


Electrical Resistivity - Grade 9134

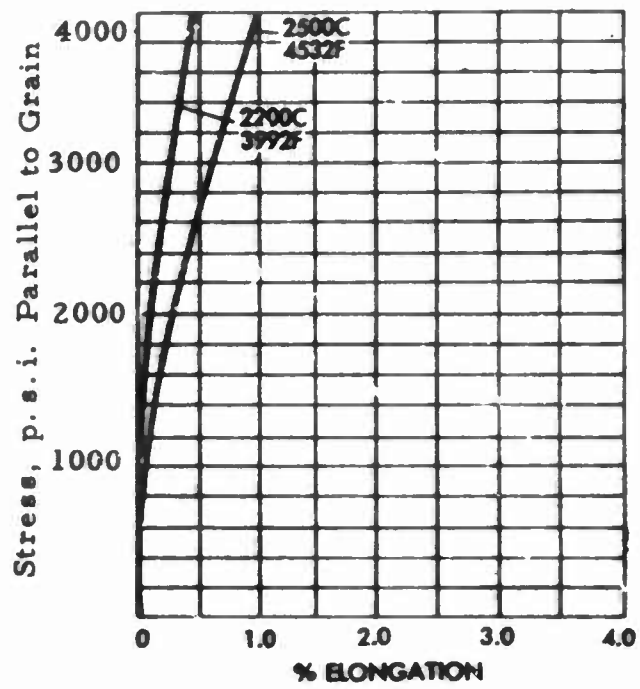


Thermal Conductivity - Grade 9134

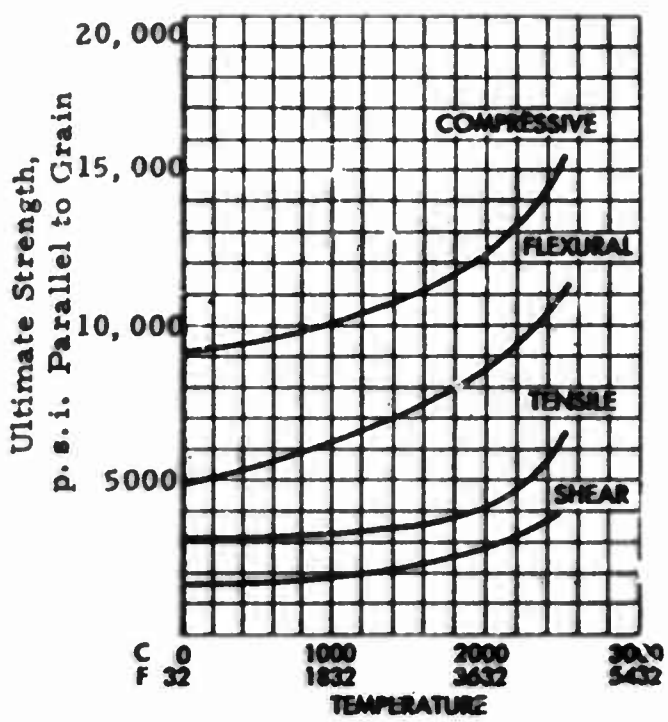
FIGURE 8 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 43
(Furnished by Speer Carbon)



Tensile Stress-Strain Curves
at Various Temperatures
Grade 9134



Tensile Stress-Strain Curves
at Various Temperatures
Grade 9134



Ultimate Strength-Grade 9134

FIGURE 9 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 43
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 44

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; long experience; high production; used for mold stock, rocket nozzle inserts, sintering boats, continuous casting dies, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.03%

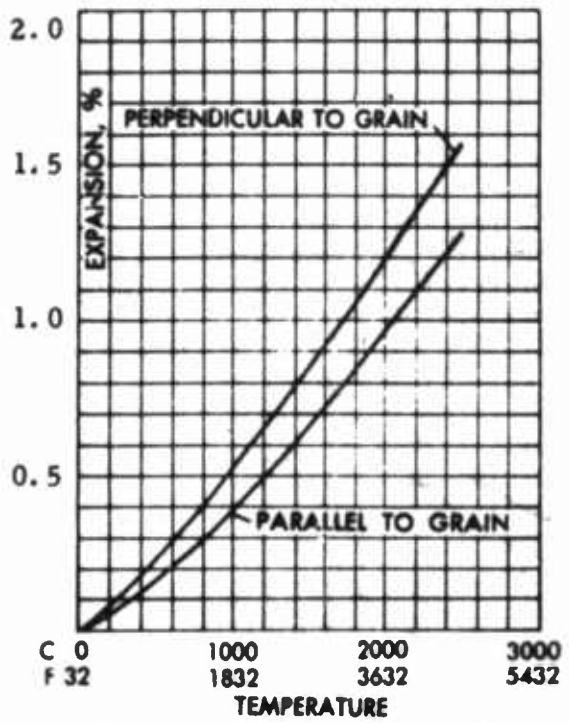
PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)			1.3, 1.3, -			
T. Str. (10^3psi)	(2)	2.0, 2.4, 2.0		1.8, 2.0, 9.6		3.2	5.0
C. Str. (10^3psi)	(3)	8.2, 9.0, 8.8		9.0, 9.7, 9.6		10.0	15.0
Flex. Str. (10^3psi)	(4)	4.0, 4.7, 4.6		3.8, 3.6, -		6.2	10.0
Density (g/cc)	(5)	1.73, 1.79, 1.79					
C. Exp. (10^{-6}/°C)	(6)	3.4		4.5			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					.25	
S. Res. (10^{-4}ohm cm)	(8)	9.9, 8.9, 8.6				7.6	13.5, 13.5, 13.0
Scleroscope Hardness		45					
Permeability (cm^2/sec^{-1})		0.42		0.48			

Supplier's Availability

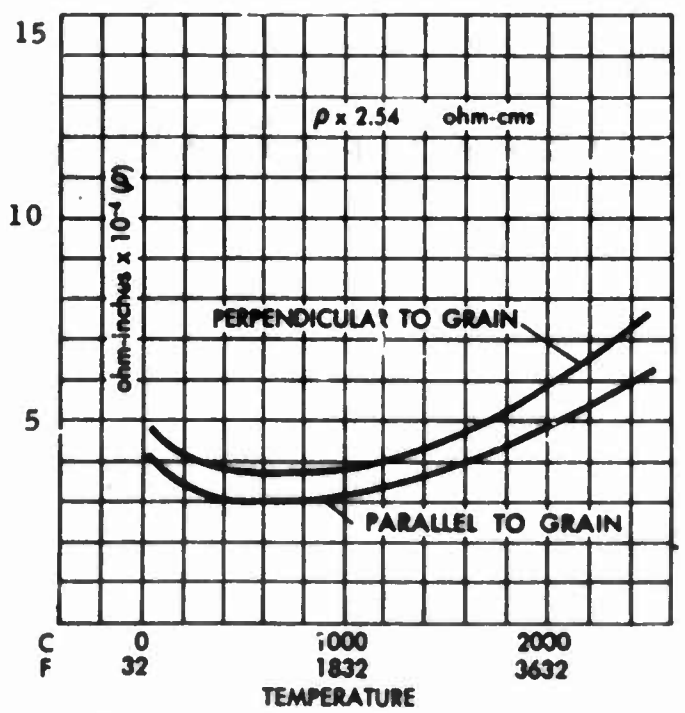
SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	8882	cyl 10-13"-	$1-10/lb	100-3 M T/yr	0-3 mo
Speer Carbon	8882	cyl 2-5/8-8" dia	$1-10/lb	100-3 M T/yr	0-3 mo
Speer Carbon	8826	blk 12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	0-3 mo

* First number refers to first product

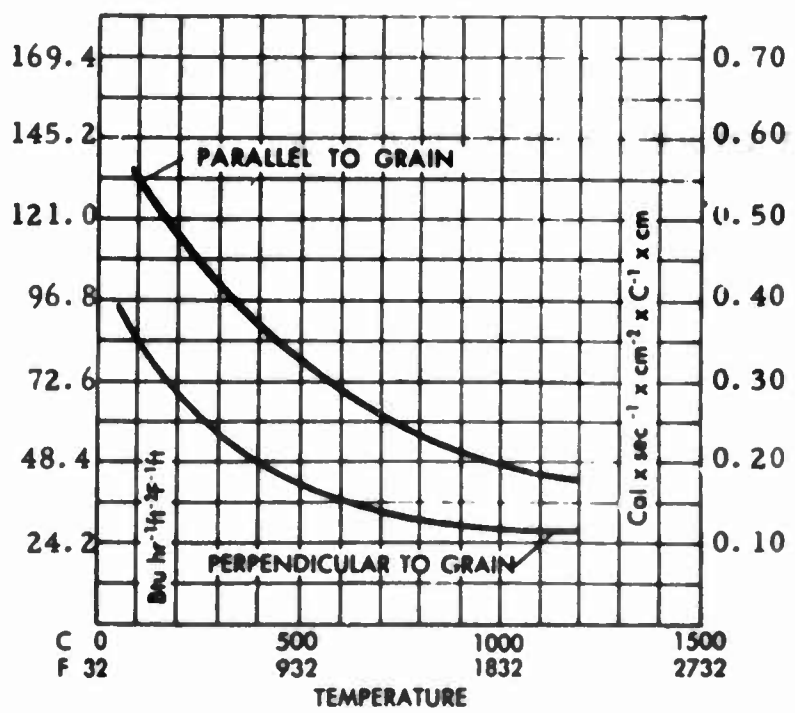
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps



Thermal Expansion vs. Temperature - Grade 8882

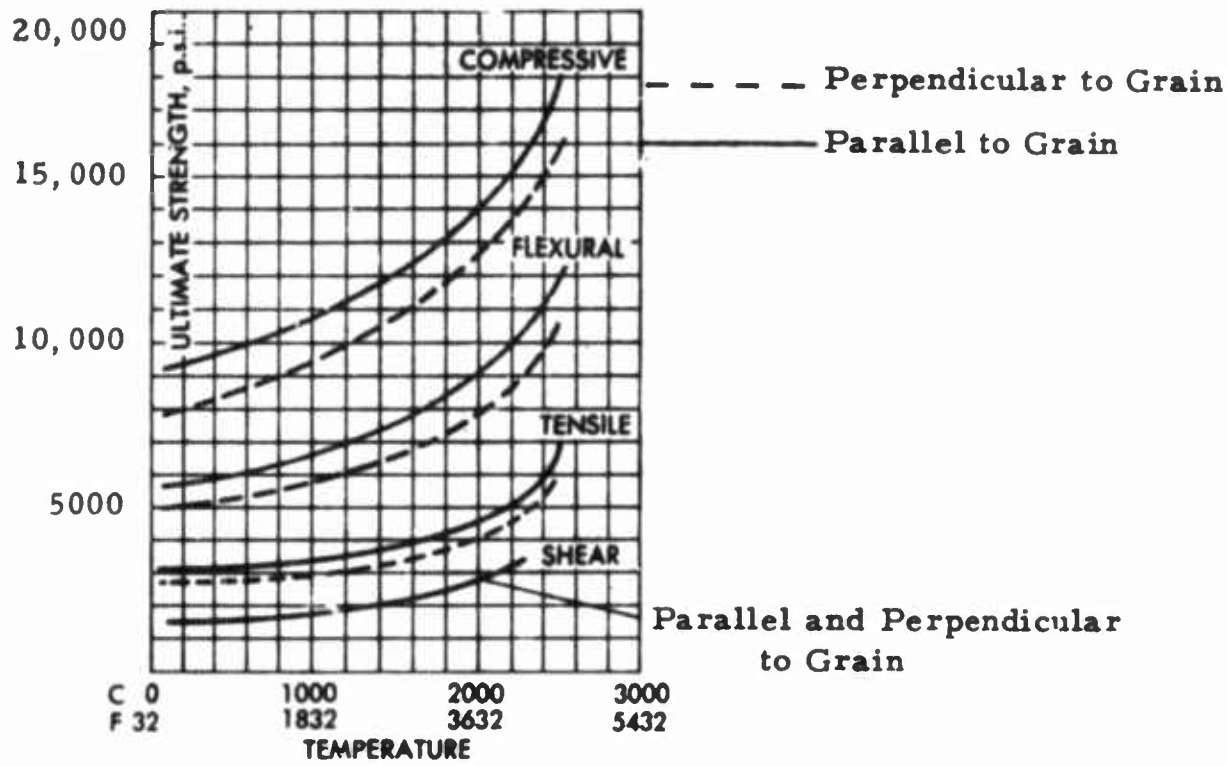


Electrical Resistivity - Grade 8882



Thermal Conductivity - Grade 8882

FIGURE 10 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 44
(Furnished by Speer Carbon)



Ultimate Strength-Grade 8882

FIGURE 11 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 44
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 45

Characterization

TYPE: molded, fine grained; high strength; high density; used for EDM electrodes, molds, jigs, fixtures, sintering boats, heater elements, crucibles, rocket nozzle inserts, continuous casting dies, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	6.5					
Density (g/cc)	(2)	1.92					
C. Exp. (10^{-6}/°C)	(3)	5.3		6.3			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	12.4					
Scleroscope Hardness		75					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9326	blk 4" x 12" x 2" 4" x 10" x 4"	$1-10/lb	10-100 T/yr	0-6 mo

(1) 4 Point loading
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 46

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; low friction; low porosity; chemical resistant; abrasion resistant; long experience; used for mechanical applications such as seals, bearings, end plates, and valves

MFG: artificial graphite and coal tar pitch; processed under 2500C; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	4.0					
C. Str. (10^3psi)	(2)	20.0					
Flex. Str. (10^3psi)	(3)	6.8					
Density (g/cc)	(4)	1.8					
C. Exp. (10^{-6}/°C)	(5)	2.6					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							
Scleroscope Hardness		65					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9372	blk 12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	0-3 mo

(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C

GRAPHITE PRODUCT NO. 47

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; abrasion resistant; long experience; high hardness; used for jigs and fixtures, sintering boats, blades, pistons, support material in furnace brazing & heat treating

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2					
T. Str. (10^3psi)	(2)	2.5					
C. Str. (10^3psi)	(3)	10.0		12.0			
Flex. Str. (10^3psi)	(4)	5.0		4.6			
Density (g/cc)	(5)	1.67					
C. Exp. (10^{-6}/°C)	(6)	5.6		5.5			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	30.5					
Scleroscope Hardness		71					
Rockwell Hardness (M)		77					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9420	blk 10" x 4" x 3"	$1-10/lb	100-3 M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 48

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; long experience; used for jigs and fixtures, sintering boats, support material in furnace brazing & heat treating; used as a substrate grade

MFG: lamp black; graphitized over 2500C; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.12%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.1					
T. Str. (10^3psi)	(2)	2.3					
C. Str. (10^3psi)	(3)	10.2		10.5			
Flex. Str. (10^3psi)	(4)	4.5		4.2			
Density (g/cc)	(5)	1.58					
C. Exp. (10^{-6}/°C)	(6)	5.7		5.6			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	35.6					
Scleroscope Hardness (A)		60					
Rockwell Hardness (L)		85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9429	blk 12"x6"x2-1/4"	$1-10/lb	100-300 T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 49

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; low friction; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.4, 2.7					
Density (g/cc)	(2)	1.64, 1.56					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	45.7, 61.0					
Scleroscope Hardness		61, 55					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	9457	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E57	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

* First number refers to first product

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 50

Characterization

TYPE: molded, fine grained; high reproducibility; long experience; used for brushes

MFG: calcined petroleum coke; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.05%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.5	1				
Density (g/cc)	(2)	1.70	.02				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	8.4	1				
Scleroscope Hardness		35.5	5				
Rockwell Hardness (R)		73					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-3	blk< 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 51

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: calcined petroleum coke; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.8	2				
Density (g/cc)	(2)	1.60	1				
C. Exp. (10^{-6}/°C)	(3)	4.4		5.4			
Therm. Cond. (cal-cm/sec cm^2 K)							
S. Res. (10^{-4}ohm cm)	(4)	17.9	6				
Scleroscope Hardness		37					
Rockwell Hardness		85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-22	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 52

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	4.6,3.5,3.8,4.0	12				
Density (g/cc)	(2)	1.65,1.52,1.58,1.66	2				
C. Exp. (10^{-6}/°C)	(3)	6.1,6.0,5.7,6.0		6.0,6.2,5.7,6.1			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	37.3,69.1,59.1,67.0	6				
Scleroscope Hardness		69, 94, 80, 83	6				

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-23	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-43	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-27	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-24	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

* First number refers to first product

GRAPHITE PRODUCT NO. 53

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1330F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	5.1, 5.2, 5.9	11				
Density (g/cc)	(2)	1.68, 1.73, 1.74	2				
C. Exp. (10^{-6}/°C)	(3)	5.5, 6.0		6.0, 6.1			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	31.5, 49.3, 40.4	7				
Scleroscope Hardness		69, 84, 85	4				
Rockwell Hardness (L)		100, 115, 100					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-25	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-38	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-44	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

* First number refers to first product

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 54

Characterization

TYPE: molded, fine grained; high electrical resistance; long experience; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	4.4	22				
Density (g/cc)	(2)	1.59	2				
C. Exp. (10^{-6}/°C)	(3)	6.0		6.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	48.8	7				
Rockwell Hardness		107	5				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-37	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 55

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	5.0					
Density (g/cc)	(2)	1.80					
C. Exp. (10^{-6}/°C)	(3)	6.0		6.1			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	40.6					
Scleroscope Hardness		75					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-46	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 56

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.12%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	1.9					
Density (g/cc)	(2)	1.48					
C. Exp. (10^{-6}/°C)	(3)	6.2		6.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	66.0					
Scleroscope Hardness		44					
Rockwell Hardness		35					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-48	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 57

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; long experience; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL: Ash
Av. value 0.1%

PROPERTIES:	Test Specimen or Method	With Grain Av. Value*	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.2, 3.1, 2.7	2				
Density (g/cc)	(2)	1.64, 1.56, 1.54	2				
C. Exp. (10^{-6}/°C)	(3)	5.5, 5.9, 5.9		6.0			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	53.1, 59.2, 60.2	9				
Scleroscope Hardness		63, 61, 63					
Rockwell Hardness (L)		86, 82, 85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-50	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-45	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	E-41	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

*First number refers to first product

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 58

Characterization

TYPE: molded, fine grained; high electrical resistance; high reproducibility; used for brushes

MFG: lamp black; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.0					
Density (g/cc)	(2)	1.54					
C. Exp. (10^{-6}/°C)	(3)	6.2	6.2				
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	66.0					
Scleroscope Hardness		60					
Rockwell Hardness (L)		85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	E-51	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 59

Characterization

TYPE: molded, fine grained; high reproducibility; low friction; abrasion resistant; long experience; low hardness; used for sintering boats, heater elements, and mechanical applications such as seals, bearings, brushes, etc.

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

	Ash
Av. value	0.07%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2					
T. Str. (10^3psi)	(2)	1.6					
C. Str. (10^3psi)	(3)	6.3		7.0			
Flex. Str. (10^3psi)	(4)	3.5		3.1			
Density (g/cc)	(5)	1.66					
C. Exp. (10^{-6}/°C)	(6)	3.1		4.2			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	11.2					
Scleroscope Hardness		40					
Rockwell Hardness (R)		80					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	EH	blk 12"x12"x2-1/2"	$1-10/lb	100-3 M T/yr	

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 60

Characterization

TYPE: molded, fine grained; high strength; high electrical resistance; high reproducibility; long experience; used for brushes, sintering boats, high temperature steam turbine seals, blades, and pistons

MFG: calcined petroleum coke and coal tar pitch; processed under 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.25%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7					
T. Str. (10^3psi)	(2)	2.1					
C. Str. (10^3psi)	(3)	10.5		11.0			
Flex. Str. (10^3psi)	(4)	4.6		4.0			
Density (g/cc)	(5)	1.66					
C. Exp. (10^{-6}/°C)	(6)	3.7		4.9			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	25.4					
Scleroscope Hardness		52					
Rockwell Hardness (M)		50					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	H	blk 12"x12"x2-1/2"	$1-10/lb	100-3M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 61

Characterization

TYPE: molded, fine grained; good electrical conductor; high reproducibility; used for electric discharge machine

MFG: calcined petroleum coke; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.0, -					
T. Str. (10^3psi)	(2)	2.0, 1.9					
C. Str. (10^3psi)	(3)	9.6, 6.4		8.8, 6.8			
Flex. Str. (10^3psi)	(4)	4.6, 3.7					
Density (g/cc)	(5)	1.79, 1.65					
C. Exp. (10^{-6}/°C)	(6)	3.4, 3.3		4.5, 4.4			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	8.6, 8.6					
Scleroscope Hardness		45, 36					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	KK-10	blk 12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	1 mo
Speer Carbon	KK-8	blk 12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	0 mo

* First number refers to first product

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) Single point
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 62

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; high density; low porosity; low cost; used for electric discharge machine

MFG: calcined petroleum coke; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	7.0					
Density (g/cc)	(2)	1.91					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	8.6					
Scleroscope Hardness		50					
Rockwell Hardness (L)		95					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	KK-12	blk 12"x12"x2-1/2"	$1-10/lb	10-100 T/yr	0 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 63

Characterization

TYPE: molded, fine grained; high reproducibility; long experience; high production; used for jigs and fixtures, bearings, brushes, and sintering boats

MFG: calcined petroleum coke and petroleum pitch; graphitized over 2500C; machining and grinding; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	.05%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	3.3					
Density (g/cc)	NEMA	1.60					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	0.4					
Scleroscope Hardness		35					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Stackpole Carbon	L1	cyl 1/8-3" blk 1-3" rod 10 mil-18" plt 1/4-1" plt <1/16" pipe < 1/2" pipe 1/2-3"	$1-10/lb	10-100 T/yr		
Ohio Carbon	2BE[1]	cyl 1/8-45" blk 1-6" plt <1/16-1" pipe < 1/2-10"	$1-10/lb	10 T/yr	10-100 T/yr	1 mo

1 Ash - .1-.5%
Hardness - 45S

GRAPHITE PRODUCT NO. 64

Characterization

TYPE: molded, fine grained; long experience; high production; high reproducibility; used for jigs and fixtures, support material in furnace brazing & heat treating, sintering boats, and heater elements

MFG: lamp black and coal tar pitch; graphitized over 2500C; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.07%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3		1.1			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	14		15			
Flex. Str. (10^3psi)	(3)	6		5			
Density (g/cc)	(4)	1.65		1.65			
C. Exp. (10^{-6}/°C)	(5)	6.1					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(6)	32					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	L 31	blk 12" x 12" x 12" max	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 65

Characterization

TYPE: molded, fine grained; high reproducibility; long experience; high production; used for mechanical and high temperature application, rocket nozzle inserts, continuous casting dies, sintering boats, heater elements, crucibles, and EDM electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; finishing as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.08%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7		1.2			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	16		12			
Flex. Str. (10^3psi)	(3)	5.7		5.4			
Density (g/cc)	(4)	1.74		1.74			
C. Exp. (10^6/°C)	(5)	3.2		4.9			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)	(6)	2.0					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	331	blk 12" x 12" x 3"	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 66

Characterization

TYPE: molded, fine grained; high reproducibility; used for mechanical applications, continuous casting dies, sintering boats, heater elements, and EDM electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.15%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.1		1.2			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	19		17.5			
Flex. Str. (10^3psi)	(3)	7.3		5.8			
Density (g/cc)	(4)	1.82		1.82			
C. Exp. (10^{-6}/°C)	(5)	4.1		7.2			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	2.1					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	2000	blk 12"x12"x1-1/4"	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 67

Characterization

TYPE: molded, fine grained; high reproducibility; large sizes; used for mechanical applications, rocket nozzle inserts, continuous casting dies, rupture discs, sintering boats, heater elements, also used for high temperature applications, EDM electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding as required; 1002-000 lb batch size

ANALYTICAL:	Ash
Av. value	.15%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3		1.4			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	12.5		12.0			
Flex. Str. (10^3psi)	(3)	4.2		4.3			
Density (g/cc)	(4)	1.72					
C. Exp. (10^{-6}/°C)	(5)	4.3		3.4			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(6)	21					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	2020	blk 13"x13"x72"max	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 68

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; long experience; high production; used for jigs and fixtures, rocket nozzle inserts, continuous casting dies, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; over 20T batch size

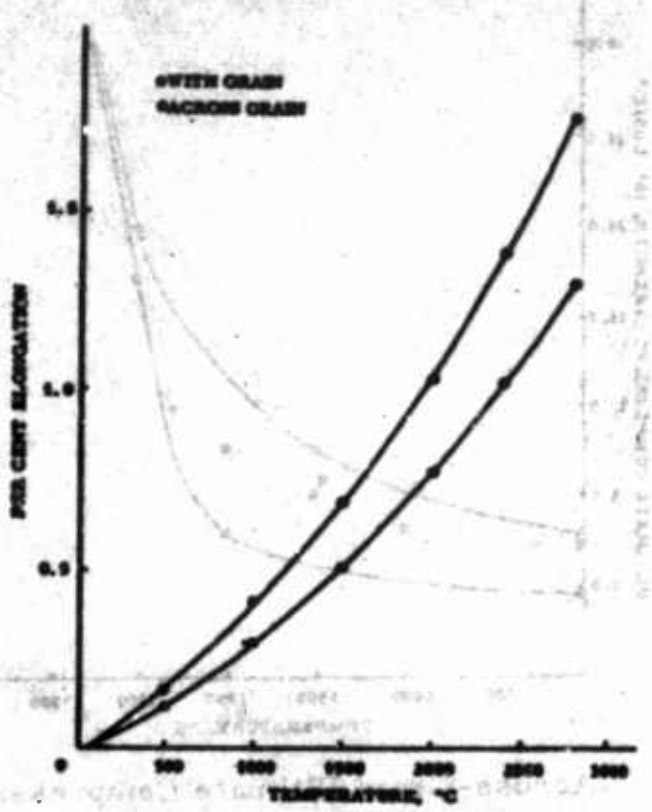
ANALYTICAL:	Ash
Av. value	0.15%
Std. dev. (%)	2.5

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	11	1.0	8		
T. Str. (10^3psi)	(2)	3.4	11	2.9	10		
C. Str. (10^3psi)	(3)	8.3	12	8.6	13		
Flex. Str. (10^3psi)	(4)	4.0	19	8.5	13		
Density (g/cc)	(5)	1.7	2				
C. Exp. (10^{-6}/°C)	(6)	2.2	10	3.4	6		
Therm. Cond. (cal-cm/sec cm²°K)		0.28		0.21			
S. Res. (10^{-4}ohm cm)	(7)	11.0	15	14.5	10		

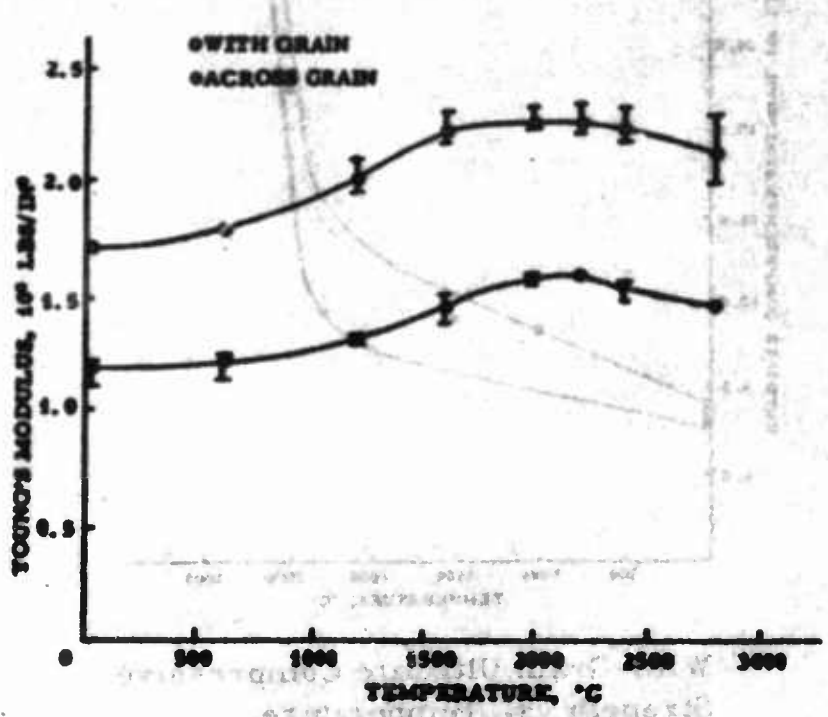
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	ATJ	cyl 13-17" blk 9" x 20" x 24"	<$1/lb	3M-30M T/yr	100-3M T/yr	1 mo

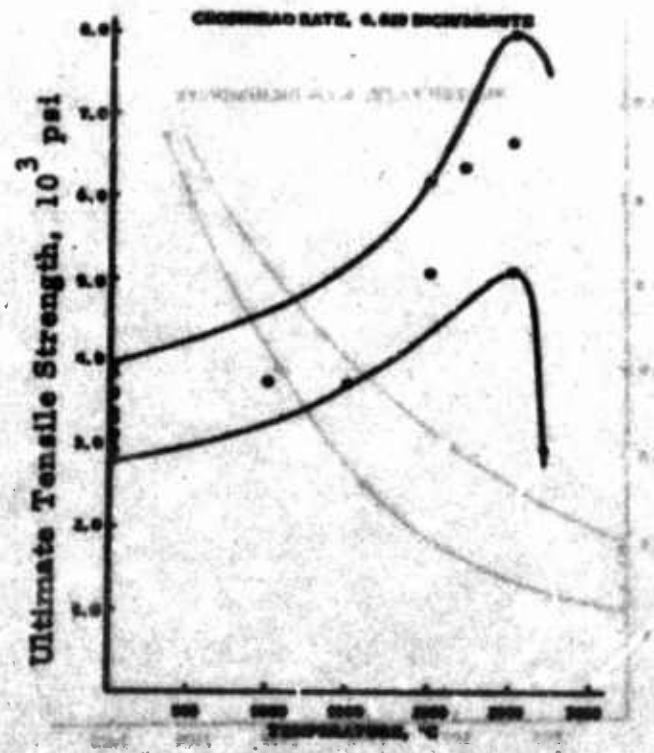
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-190-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps



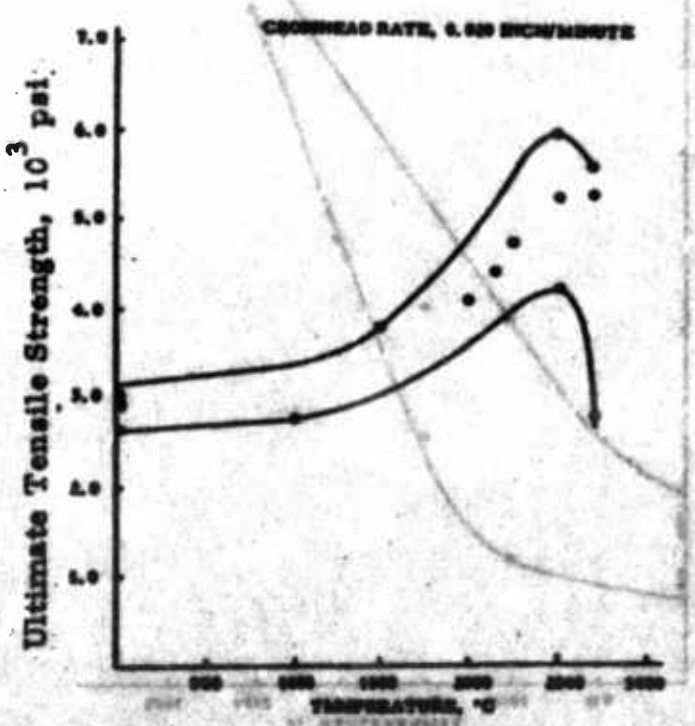
Thermal Expansion vs. Temperature, ATJ Graphite, 9" x 20" x 24"



Young's Modulus vs. Temperature, ATJ Graphite, 9" x 20" x 24"

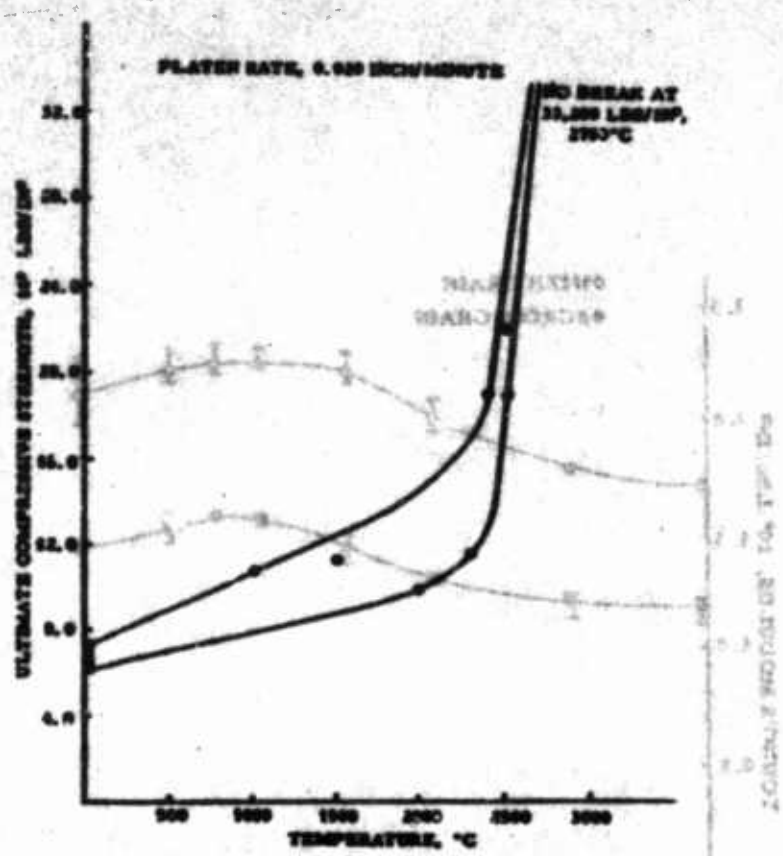


With-Grain Ultimate Tensile Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"

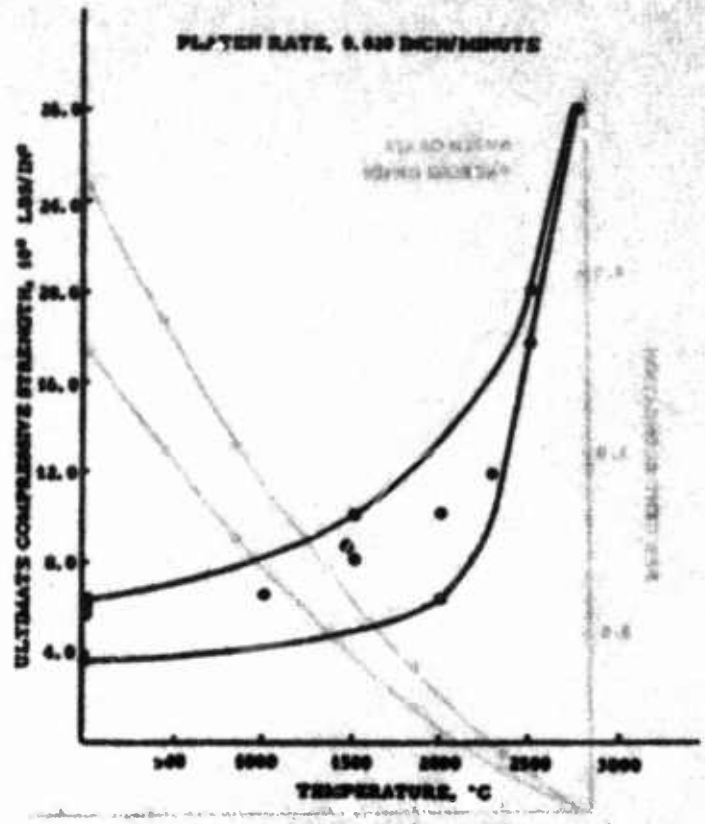


Across-Grain Ultimate Tensile Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"

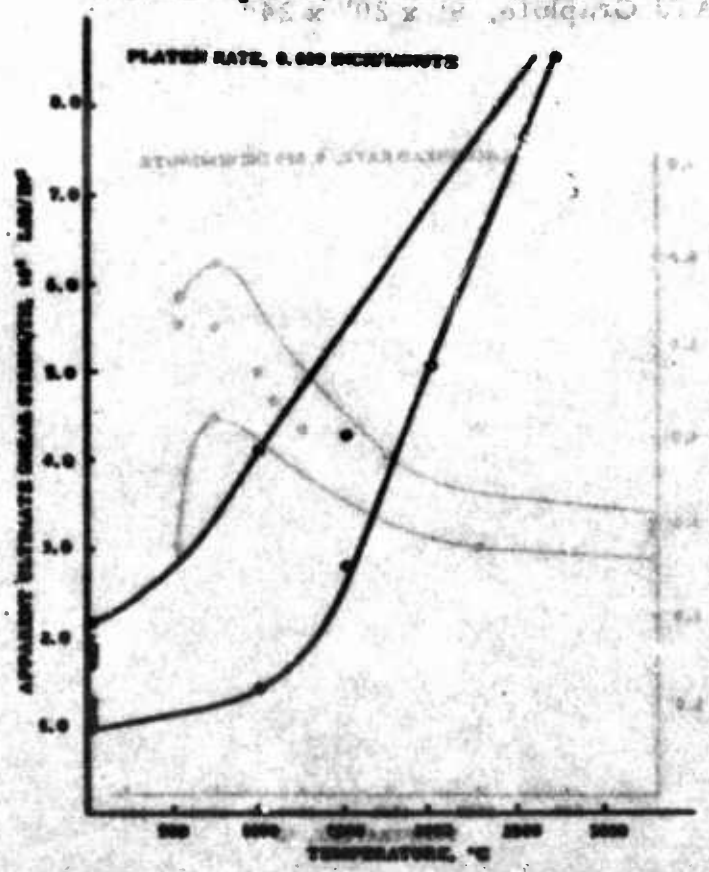
FIGURE 12 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 68
(Furnished by Union Carbide)



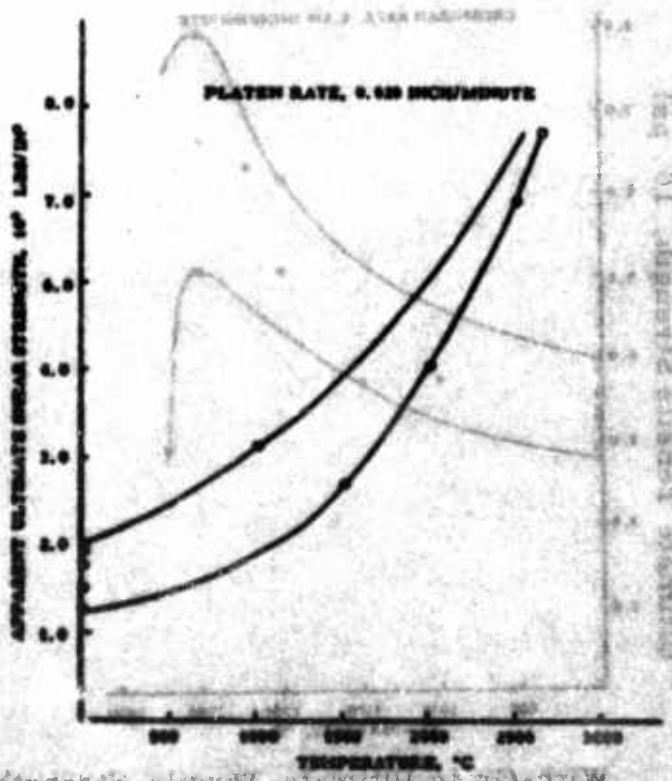
With-Grain Ultimate Compressive Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"



Across-Grain Ultimate Compressive Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"



With-Grain Apparent Ultimate Shear Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"



Across-Grain Apparent Ultimate Shear Strength vs. Temperature, ATJ Graphite, 9" x 20" x 24"

FIGURE 13 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 68
(Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 69

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; high density; low porosity; high temperature oxidation resistance; used for rocket nozzle inserts, sintering boats, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1900F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.1			
T. Str. (10^3psi)	(2)	4.4		3.3			
C. Str. (10^3psi)	(3)	11.7		12.8			
Flex. Str. (10^3psi)	(4)	5.7		4.3			
Density (g/cc)	(5)	1.83					
C. Exp. (10^{-6}/°C)	(6)	1.8		3.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	8.0		11.5			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	ATJS	cyl 13-17" blk 9" x 20" x 24"	$1-10/lb	< 10 T/yr	100-3M T/yr	3 mo

(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 70

Characterization

TYPE: molded, fine grained; high strength; high purity; long experience

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; electric resistance furnace; impregnated in secondary processing; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 15 ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.4		1.2			
T. Str. (10^3psi)		3.5		2.9			
C. Str. (10^3psi)		8.2		8.5			
Flex. Str. (10^3psi)		4.0		3.6			
Density (g/cc)		1.73					
C. Exp. (10^{-6}/°C)		2.2		3.4			
Therm. Cond. (cal-cm/sec cm^2°K)		0.28		0.21			
S. Res. (10^{-4}ohm cm)		11.0		1.4			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CCT	as finished machined parts - max size 6-1/2" dia x 24" lg	$1-10/lb	< 10 T/yr	2-5 mo

GRAPHITE PRODUCT NO. 71

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; high density; low porosity; used for electrolytic anodes, rocket nozzle inserts, continuous casting dies, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.15%
Std. dev.(%)	2.5

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.6		1.4			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	11		10.5			
Flex. Str. (10^3psi)	(3)	4.4		4.1			
Density (g/cc)	(4)	1.80					
C. Exp. (10^{-6}/°C)	(5)	2.2		3.4			
Therm. Cond. (cal-cm/sec cm^2°K)	(6)	.28		.21			
S. Res. (10^{-4}ohm cm)	(7)	11.0		14.5			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	CGW	cyl 14-17" blk 9" x 20" x 24"	$1-10/lb	10-100 T/yr	100-3M T/yr	1 mo

(1) Sonic
(2) ASTM-C-109-54T
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) cyl 1/2-1" dia x 6" lg
(7) Volt/amps

GRAPHITE PRODUCT NO. 72

Characterization

TYPE: molded, fine grained; high strength; abrasion resistant; used for seals and bearings

MFG: lamp black and natural graphite; processed below 2500C in a fuel fired furnace; impregnated in secondary processing; machined and ground; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		3.5	<10	3.5	< 10		
T. Str. (10^3psi)		7.5	7.5	7.5	7.5		
C. Str. (10^3psi)		30	7.5	30	7.5	Maximum	
Flex. Str. (10^3psi)		7.5	7.5	7.5	7.5	Useful	
Density (g/cc)		1.72	<1			Temperature	
C. Exp. (10^{-6}/°C)		< 2	15	6	15	1000°F	
Therm. Cond. (cal-cm/sec cm^2°K)		<.1		.3			
S. Res. (10^{-4}ohm cm)							
Hardness (Rockwell E)		109					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CDJ-83	cyl 1/8-20"	$1-10/lb (determined by size and configuration)	100-3M T/yr	2 mo
	CCP-72*	cyl 1/8-12"	$1-10/lb (determined by size and configuration)	100-3M T/yr	2 mo

* Hardness - 85E
Max Useful Temperature - 500°F

GRAPHITE PRODUCT NO. 73

Characterization

TYPE: molded, fine grained; high strength; low in gas evolution; used for jigs and fixtures, and in semi-conductor applications

MFG: calcined petroleum coke and lamp black; graphitized over 2500C; electric resistance furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.02%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.9					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		7.3					
Density (g/cc)		1.74					
C. Exp. (10^{-6}/°C)		4.5					
Therm. Cond. (cal-cm/sec cm²°K)		.103					
S. Res. (10^{-4}ohm cm)							
Hardness		65S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CMB	blk 6" x 4" x 2-1/2"	$1-10/lb	10-100 T/yr	6 mo

GRAPHITE PRODUCT NO. 74

Characterization

TYPE: molded, fine grained; high strength; high reproducibility; high density; large sizes; used for electrolytic anodes, rocket nozzle inserts, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; 1-20T batch size

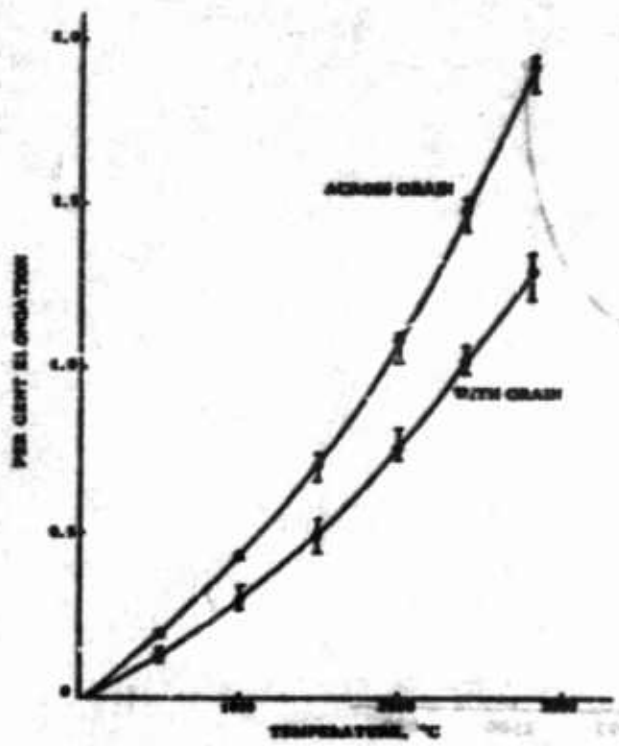
ANALYTICAL:	Ash
Av. value	0.16%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.1	3	1.1	4		
T. Str. (10^3psi)	(2)	4.1	11	2.7	8		
C. Str. (10^3psi)	(3)	11.6	9	12.3	6		
Flex. Str. (10^3psi)	(4)	4.7	8	3.1	7		
Density (g/cc)	(5)	1.87	2				
C. Exp. (10^{-6}/°C)	(6)	1.7		3.5			
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.27		0.20			
S. Res. (10^{-4}ohm cm)	(8)	12.6	3	21.6	4		

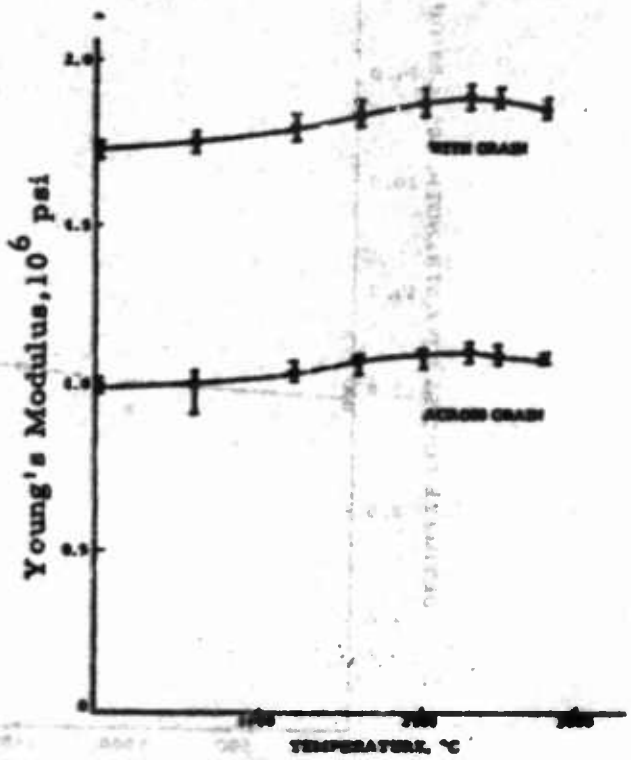
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	RVD	cyl 1/8-18"	$1-10/lb	10-100 T/yr	1 mo

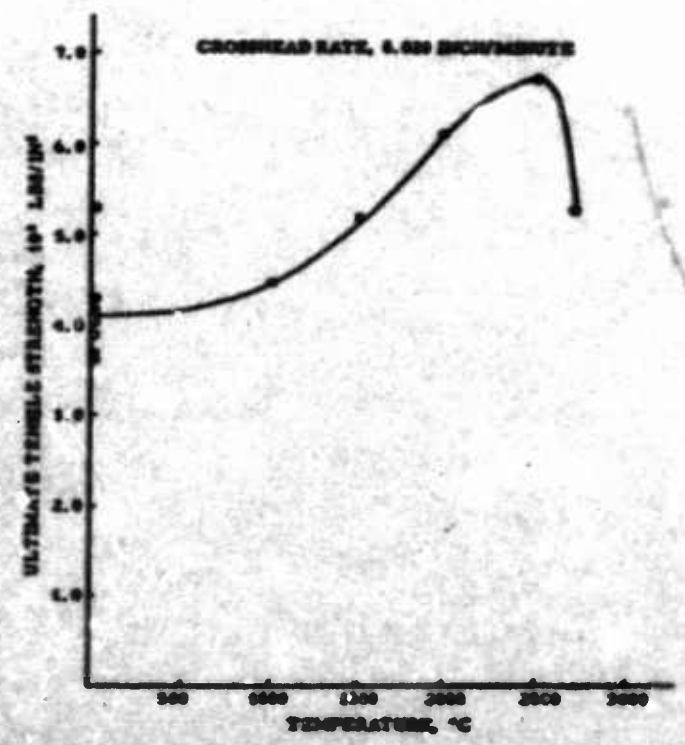
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) 1/2-1" dia x 6" lg
(8) Volt/amps



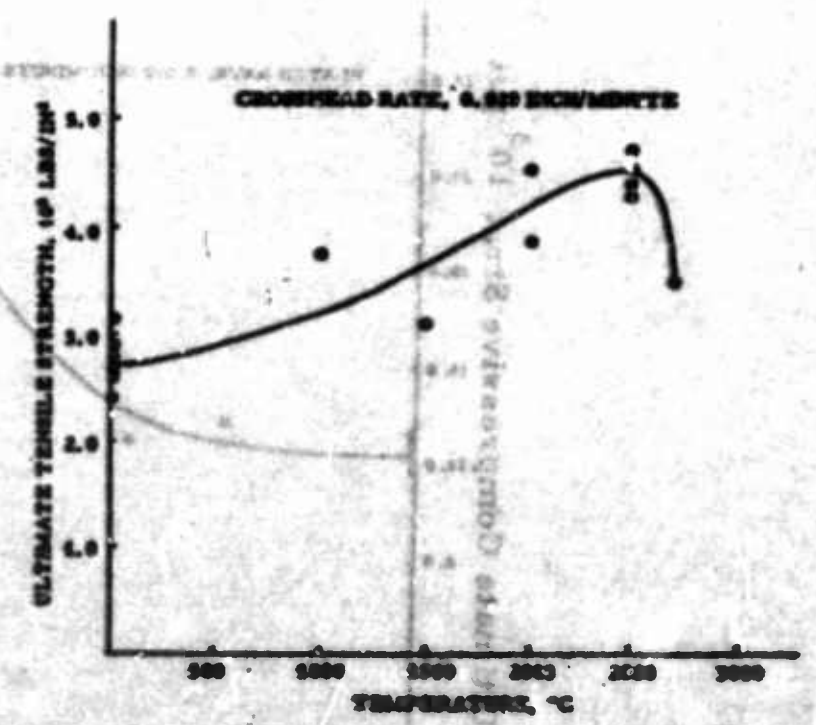
Thermal Expansion vs. Temperature, RVD Graphite, 18" dia. x 17"



Young's Modulus vs. Temperature, RVD Graphite, 18" dia. x 17", Block No. 199

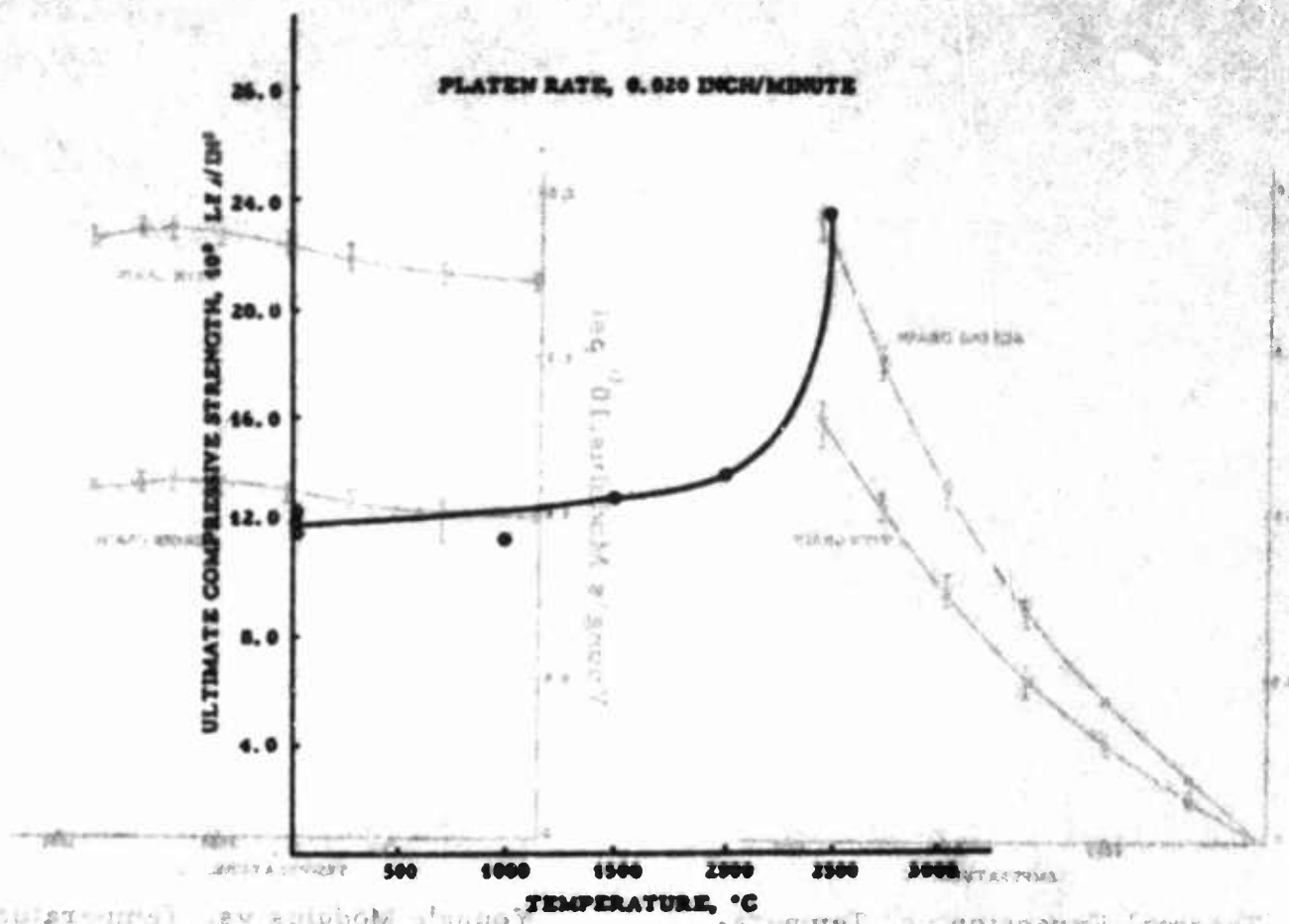


With-Grain Ultimate Tensile Strength vs. Temperature, RVD Graphite, Block No. 199, 18" dia. x 17"

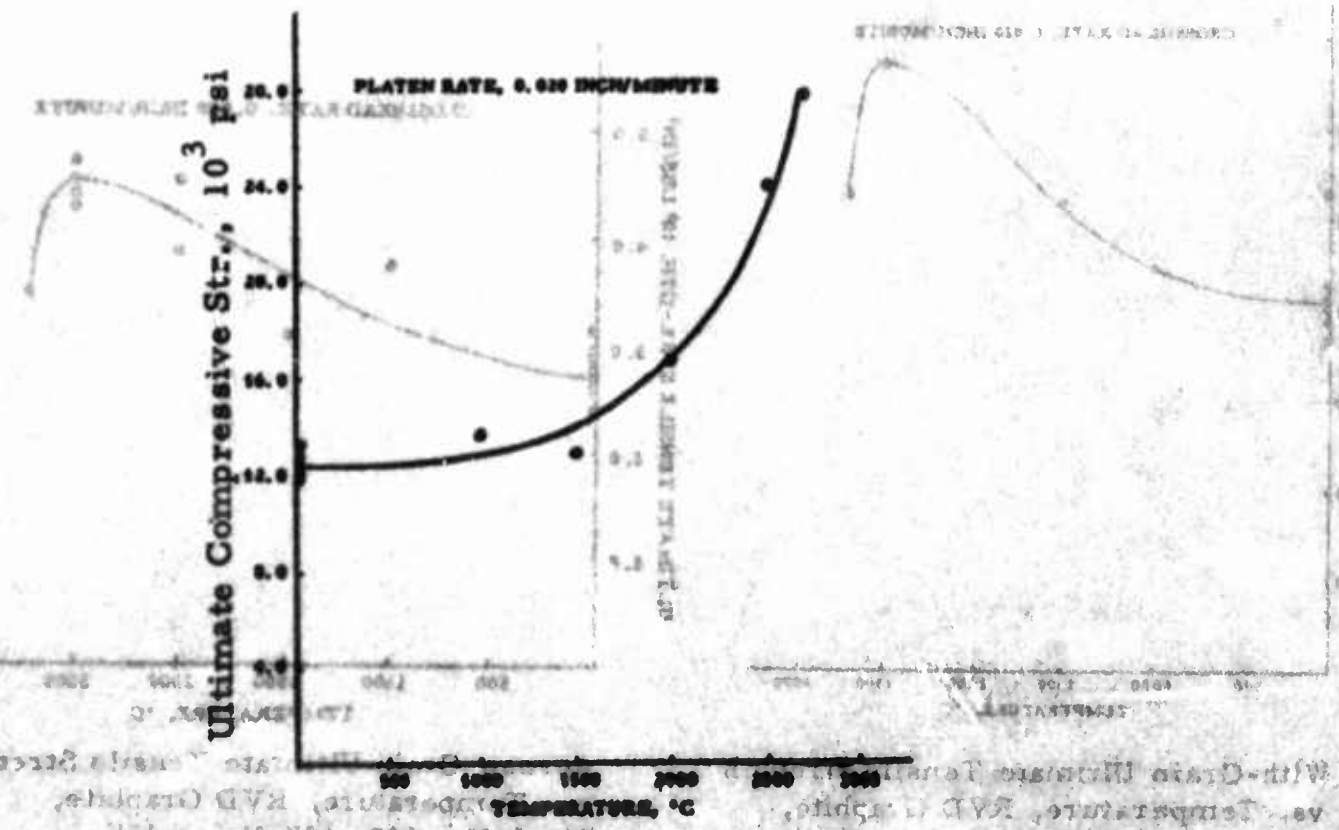


Across-Grain Ultimate Tensile Strength vs. Temperature, RVD Graphite, Block No. 199, 18" dia. x 17"

FIGURE 14 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 74
(Furnished by Union Carbide)



With-Grain Ultimate Compressive Strength vs. Temperature, RVD Graphite, Block No. 199, 18" dia. x 17"



Across-Grain Ultimate Compressive Strength vs. Temperature, RVD

FIGURE 15 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 74 (Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 75

Characterization

TYPE: molded, fine grained; carbon-graphite; for mostly mechanical applications, including seal rings and bearings; also for bushings; low coefficient of friction; will stand oxidizing atmosphere to 700F; good electrical conductor; chemical resistant

MFG: carbon and graphite powders; compacted under high pressure; furnaced at temperatures up to 4500F; machined or ground to tolerance

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		2.3					
T. Str. (10^3psi)		4.5					
C. Str. (10^3psi)		23.0					
Flex. Str. (10^3psi)		5-10					
Density (g/cc)		1.8					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		10-50					
Hardness		85S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
U. S. Graphite	2	cyl 1/8-12" blk 1-4" ring up to 13-3/4" x 10" x 1-3/4"			

GRAPHITE PRODUCT NO. 76

Characterization

TYPE: molded, fine grained; low coeff. therm. exp.; good electrical conductivity; good thermal insulator; high purity; good nuclear properties; high reproducibility; low friction; low porosity; chemical resistant; abrasion resistant; large sizes

MFG: resin; processed below 2500C; 100-2000 lb batch size

ANALYTICAL:

Carbon 99.99%

PROPERTIES:

	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)		3.5					
T. Str. (10^3psi)		---					
C. Str. (10^3psi)		100.0					
Flex. Str. (10^3psi)		10-30					
Density (g/cc)		1.3	1.5				
C. Exp. (10^{-6}/°C)		2.0				3.2	
Therm. Cond. (cal-cm/sec cm^2°K)		.02					
S. Res. (10^{-4}ohm cm)		10-50					
Permeability to He(10^{-11}cm^2/sec)		<0.25					
Hardness		820 Knoop (107 Shore)					
Specific Heat (cal/g per °c)		0.3					
Maximum Usable Temperature		3,000°C (Inert atmosphere)					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Vitreous Carbon	1	cyl 30" dia plt 18" x 24" x 1/4" molded shapes - sizes upon request	$10-100/lb	10-100 T/yr	3-6 mo

GRAPHITE PRODUCT NO. 77

Characterization

TYPE: molded, medium grained; good electrical conductivity; high reproducibility; large sizes; used for molds, jigs and fixtures

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.40%	0.10%	0.06%	0.06%	0.04%	0.02%	0.01%
Std. dev. (%)	<50	<30	<30	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	10	1.0	10		
T. Str. (10^3psi)	(2)	1.3	10	1.0	10		
C. Str. (10^3psi)	(3)	5.2	10	5.2	10		
Flex. Str. (10^3psi)	(4)	2.2	10	1.7	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	2.6	5	2.4	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.09	10	0.1	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	10	10		
Permeability (D'Arcy)		0.36	5				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	MHLM	cyl 16-56"	<$1/lb	3M-30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 78

Characterization

TYPE: molded, medium grained; good electrical conductivity; high reproducibility; used for molds, jigs and fixtures, heat exchangers, sintering boats, crucibles, and support material in furnace brazing and heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.40%	0.10%	0.06%	0.06%	0.04%	0.02%	0.01%
Std. dev. (%)	<50	<30	<30	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.5	10		
T. Str. (10^3psi)	(2)	1.8	10	1.5	10		
C. Str. (10^3psi)	(3)	6.0	10	5.8	10		
Flex. Str. (10^3psi)	(4)	3.1	10	2.4	10		
Density (g/cc)	(5)	1.83	2				
C. Exp. (10^{-6}/°C)	(6)	2.8	5	2.7	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.16	10	0.18	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	7	10		
Permeability (D'Arcy)		0.009	5	0.005	5		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	MHLM-85	cyl 16-56"	<$1/lb	3 M-30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-46T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

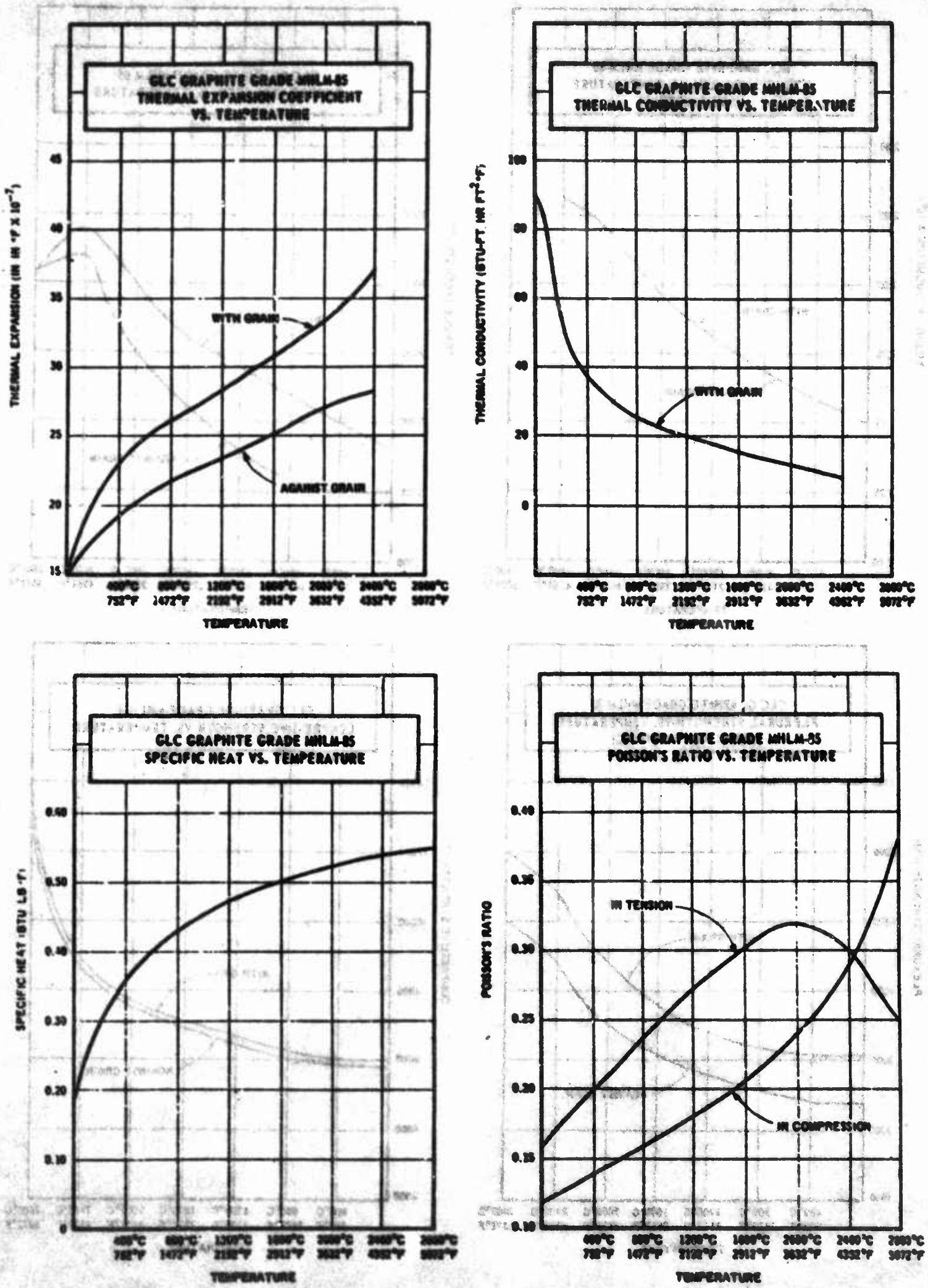


FIGURE 16 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 78
(Furnished by Great Lakes Carbon)

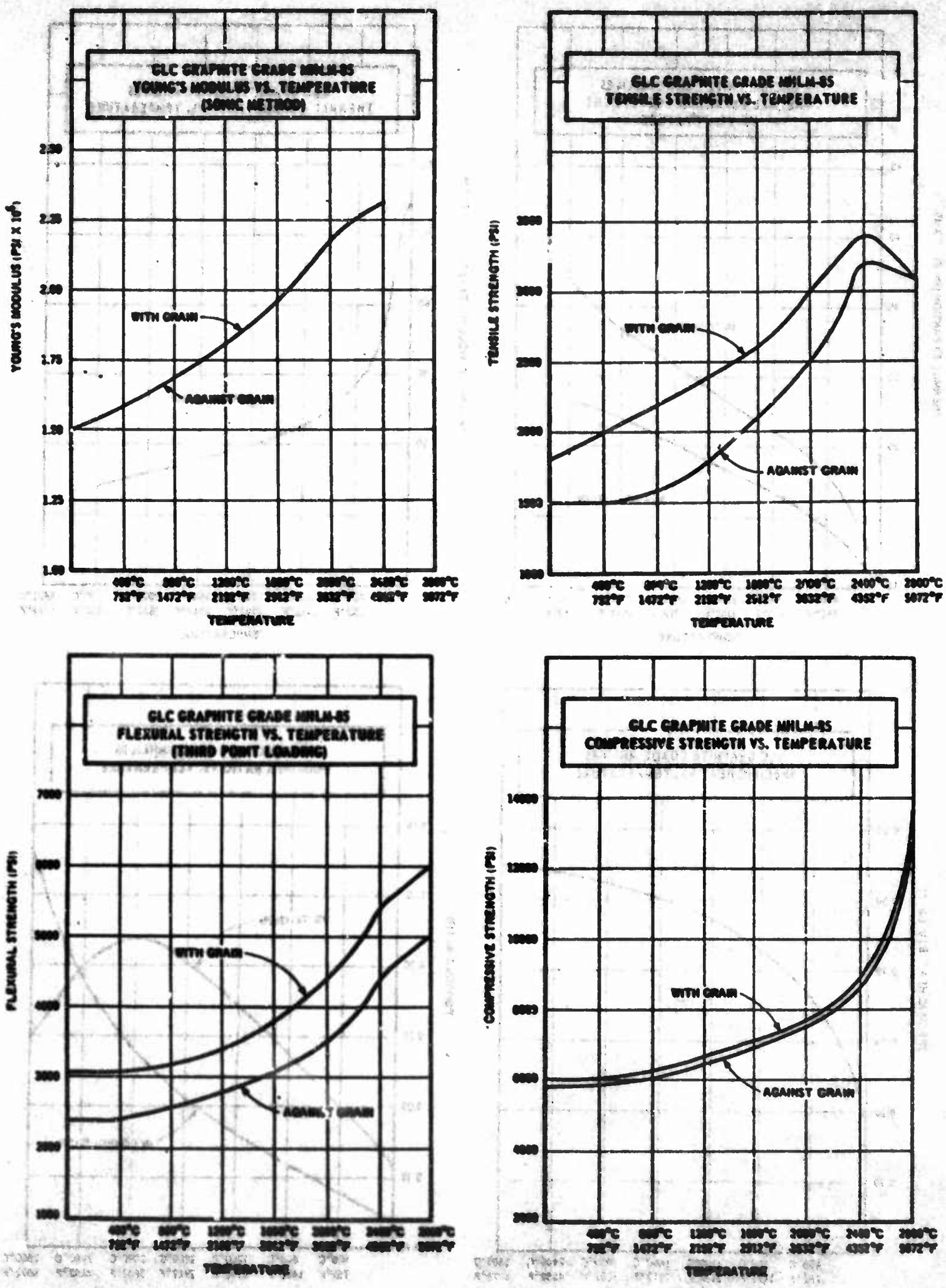


FIGURE 17 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 78
(Furnished by Great Lakes Carbon)

GRAPHITE PRODUCT NO. 79

Characterization

TYPE: molded, medium grained; long experience; large sizes; high production; used for molds, jigs and fixtures, susceptor in induction heating furnaces, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	1.0%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	1.1	23	1.1	24		
C. Str. (10^3psi)	(2)	5.1	24	5.1	25		
Flex. Str. (10^3psi)	(3)	2.2	15	2.4	19		
Density (g/cc)	(4)	1.78	1				
C. Exp. (10^{-6}/°C)	(5)	2.4	9	2.4	7		
Therm. Cond. (cal-cm/sec cm^2°K)		0.27		0.26			
S. Res. (10^{-4}ohm cm)	(6)	11.3	8	11.8	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	ATL	cyl 30-50" blk 20x47" cross sec.	<$1/lb	over 30 M T/yr	1 mo

(1) ASTM-C-190-49
(2) ASTM-C-109-54T
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 80

Characterization

TYPE: molded, medium grained; long experience; used for molds, jigs and fixtures, and sintering boats

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1500F	4000F
Y. Mod. (10^6psi)	(1)	0.69					
T. Str. (10^3psi)	(2)	.628					
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	1.3					
Density (g/cc)	(4)	1.36					
C. Exp. (10^{-6}/°C)	(5)	2.1					
Therm. Cond. (cal-cm/sec cm²°K)		0.23					
S. Res. (10^{-4}ohm cm)	(6)	13.5					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CDG	plt 12" x 12" x 1/4" to 1" thk	< $10/lb	< 10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 81

Characterization

TYPE: molded, medium grained; long experience; used for molds, jigs and fixtures, and sintering boats

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.8					
T. Str. (10^3psi)	(2)	0.8					
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	1.4					
Density (g/cc)	(4)	1.40					
C. Exp. (10^{-6}/°C)	(5)	2.1					
Therm. Cond. (cal-cm/sec cm^2°K)		2.0					
S. Res. (10^{-4}ohm cm)	(6)	15.2					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CDG	plt 15" x 18" x 1/4" to 2" thk	<$10/lb	<10 T/yr	1 mo

(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 82

Characterization

TYPE: molded, medium grained; high reproducibility; high density; low porosity; large sizes; used for rocket nozzle inserts

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; over 20T batch size

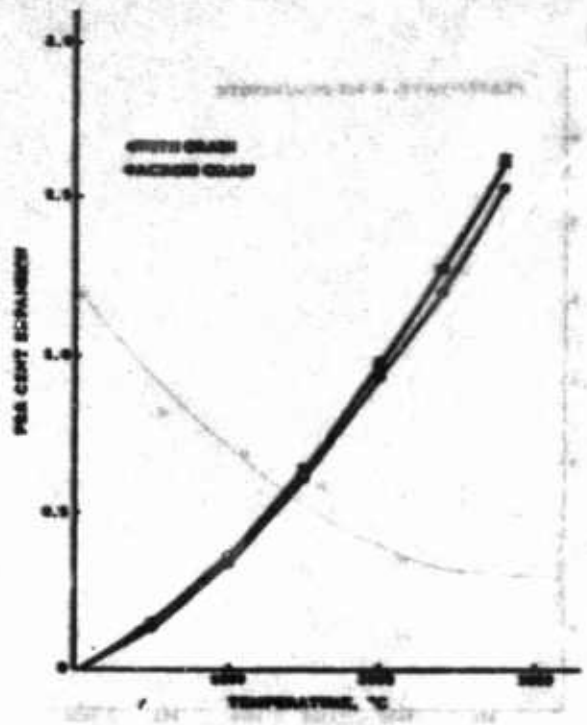
ANALYTICAL:	Ash
Av. value	0.34%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	8	1.3	7		
T. Str. (10^3psi)	(2)	1.7	10	1.6	8		
C. Str. (10^3psi)	(3)	8.2	14	8.2	13		
Flex. Str. (10^3psi)	(4)	2.3	9	2.3	9		
Density (g/cc)	(5)	1.87	2				
C. Exp. (10^{-6}/°C)	(6)	2.0	9	2.3	6		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	.36	5	.34	5		
S. Res. (10^{-4}ohm cm)	(8)	10.0	7	11.0	8		

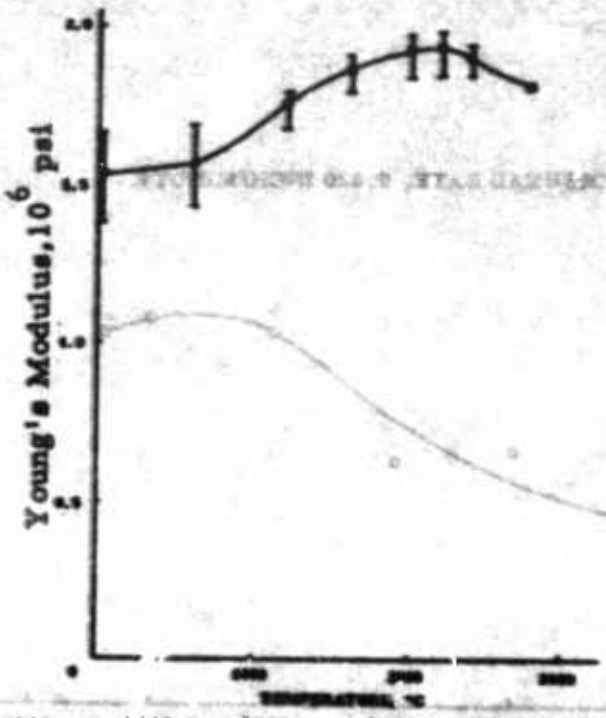
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	CFW	cyl 30-103"	$1-10/lb	100-3 M T/yr	3 M-30 M T/yr	6 mo

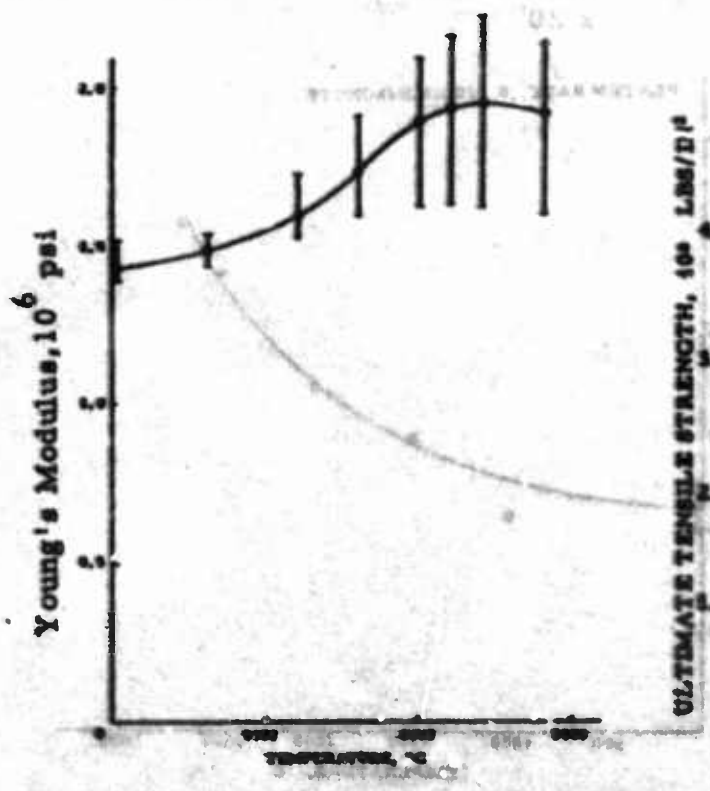
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-78-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) 1/2-1" dia x 6" lg
(8) Volt/amps



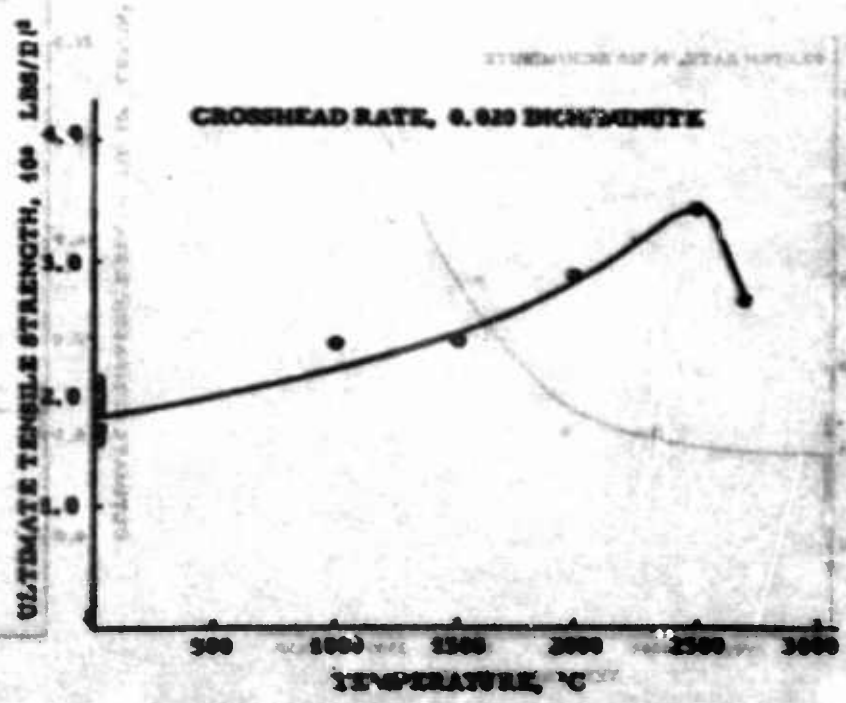
Thermal Expansion vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"



With-Grain Young's Modulus vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"

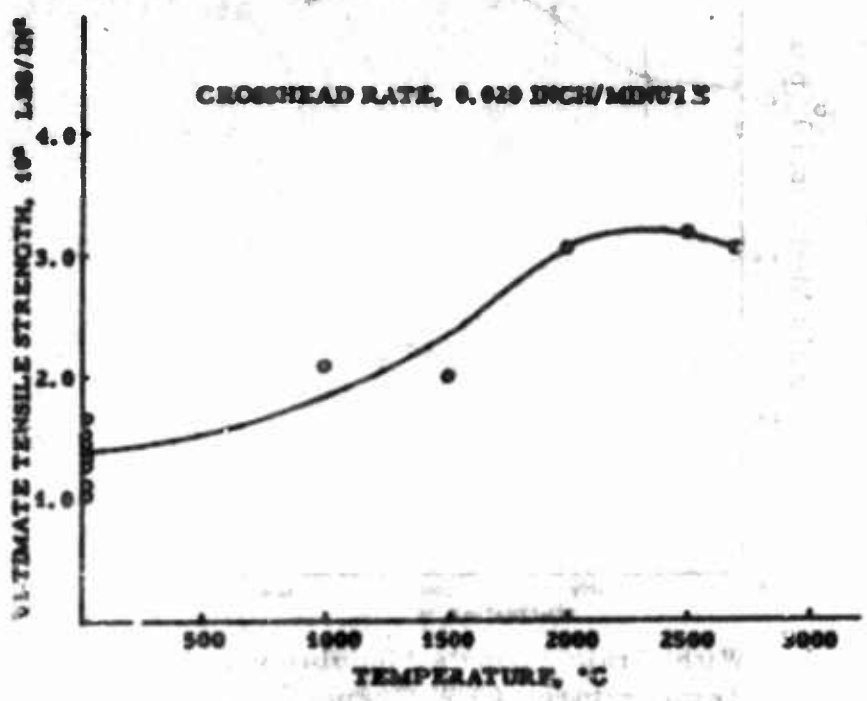


Across-Grain Young's Modulus vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"

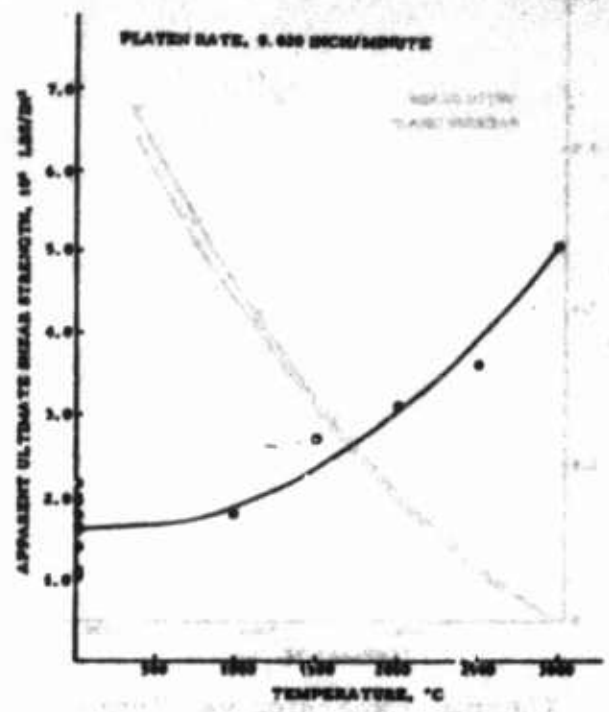


With-Grain Ultimate Tensile Strength vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"

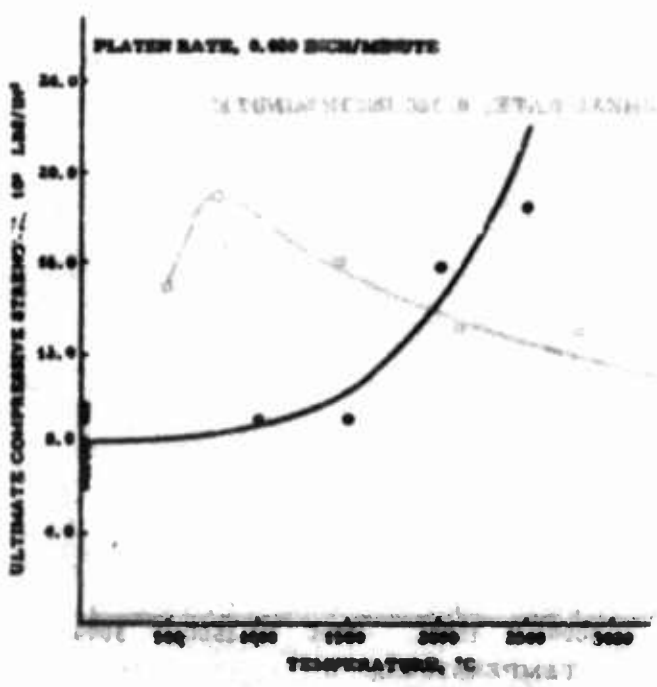
FIGURE 18 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 82
(Furnished by Union Carbide)



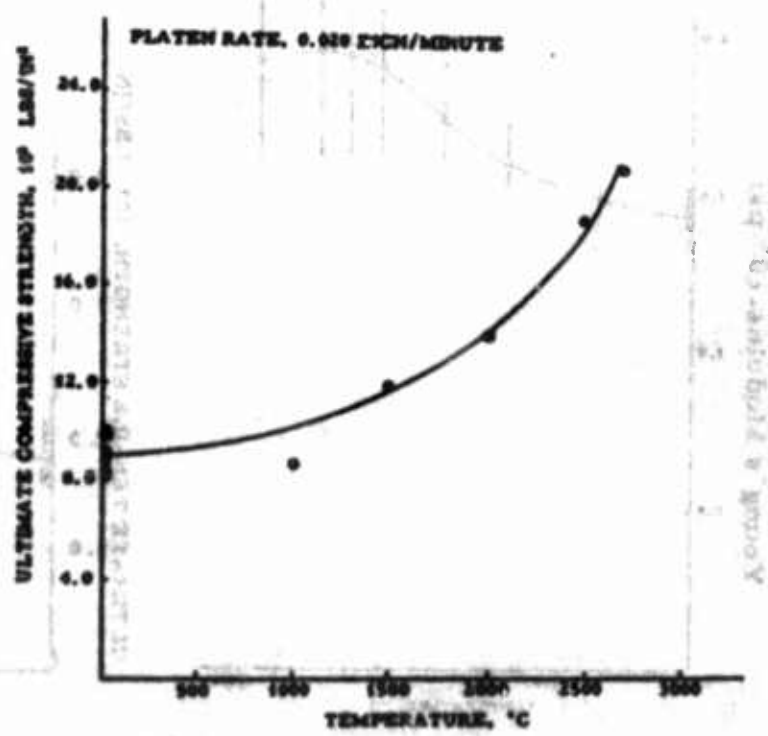
Across-Grain Ultimate Tensile Strength vs. Temperautre, CFW Graphite, 40" O. D. x 15" I. D. x 20"



With-Grain Apparent Ultimate Shear Strength vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"



Across-Grain Ultimate Compressive Strength vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"



With-Grain Ultimate Compressive Strength vs. Temperature, CFW Graphite, 40" O. D. x 15" I. D. x 20"

FIGURE 19 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 82
(Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 83

Characterization

TYPE: molded, medium grained; high strength; high reproducibility; high density; low porosity; large sizes; used for rocket nozzle inserts

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; 1-20T batch size

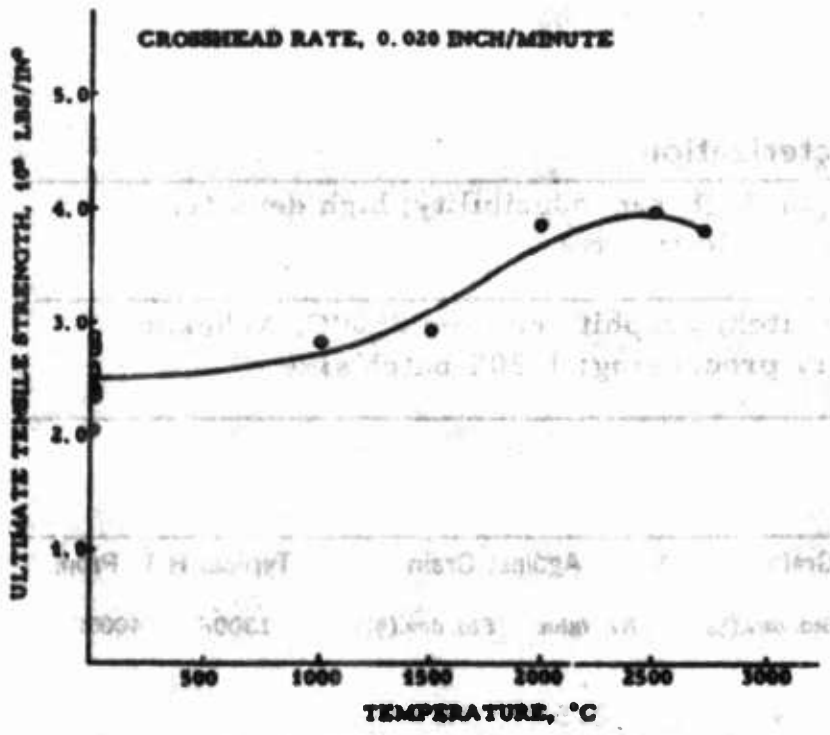
ANALYTICAL:	Ash
Av. value	0.25%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.9	4	1.5	3		
T. Str. (10^3psi)	(2)	3.0	9	2.5	10		
C. Str. (10^3psi)	(3)	10	14	12	6		
Flex. Str. (10^3psi)	(4)	4.0	9	3.4	8		
Density (g/cc)	(5)	1.91	1				
C. Exp. (10^{-6}/°C)	(6)	1.9		2.64			
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.32		0.25			
S. Res. (10^{-4}ohm cm)	(8)	12.7		16.1			

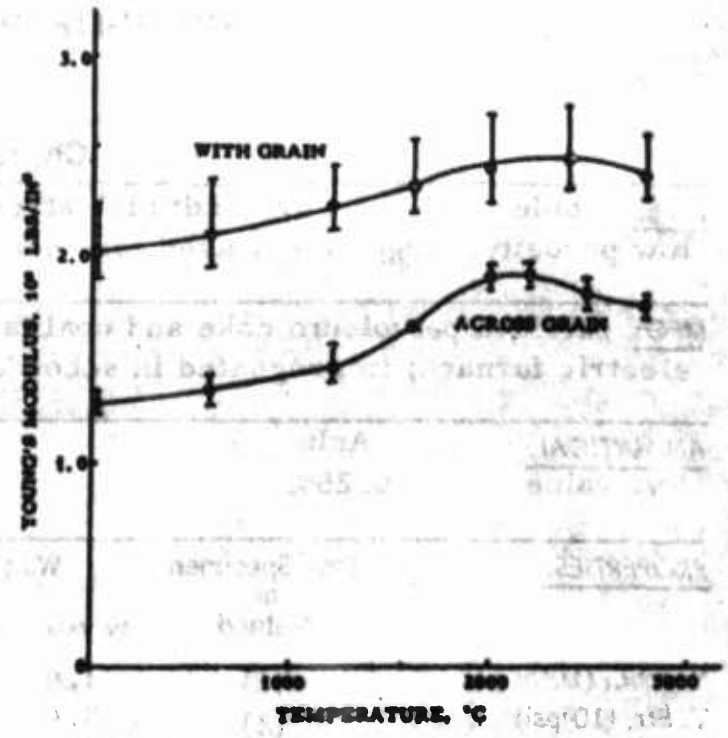
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CFZ	cyl up to 30"	$1-10/lb	100-3M T/yr	3 mo

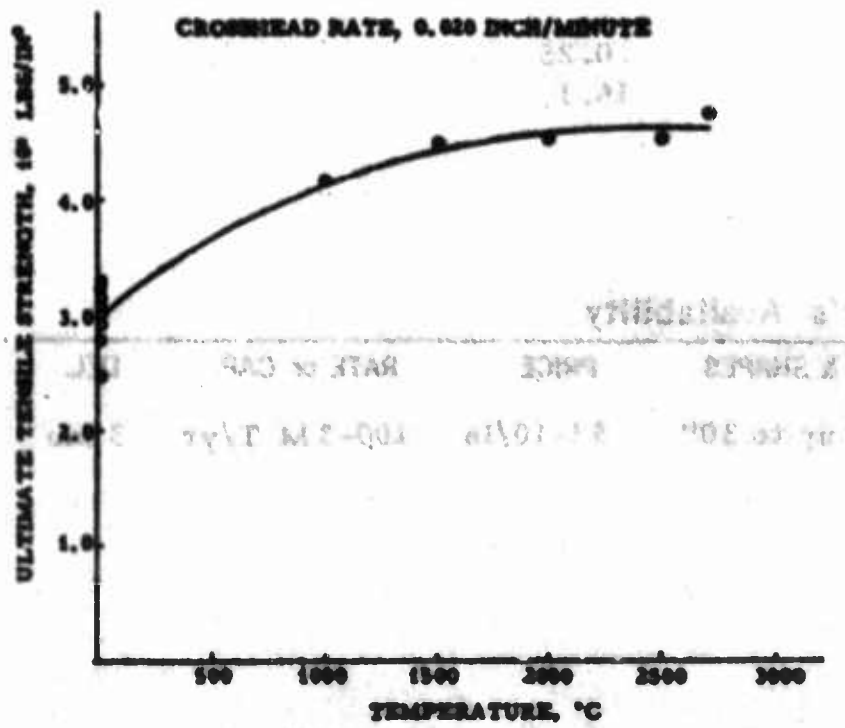
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) cyl 1/2-1" dia x 6" lg
(8) Volt/amps



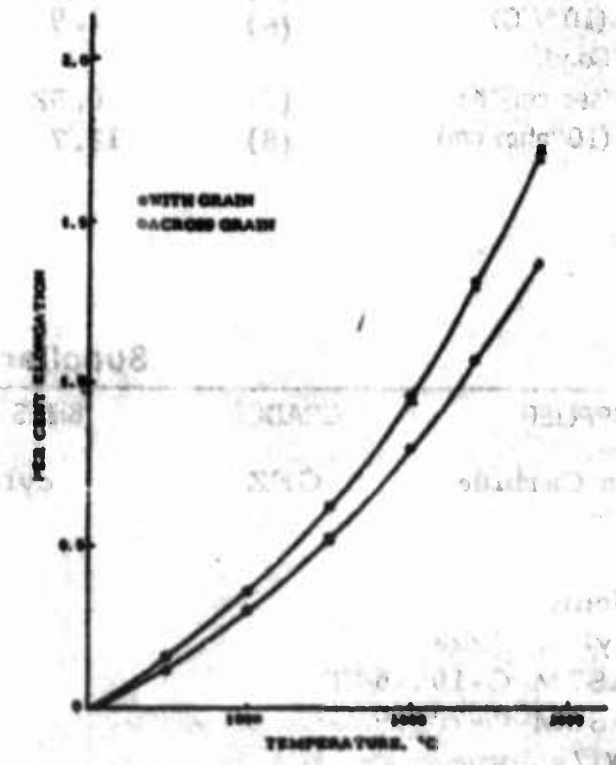
Across-Grain Ultimate Tensile Strength vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"



Young's Modulus vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"

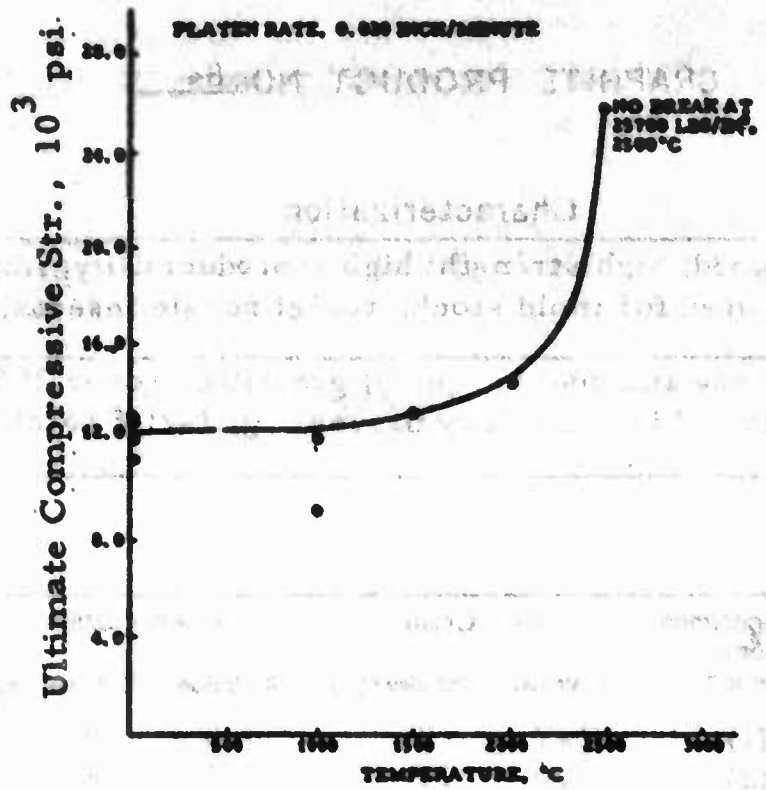


With-Grain Ultimate Tensile Strength vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"

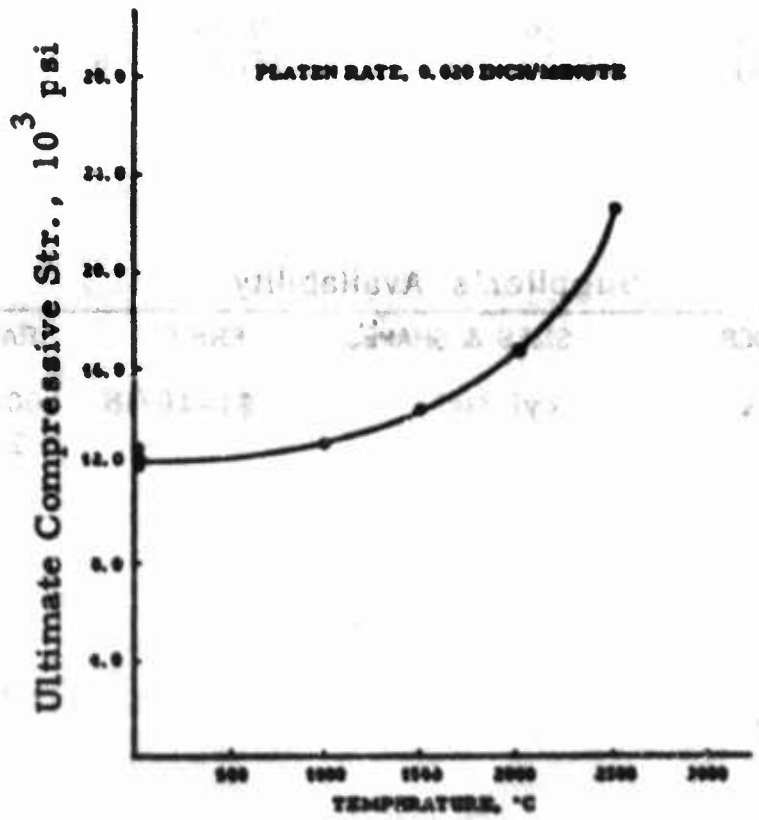


Thermal Expansion vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"

FIGURE 20 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 83 (Furnished by Union Carbide)



With-Grain Ultimate Compressive Strength vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"



Across-Grain Ultimate Compressive Strength vs. Temperature, CFZ Graphite, 14" dia. x 13-1/2"

FIGURE 21 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 83 (Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 84

Characterization

TYPE: molded, medium grained; high strength; high reproducibility; high density; long experience; large sizes; used for mold stock, rocket nozzle inserts, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; 1-20T batch size

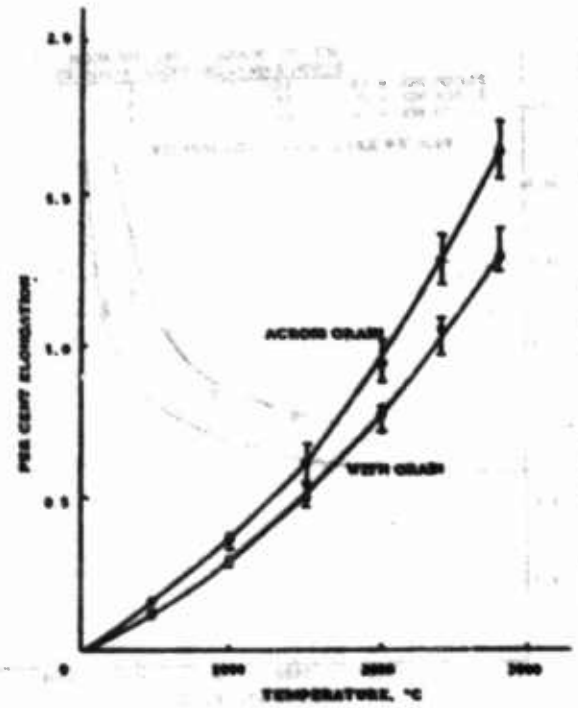
ANALYTICAL: Ash
Av. value 0.30%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7	9	1.3	9		
T. Str. (10^3psi)	(2)	3.0	15	2.1	8		
C. Str. (10^3psi)	(3)	8.4	13	8.1	15		
Flex. Str. (10^3psi)	(4)	3.7	8	3.0	10		
Density (g/cc)	(5)	1.84	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.7	3		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.26		0.21			
S. Res. (10^{-4}ohm cm)	(8)	12.2	3	15.7	6		

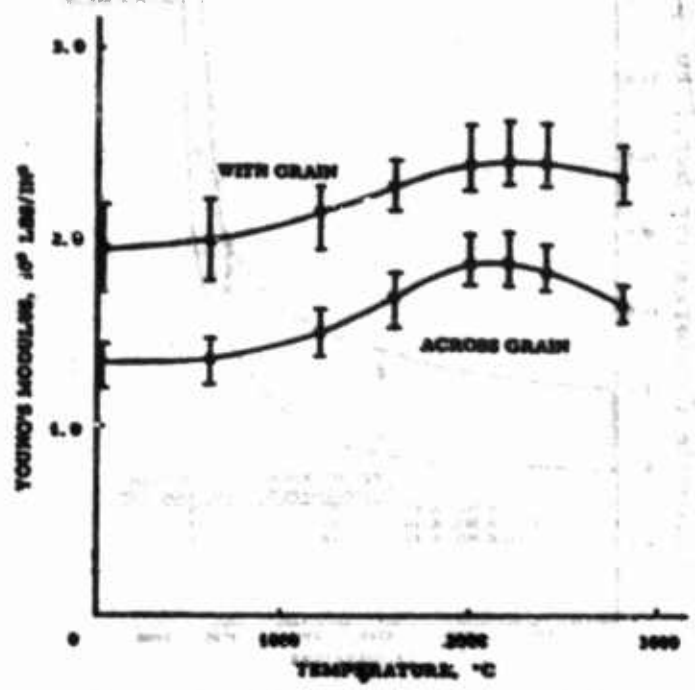
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	RVA	cyl 30"	$1-10/lb	100-3M T/yr	3M-30M T/yr	1 mo

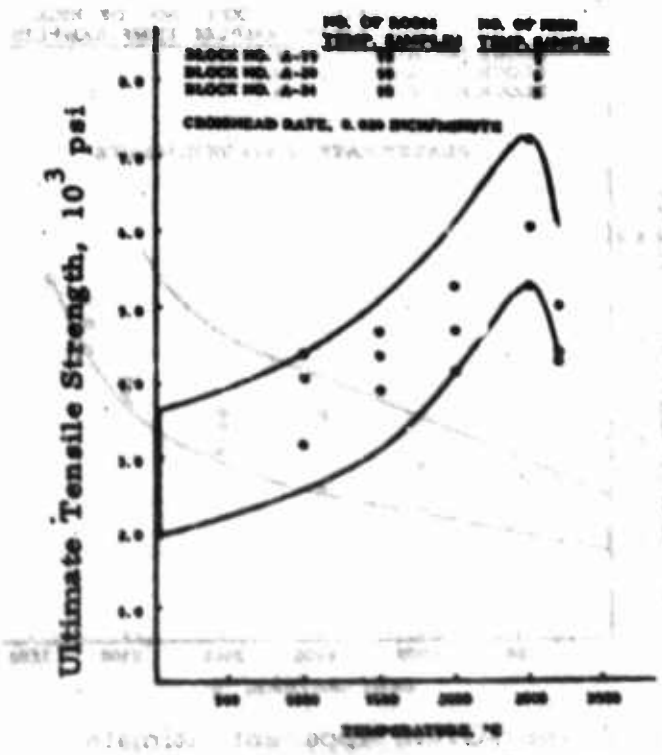
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) 1/2-1" dia x 6" lg
(8) Volt/amps



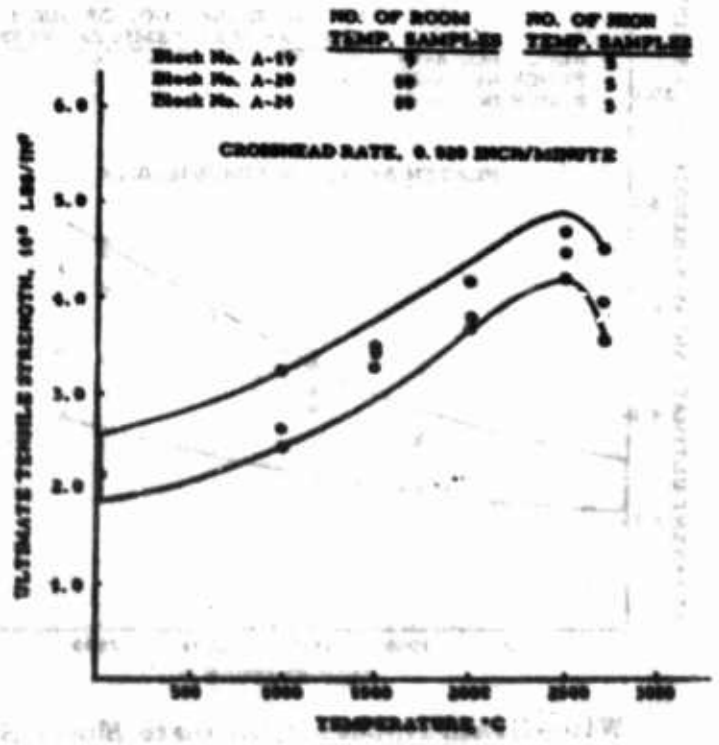
Thermal Expansion vs. Temperature, RVA Graphite, 33" dia. x 42"



Young's Modulus vs. Temperature, RVA Graphite, 33" dia. x 42"

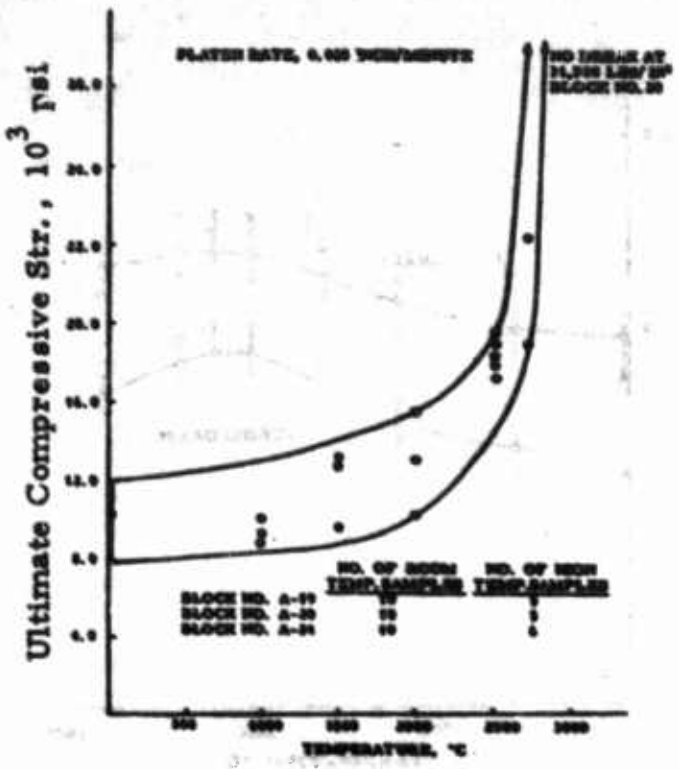


With-Grain Ultimate Tensile Strength vs. Temperature, RVA Graphite, 33" dia. x 42"

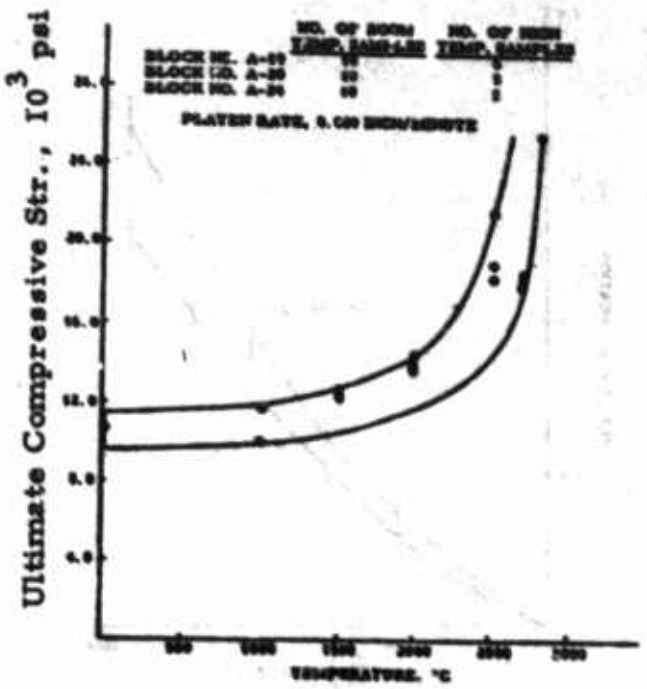


Across-Grain Ultimate Tensile Strength vs. Temperautre, RVA Graphite, 33" dia. x 42"

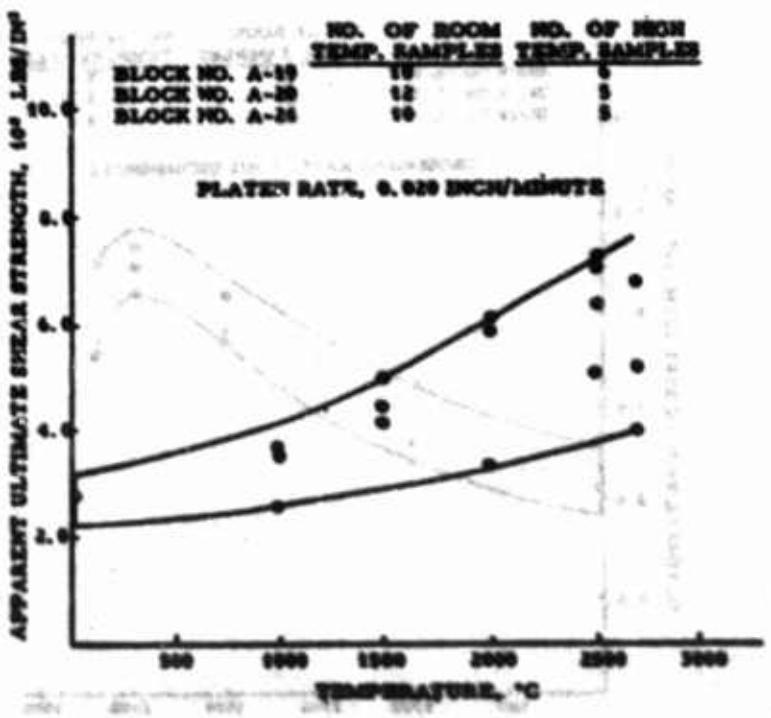
FIGURE 22 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 84
(Furnished by Union Carbide)



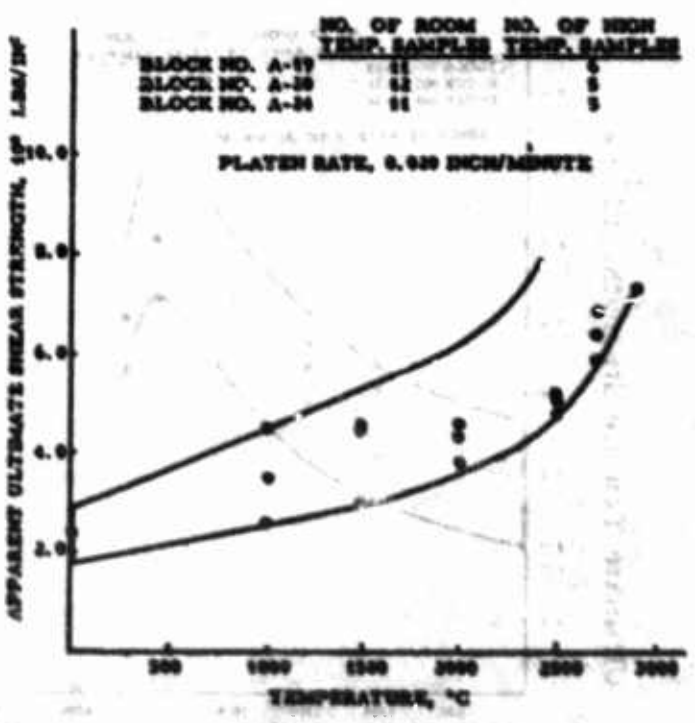
With-Grain Ultimate Compressive Strength vs. Temperature, RVA Graphite, 33" dia. x 42"



Across-Grain Ultimate Compressive Strength vs. Temperature, RVA Graphite, 33" dia. x 42"



With-Grain Apparent Ultimate Shear Strength vs. Temperature, RVA Graphite, 33" dia. x 42"



Across-Grain Apparent Ultimate Shear Strength vs. Temperature, RVA Graphite, 33" dia. x 42"

FIGURE 23 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 84
(Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 85

Characterization

TYPE: molded, medium grained; high reproducibility; recommended as a substrate for silicon carbide coatings; nearly isotropic high CTE

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined

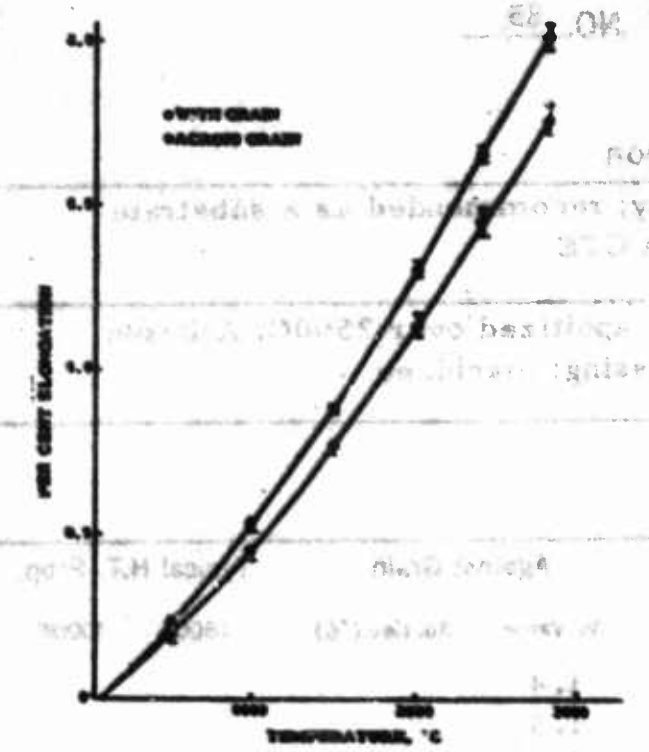
ANALYTICAL:	Ash	Fe
Av. value	.1-.5%	.05-.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.4			
T. Str. (10^3psi)	(2)	2.7		1.3			
C. Str. (10^3psi)	(3)	11		11			
Flex. Str. (10^3psi)	(4)	3.2		2.0			
Density (g/cc)	(5)	1.84					
C. Exp. (10^{-6}/°C)	(6)	3.69		4.45			
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.27		0.24			
S. Res. (10^{-4}ohm cm)	(8)	15.0		16.4			

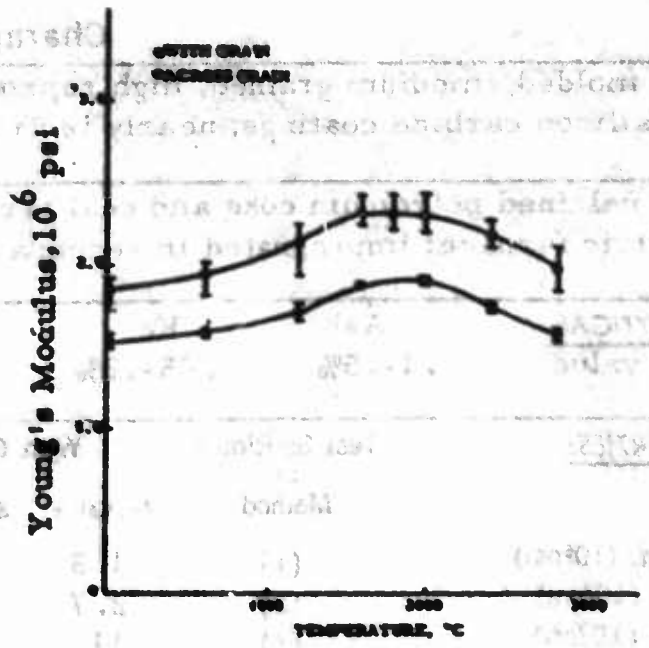
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	RVC	cyl 17" dia x 14" lg	$1-10/lb	10-100 T/yr	3 mo

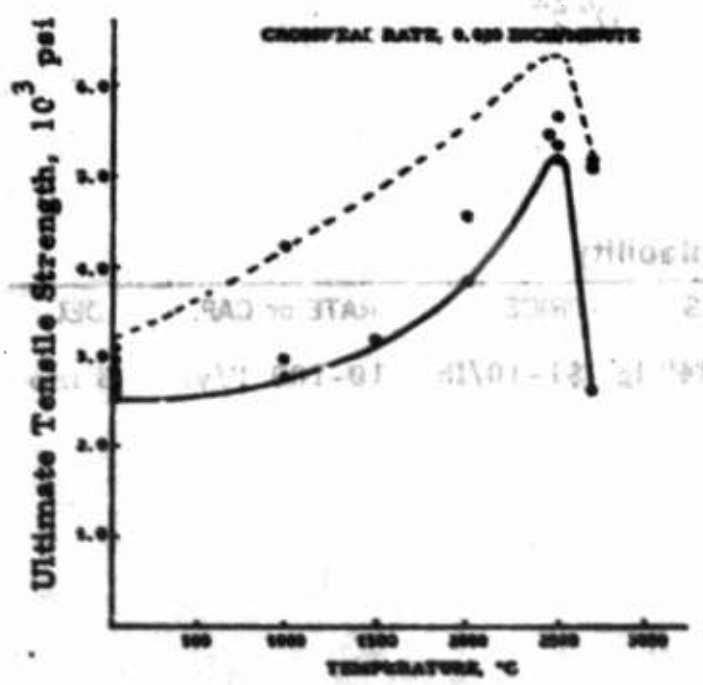
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) cyl 1/2-1" dia x 6" lg
(8) Volt/amps



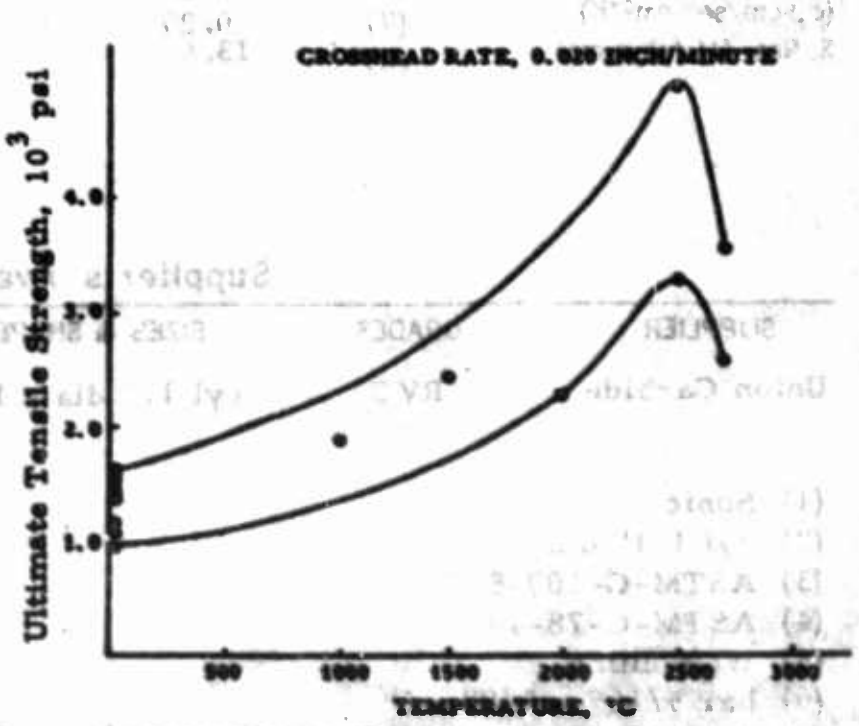
Thermal Expansion vs. Temperature, RVC Graphite, 18" dia. x 17"



Young's Modulus vs. Temperature, RVC Graphite, 18" dia. x 17", Block No. 163

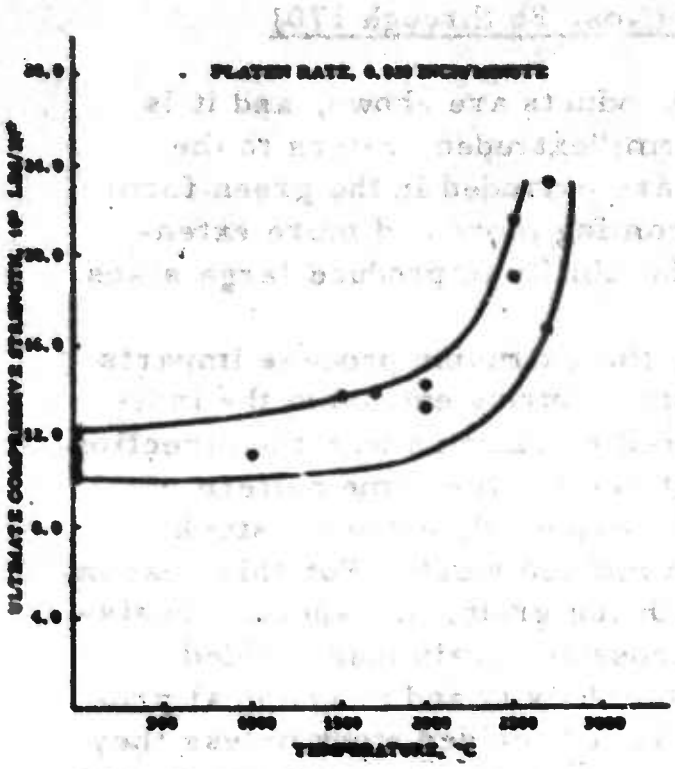


With-Grain Ultimate Tensile Strength vs. Temperature, RVC Graphite, Block No. 163, 18" dia. x 17"

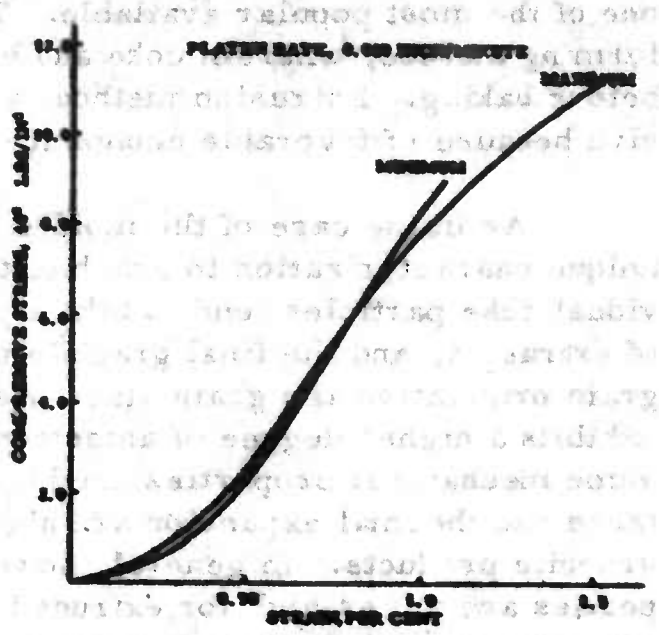


Across-Grain Ultimate Tensile Strength vs. Temperature, RVC Graphite, Block No. 163, 18" dia. x 17"

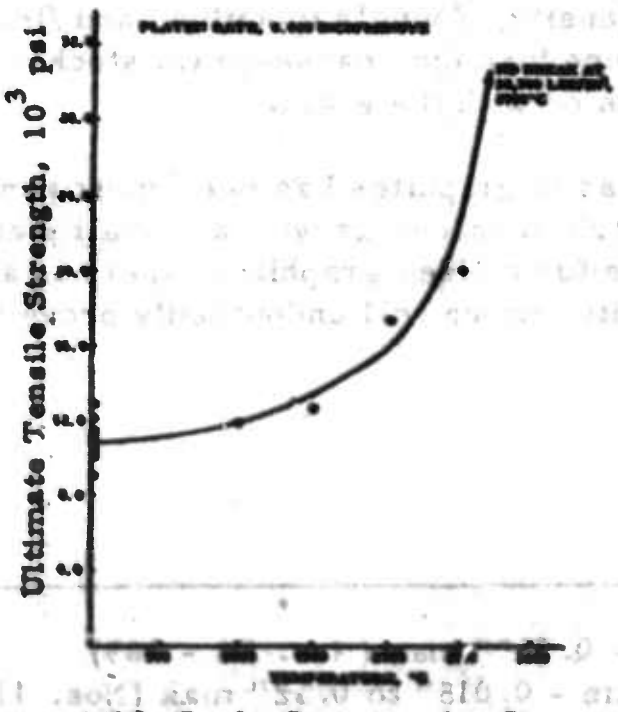
FIGURE 24 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 85 (Furnished by Union Carbide)



With-Grain Ultimate Compressive Strength vs. Temperature, RVC Graphite, Block No. 163, 18" dia. x 17"



Across-Grain Ultimate Compressive Strength vs. Temperature, RVC Graphite, Block No. 163, 18" dia. x 17"



With-Grain Compressive Stress-Strain Curves, RVC Graphite, Block No. 163, 18" dia. x 17", Room Temperature

FIGURE 25 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 85 (Furnished by Union Carbide)

Extruded Graphite Products (Nos. 86 through 170)

In the extruded class, 85 graphite products are shown, and it is one of the most popular available. The term "extruded" refers to the forming method, wherein coke and binder are extruded in the green form before baking. Extrusion methods are becoming more and more extensive because of favorable economics and the ability to produce large sizes.

As in the case of the molded class, the extrusion process imparts unique characterization to graphite products. During extrusion the individual coke particles tend to take a preferred orientation with the direction of extrusion, and the final graphite product retains the same pattern of grain orientation and grain size. As can be expected, extruded stock exhibits a higher degree of anisotropy than molded stock. For this reason, some mechanical properties are higher with the grain, and specific resistance and thermal expansion are higher across the grain than molded graphite products. In general, however, the density and mechanical properties are not as high for extruded stock as for molded stock unless they are impregnated in secondary processing.

Grain size also has a profound effect on the properties of extruded graphite and, like the molded class, the extruded class is subclassed* in accordance with maximum particle size. For the extruded class, the fine-grain stock has higher density, Young's modulus, and flexural strength and a lower specific resistance than the coarse-grain stock as measured along the direction of extrusion or with the grain.

The extruded class of graphites has been most popular for use as large electrodes in electric furnaces as well as small electrodes or anodes in electrolytic cells. As for molded graphites, there is a great deal of experience and familiarity, which will undoubtedly prove important for new applications.

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*Fine grain - 0.015" max (Nos. 86 - 109)
Medium grain - 0.015" to 0.12" max (Nos. 110-160)
Coarse grain - 0.12" max (Nos. 161-168)
Very coarse grain - > 0.50" (Nos. 169-170)

GRAPHITE PRODUCT NO. 86

Characterization

TYPE: extruded, fine grained; max grain size 0.008"

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding

ANALYTICAL:	Ash
Av. value	0.2% max

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
Typical		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.2		0.84			
T. Str. (10^3psi)		2.4		1.7			
C. Str. (10^3psi)		5.0		5.0			
Flex. Str. (10^3psi)							
Density (g/cc)		1.55					
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^4ohm cm)		12		17			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Product Division, Carborundum Co.	GS	cyl 3/8- 1-1/4" (up to 48" lg)	<$1/lb		

GRAPHITE PRODUCT NO. 87

Characterization

TYPE: extruded, fine grained; max grain .008"; high purity

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding

ANALYTICAL:

	Ash
Av. value	.06% max

PROPERTIES:

Typical	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.1		0.8			
T. Str. (10^3psi)		1.6		1.1			
C. Str. (10^3psi)		4.7		4.7			
Flex. Str. (10^3psi)							
Density (g/cc)		1.55					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		11.4		16.0			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	GSP	cyl 3/8-5"	<$1/lb		

GRAPHITE PRODUCT NO. 88

Characterization

TYPE: extruded, fine grained; good electrical conductor; max grain size 0.008"; good thermal conductor; high reproducibility; chemical resistant

MFG: calcined petroleum coke, coal tar pitch; graphitized over 2500C; electric resistance furnace; machined and ground; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.2% max

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Typical							
Y. Mod. (10^6psi)		1.2		.8			
T. Str. (10^3psi)		2.1		1.5			
C. Str. (10^3psi)		6.5		6.5			
Flex. Str. (10^3psi)							
Density (g/cc)		1.68					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		11.4		16.0			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	GSX	cyl 3/8-2" pipe 1-1/4 - 5-1/4" (density 1.65)	<$1/lb		

GRAPHITE PRODUCT NO. 89

Characterization

TYPE: extruded, fine grained; good electrical conductor; good thermal conductor; high reproducibility; chemical resistant; high purity; good nuclear properties

MFG: calcined petroleum coke, coal tar pitch; graphitized over 2500C; electric resistance furnace; machined and ground; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value .06-.08% depending on size

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Typical							
Y. Mod. (10^6psi)		0.9-1.3		0.7-0.9			
T. Str. (10^3psi)		2.1, 1.6		1.5, 1.1			
C. Str. (10^3psi)		4.5, 7.5		4.5, 7.5			
Flex. Str. (10^3psi)							
Density (g/cc)		1.65, 1.68					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		11.4, 11.4		16, 16			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division,	GSXP	pipe 1-1/4 - 5-1/4"	$1-10/lb		
Carborundum Co.	GSXP	1 3/8 - 30"	<$1/lb		

*First number refers to first product

GRAPHITE PRODUCT NO. 90

Characterization

TYPE: extruded, fine grained; high strength; high density; low porosity; chemical resistant; good thermal conductor; high reproducibility

MFG: calcined petroleum coke, coal tar pitch; gaseous hydrocarbon, resin; graphitized under 2500C; electric resistance furnace; impregnated; machined and ground; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 0.6-1.0% depending on size

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
Typical		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.6		1.1			
T. Str. (10^3psi)		3.6		2.5			
C. Str. (10^3psi)		12.5		12.5			
Flex. Str. (10^3psi)							
Density (g/cc)		1.91		1.91			
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		11.4		16			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	Graph-I-Tite* "A"	cyl 3/8 - 30" pipe 7/8 - 5-1/4"	$1-10/lb		

* Registered trademark

GRAPHITE PRODUCT NO. 91

Characterization

TYPE: extruded, fine grained; high strength; high density; low porosity; chemical resistant; good thermal conductor; high reproducibility; high purity; good nuclear properties; good electrical conductor

MFG: calcined petroleum coke, coal tar pitch, gaseous hydrocarbon, resin; graphitized over 2500C; electric resistance furnace; impregnated; machined and ground; 100-2000 lb batch size

ANALYTICAL: Ash

Av. value 0.06-0.08% depending on size

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Typical							
Y. Mod. (10^6psi)		1.4		1.0			
T. Str. (10^3psi)		2-3.6		1.4-2.2			
C. Str. (10^3psi)		7.5-12		7.5-12			
Flex. Str. (10^3psi)							
Density (g/cc)		1.89		1.89			
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		9.0		12.5			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	Graph-I-Tite* "G"	cyl 3/8 - 30" pipe 7/8 - 5-1/4"	$1-10/lb		

* Registered trademark

GRAPHITE PRODUCT NO. 92

Characterization

TYPE: extruded, fine grained; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high density; used for rocket nozzle inserts, sintering boats, and crucibles

MFG: graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.0	10	1.3	10		
T. Str. (10^3psi)	(2)	2.6	10	2.1	10		
C. Str. (10^3psi)	(3)	7.9	10	7.9	10		
Flex. Str. (10^3psi)	(4)	4.1	10	3.2	10		
Density (g/cc)	(5)	1.88	2				
C. Exp. (10^{-6}/°C)	(6)	2.0	5	3.3	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.48	10	0.40	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	8	10		
Permeability (D'Arcy)		0.04	10	0.03	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	H249	cyl 3-24"	$1-10/lb	100-3 M T/yr	6 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

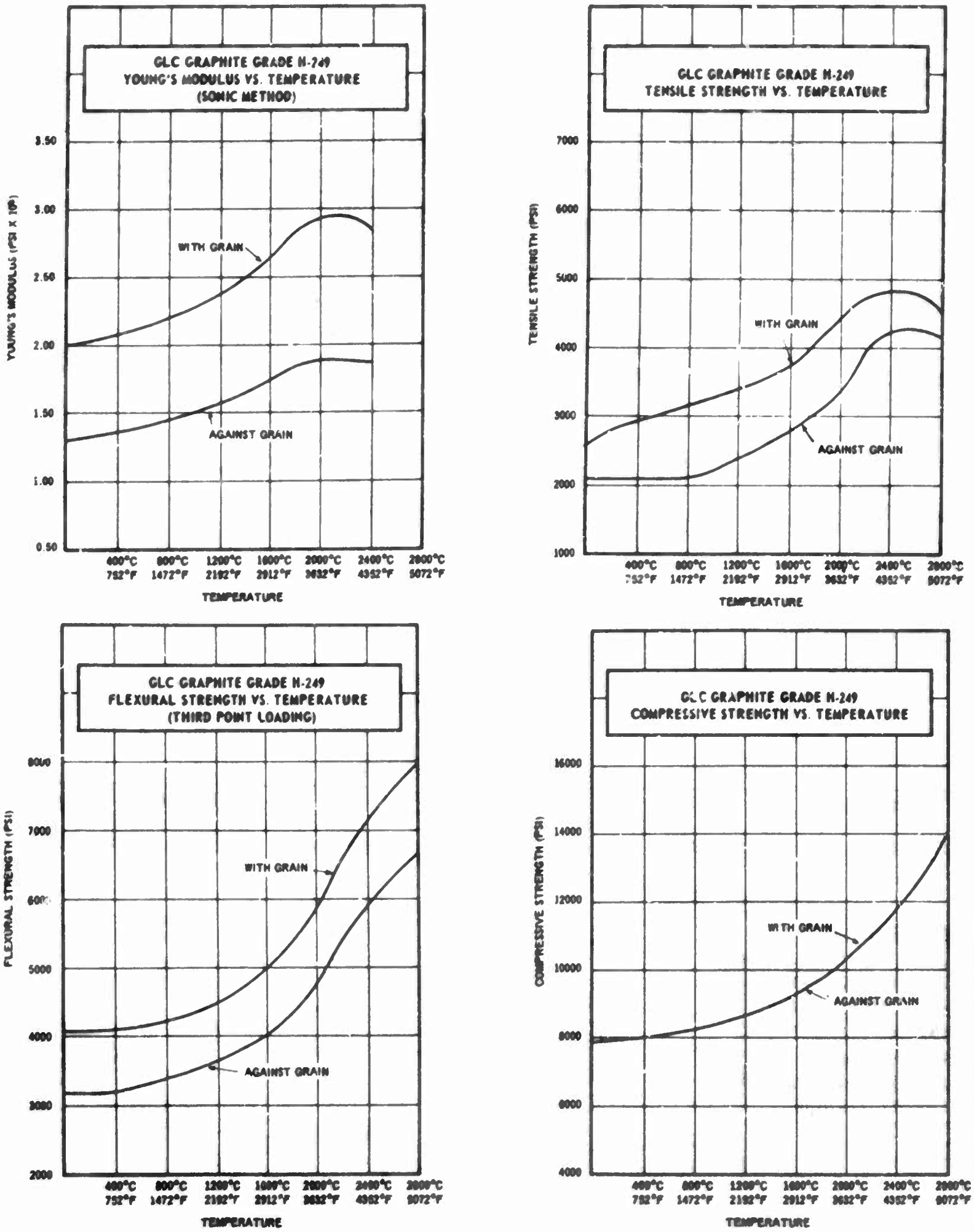
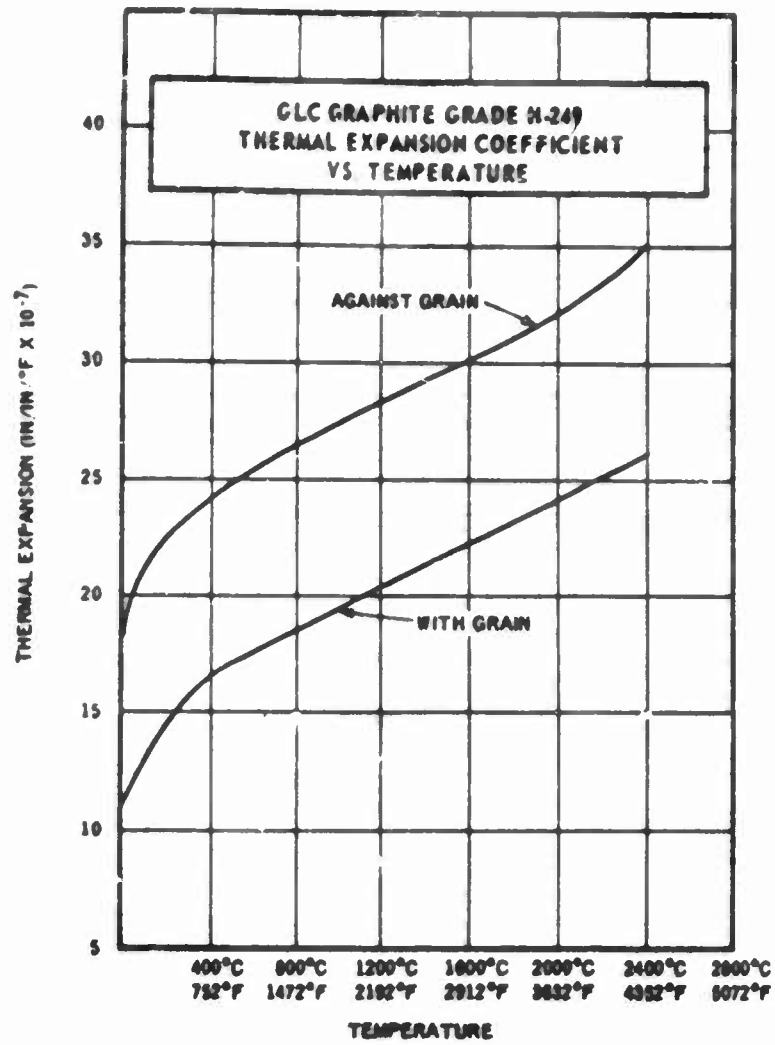


FIGURE 26 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 92
(Furnished by Great Lakes Carbon)



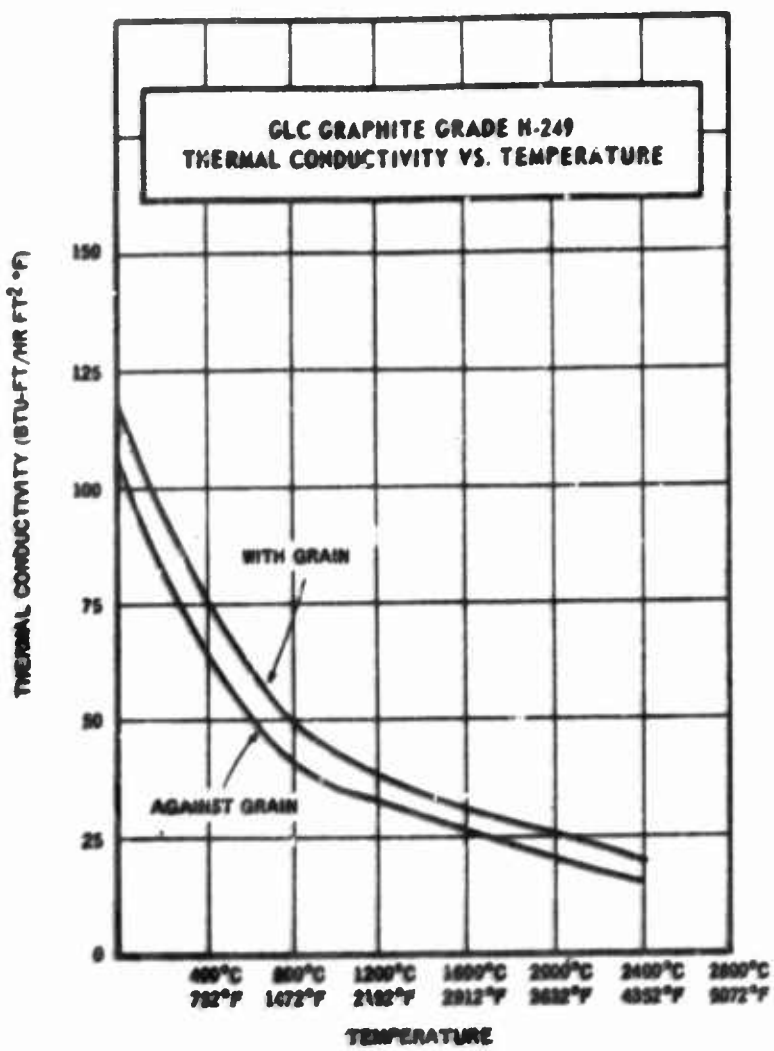


FIGURE 27 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 92
(Furnished by Great Lakes Carbon)

GRAPHITE PRODUCT NO. 93

Characterization

TYPE: extruded, fine grained; low friction; abrasion resistant; long experience; used for mold stock, sintering boats, and crucibles

MFG: artificial graphite; processed below 2500C; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.6					
Density (g/cc)	(2)	1.54					
C. Exp. (10^{-6}/°C)	(3)	2.9		5.0			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	20.3					
Scleroscope Hardness		40					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	0-15	cyl <5" dia	< $1/lb	10-100 T/yr	0-2 mo

(1) 4 Point loading
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO 94

Characterization

TYPE: extruded, fine grained; high strength; high reproducibility; long experience; high hardness; used for bearings and brushes

MFG: artificial graphite and coal tar pitch; processed below 2500C; machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.3%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	2.4					
C. Str. (10^3psi)	(2)	11.0		12.0			
Flex. Str. (10^3psi)	(3)	5.0		4.7			
Density (g/cc)	(4)	1.77					
C. Exp. (10^{-6}/°C)	(5)	2.9					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	20.3					
Scleroscope Hardness		70					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	250	cyl 1-5" dia blk 3-1/2" x 1-1/2"	<$1/lb	10-100 T/yr	0-2 mo

(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Volt/amps

GRAPHITE PRODUCT NO. 95

Characterization

TYPE: extruded, fine grained; chemical resistant; long experience; high production; recommended for fluxing tubes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3ps							
Flex. Str. (10^3psi)	(1)	4.0					
Density (g/cc)	(2)	1.63					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	7.4					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	581	pipe 2-1/2" OD x 1/2" ID	<$1/lb	100-3 M T/yr	0-2 mo

(1) 4 Point loading
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 96

Characterization

TYPE: extruded, fine grained; high strength; low coeff. therm. exp.; high purity; good nuclear properties; high temperature oxid. resist.; long experience; high production; used for molds, jigs, fixtures, sintering boats, heater elements and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 100-2000 lb batch size

ANALYTICAL:	Ash	Si	Al	Fe	Ca	Zn	Na	Mg
Av. value	100 ppm max	10ppm	<10ppm	10ppm	<10ppm	<10ppm	<10ppm	2ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.0, 2.0					
T. Str. (10^3psi)	(2)	2.3, 2.4		1.6, -		3.5	5.0
C. Str. (10^3psi)	(3)	9.0, 9.5		9.4, 10.2		9.3	14.0
Flex. Str. (10^3psi)	(4)	4.3, 4.8		3.7, 4.4		5.8	8.8
Density (g/cc)	(5)	1.79, 1.8					
C. Exp. (10^{-6}/°C)	(6)	1.8		2.9, 3.2			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.06	
S. Res. (10^{-4}ohm cm)	(8)	10.9, 10.7				9.7	11.7

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	780GL	cyl 2-1/2"-5"	<$1/lb	10-100 T/yr	0-4 mo
Speer Carbon	711GL	cyl 1-2-1/2"	<$1/lb	10-100 T/yr	0-4 mo

* First number refers to first product

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps

GRAPHITE PRODUCT NO. 97

Characterization

TYPE: extruded, fine grained; high strength; low coeff. of therm. exp.; high purity; good nuclear properties; high temperature oxidation resistant; long experience; used for furnace electrodes, molds jigs, fixtures, moderators for nuclear piles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500°C; machined; 1-20T batch size

ANALYTICAL:	Ash	Al	Ca	Fe	Mg	Ni	Si	Ti	V
Av. value	50 ppm max	<10ppm	<10ppm	<10ppm	<1ppm	<1ppm	<10ppm	<1ppm	<5ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8					
T. Str. (10^3psi)	(2)	2.2					
C. Str. (10^3psi)	(3)	7.3		5.6			
Flex. Str. (10^3psi)	(4)	4.0					
Density (g/cc)	(5)	1.69					
C. Exp. (10^{-6}/°C)	(6)	2.5		4.3			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	7.4					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	886RL	cyl 1/2-2-1/2"	<$1/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 98

Characterization

TYPE: extruded, fine grained; high strength; low coeff. of therm. exp.; long experience; high production; used for molds, jigs, fixtures, heater elements, crucibles, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.08%

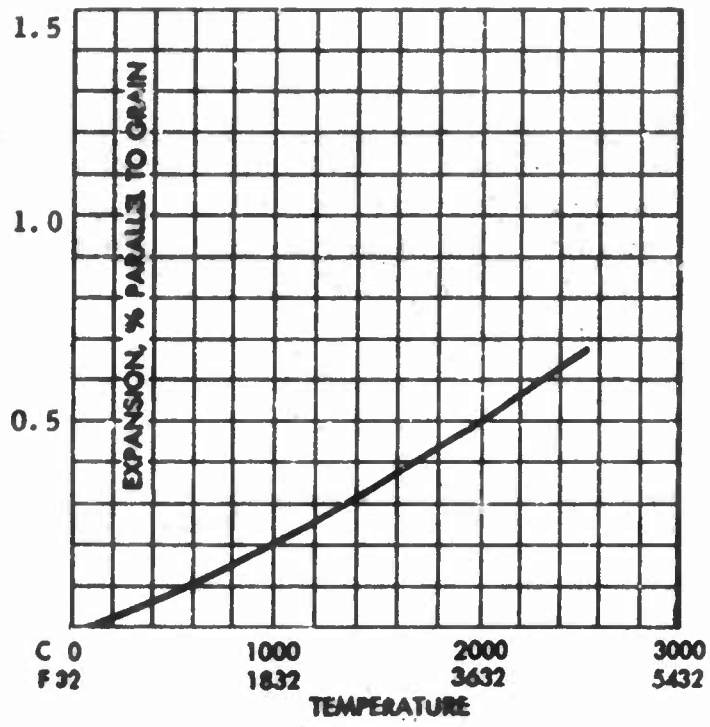
PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8,2.0,2.0					
T. Str. (10^3psi)	(2)	2.2,2.3,2.4		-, 1.6, -		-,3.5, 3.5	-,5.0,5.0
C. Str. (10^3psi)	(3)	7.3,9.0,9.5		5.6,9.4,10.2		-,9.3,9.3	-,14.0,14.0
Flex. Str. (10^3psi)	(4)	4.0,4.3,4.8		-,3.7,4.4		-,5.8,5.8	-,8.8, 8.8
Density (g/cc)	(5)	1.69,1.79,1.80					
C. Exp. (10^{-6}/°C)	(6)	2.5,1.8,1.8		4.3, 2.9,3.2			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					-,.06,.06	
S. Res. (10^{-4}ohm cm)	(8)	7.4,10.9,10.7				-,9.7,9.7	-,11.7,11.7
Scleroscope Hardness		-,47,53					

Supplier's Availability

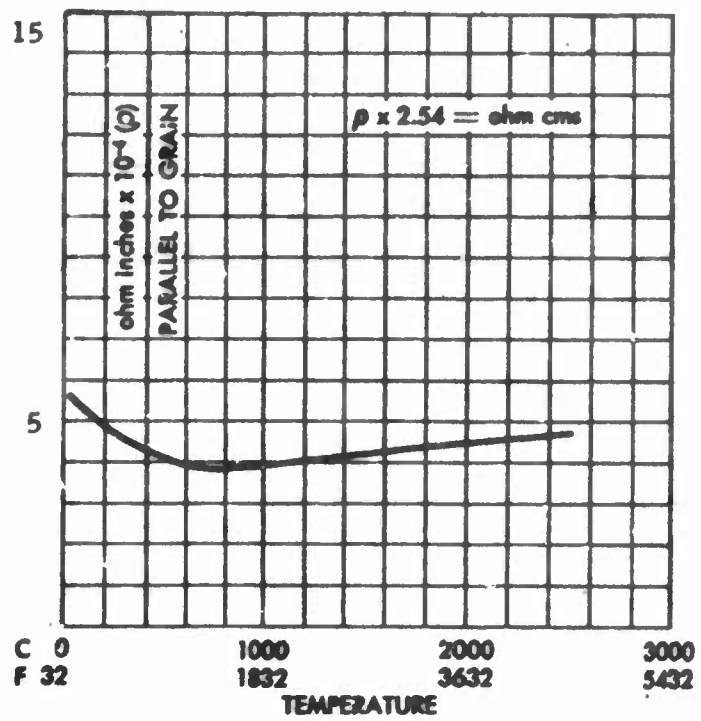
SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	886S	cyl 1/2-2-1/2"	<$1/lb	100-3 M T/yr	0-2 mo
Speer Carbon	580	cyl 2-1/2-5"	<$1/lb	10-100 T/yr	0-2 mo
Speer Carbon	580	cyl 1-2-1/2"	<$1/lb	10-100 T/yr	0-2 mo

* First number refers to first product

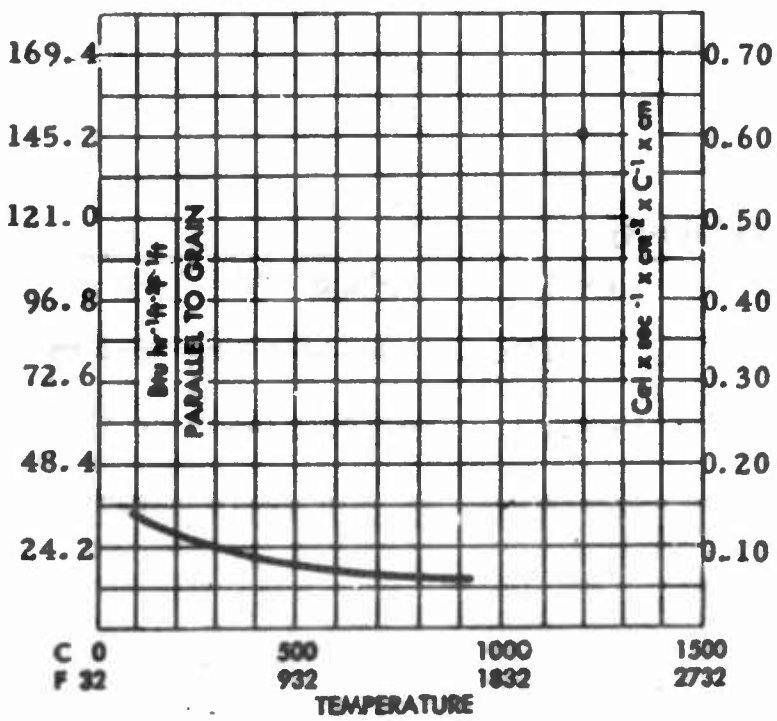
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps



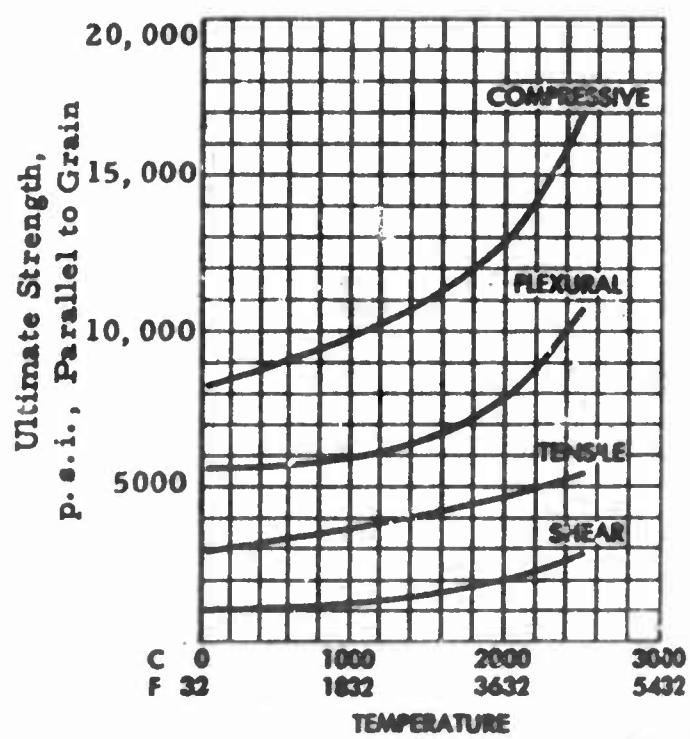
Thermal Expansion vs. Temperature
Grade 580



Electrical Resistivity - Grade 580



Thermal Conductivity - Grade 580



Ultimate Strength vs. Temperature - Grade 580

FIGURE 28 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 98
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 1

Characterization

TYPE: extruded, fine grained; high strength; low coeff. of therm. exp.; high purity; long experience; used for molds, jigs, fixtures, heater elements, crucibles, support material in furnace brazing & heat treating; and susceptor in induction heating furnaces.

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20T batch size

ANALYTICAL:	Ash
Av. value	.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8					
T. Str. (10^3psi)	(2)	2.2					
C. Str. (10^3psi)	(3)	7.3		5.6			
Flex. Str. (10^3psi)	(4)	4.0					
Density (g/cc)	(5)	1.69					
C. Exp. (10^{-6}/°C)	(6)	2.5		4.3			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	7.4					
Scleroscope Hardness		46					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	886W	cyl 1/2-2-1/2"	<$1/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-190-59
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 100

Characterization

TYPE: extruded, fine grained; high strength; high pruity; good nuclear properties; high temperature oxidation resistant; long experience; high production; used for electrolytic anodes, molds, jigs, fixtures, rocket nozzle inserts, heater elements, and crucibles.

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20T batch size

ANALYTICAL:	Ash	Al	Ca	Fe	Mg	Ni	Si	Ti	V
Av. value	100ppm max	<10ppm	<10ppm	<10ppm	<1ppm	<1ppm	<10ppm	<1ppm	<5ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.9					
T. Str. (10^3psi)	(2)	1.75		1.30		2.8	5.0
C. Str. (10^3psi)	(3)	5.50		7.0		6.4	9.6
Flex. Str. (10^3psi)	(4)	3.2		2.07		4.5	6.5
Density (g/cc)	(5)	1.70					
C. Exp. (10^{-6}/°C)	(6)	1.8		3.7			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.2	
S. Res. (10^{-4}ohm cm)	(8)	6.1				6.6	10.2

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	890RL	cyl 2-1/2-9"	<$1/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps

GRAPHITE PRODUCT NO. 101

Characterization

TYPE: extruded, fine grained; high strength; low coeff. of therm. exp.; good electrical and thermal conductor; long experience; high production; used for molds, jigs, fixtures, rocket nozzle inserts, heater elements, crucibles, and sintering boats

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

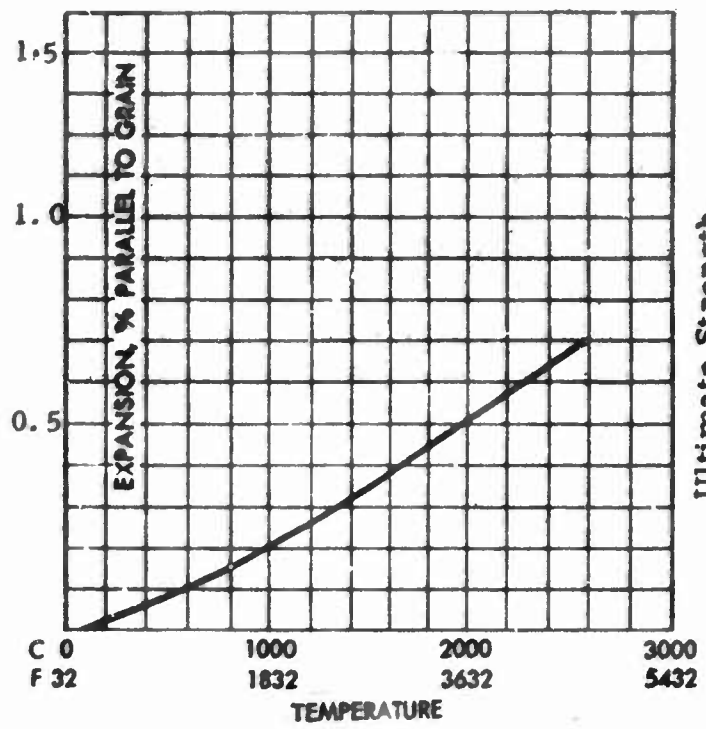
ANALYTICAL: Ash
Av. value 0.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	1.87				2.3	5.0
C. Str. (10^3psi)	(2)	1.75		1.30		6.4	9.6
Flex. Str. (10^3psi)	(3)	3.20		2.07		4.5	6.5
Density (g/cc)	(4)	1.70					
C. Exp. (10^{-6}/°C)	(5)	1.8		3.7			
Therm. Cond. (cal-cm/sec cm^2°K)	(6)					0.20	
S. Res. (10^{-4}ohm cm)	(7)	10.2				6.6	10.2
Permeability (cm^2/sec)		0.44-0.55		0.22-0.66			

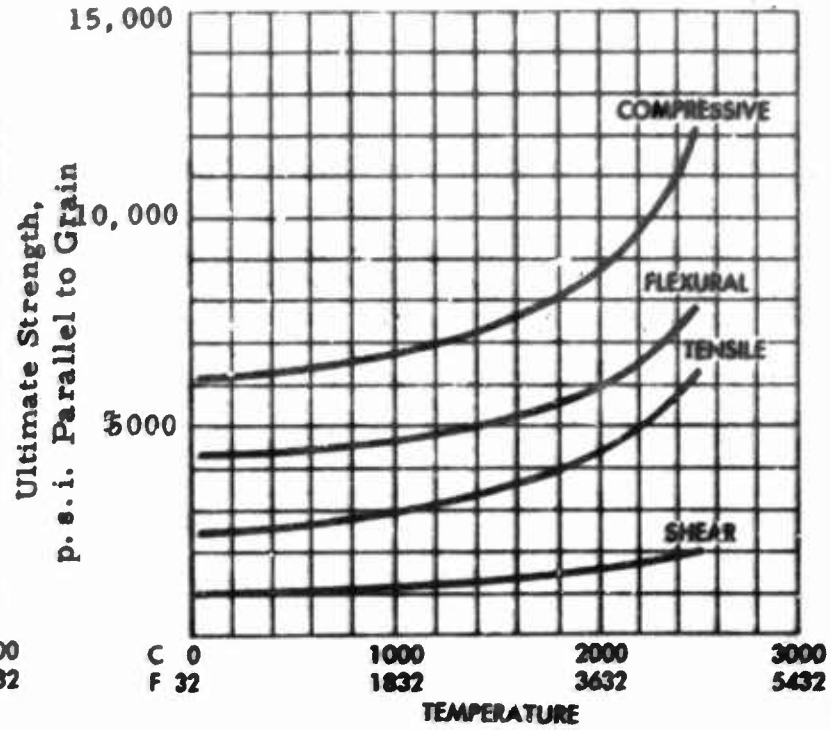
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	890S	cyl 2-1/2-9" dia blk < 40 sq in	< $1/lb	100-3M T/yr	0-2 mo

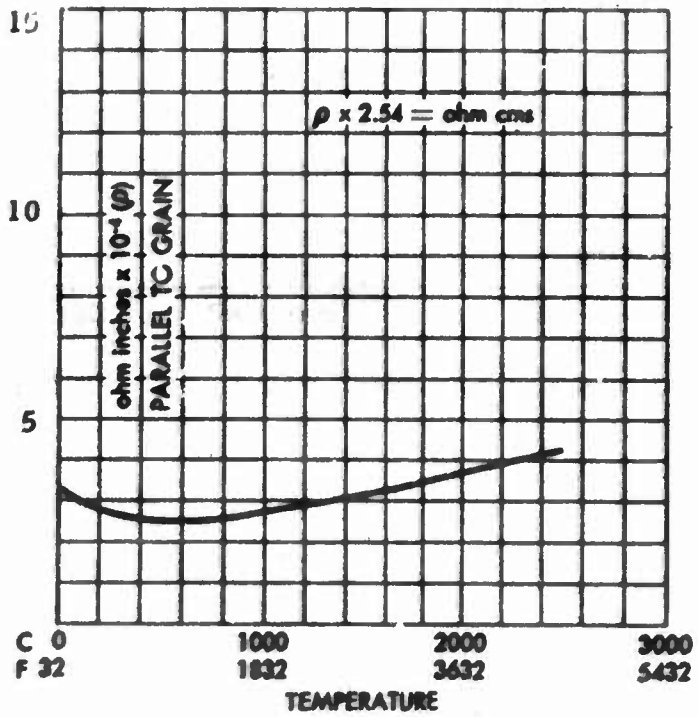
(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Guarded hot plate
(7) Volt/amps



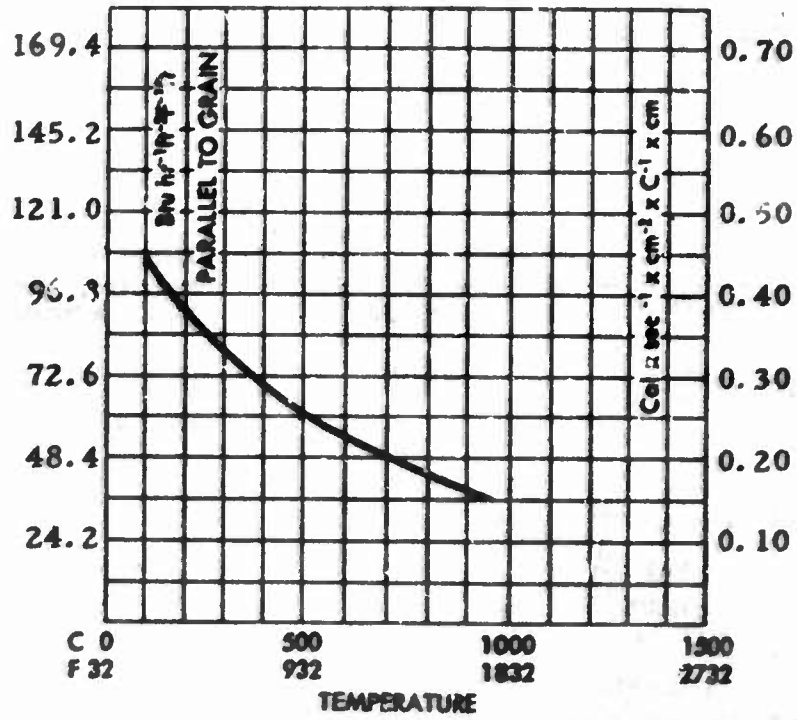
Thermal Expansion vs. Temperature
Grade 890S



Ultimate Strength vs. Temperature
Grade 890S



Electrical Resistivity - Grade 890S



Thermal Conductivity - Grade 890S

FIGURE 29 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 101
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 102

Characterization

TYPE: extruded, fine grained; high strength; high purity; high temperature oxidation resistant; long experience; high production; used for electrolytic anodes, molds, jigs, fixtures, sintering boats, heater elements, crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.9					
T. Str. (10^3psi)	(2)	1.6				2.8	5.0
C. Str. (10^3psi)	(3)	5.4		5.6		6.4	9.6
Flex. Str. (10^3psi)	(4)	2.7		2.4		4.5	6.5
Density (g/cc)	(5)	1.7					
C. Exp. (10^{-6}/°C)	(6)	1.7		3.4			
Therm. Cond. (cal-cm/sec cm^2°K)						0.2	
S. Res. (10^{-4}ohm cm)	(7)	6.9				6.6	10.2

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	890W	cyl 2-1/2-9" blk <40 sq in	< $1/lb	10-100 T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 103

Characterization

TYPE: extruded, fine grained; good electrical conductivity; low porosity; long experience; high production; used for molds, jigs and fixtures, sintering boats, heater elements, crucibles, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.05%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.2		1.3			
T. Str. (10^3psi)	(2)	2.0		1.4			
C. Str. (10^3psi)	(3)	7.2		5.9			
Flex. Str. (10^3psi)	(4)	4.0		3.0			
Density (g/cc)	(5)	1.73					
C. Exp. (10^{-6}/°C)	(6)	2.0		3.7			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	7.5					
Scleroscope Hardness		39					
Rockwell Hardness (R)		85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	900	blk up to 30 sq in	<$1/lb	3M-30M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 104

Characterization

TYPE: extruded, fine grained; high strength; low porosity; chemical resistant; abrasion resistant; long experience; used for mechanical applications such as seals, bearings, pistons, and valves

MFG: calcined petroleum coke and coal tar pitch; processed under 2500C; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	7.5					
Density (g/cc)	(2)	1.85					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	22.9					
Scleroscope Hardness		74					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	8811	cyl to 5-1/5" dia blk 3-1/2" x 1-1/2"	<$1/lb	10-100 T/yr	1 mo

(1) 4 Point loading
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 105

Characterization

TYPE: extruded, fine grained; high reproducibility; small sizes; high production; used for mechanical applications, heater elements, and EDM electrodes

MFG: graphitized over 2500C; impregnated; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	< 1.0%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.4					
Density (g/cc)	(2)	1.66					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	11					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole	6056	blk 6" dia x 2" x 6" max	< $1/lb	10-100 T/yr	3 mo

(1) NEMA
(2) NEMA
(3) NEMA

GRAPHITE PRODUCT NO. 106

Characterization

TYPE: extruded, fine grained; good thermal conductor; high reproducibility; low friction; long experience; small sizes; high production; used for mechanical applications, riser rods, heater elements, and welding electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.7%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4		.85			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	4.9		5.0			
Flex. Str. (10^3psi)	(3)	5.0					
Density (g/cc)	(4)	1.60		1.60			
C. Exp. (10^{-6}/°C)	(5)	1.3					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	7.6					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole	K1	cyl 1" dia x 60" max	<$1/lb	10-100 T/yr	0-1 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 107

Characterization

TYPE: extruded, fine grained; low cost; long experience; large and small sizes; high production; general purpose use

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.12%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	8				
T. Str. (10^3psi)	(2)	1.1	15				
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	2.6	15	.980			
Density (g/cc)	(4)	1.58	2				
C. Exp. (10^{-6}/°C)	(5)	1.1	26				
Therm. Cond. (cal-cm/sec cm²°K)		0.37		0.21			
S. Res. (10^{-4}ohm cm)	(6)	8.4	7	15.0	8		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGSR	cyl 1-2-1/2"dia blk 1/2-6" cross sec. blk 3/4 x 5" cross sec.	<$1/lb	10-100 T/yr	1 mo
	AGSR	cyl 1/8-7/8"	$1-10/lb	<10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 108

Characterization

TYPE: extruded, fine grained; high purity; long experience; small sizes; used for molds, jigs and fixtures, susceptor in induction heating furnaces, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	.08%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7	11	0.9	11		
T. Str. (10^3psi)	(2)						
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	2.3					
Density (g/cc)	(4)	1.68	3				
C. Exp. (10^{-6}/°C)	(5)	1.13	25	3.4	4		
Therm. Cond. (cal-cm/sec cm^2°K)		0.39		0.25			
S. Res. (10^{-4}ohm cm)	(6)	8.2					

Low Gas evolution

Guaranteed max. ash 0.08%, ave. 0.03%

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AUC	cyl 1/4"-141/8"	$1-10/lb	<10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 109

Characterization

TYPE: extruded, fine grained; long experience; used for jigs and fixtures, sintering boats, and end plates; general purpose use

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.13%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8	7	0.8	6		
T. Str. (10^3psi)	(2)	1.4	16				
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	3.1	13	1.3	22		
Density (g/cc)	(4)	1.67	2				
C. Exp. (10^{-6}/°C)	(5)	0.1	22				
Therm. Cond. (cal-cm/sec cm^2°K)		0.39		0.23			
S. Res. (10^{-4}ohm cm)	(6)	8.0	11	13.3	5		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGSX	cyl 1 - 2-3/4" plt 1/2-3/4"	<$1/lb	10-100 T/yr	

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 110

Characterization

TYPE: extruded, medium grained; max grain 0.06"

MFG: calcined petroleum coke and coal tar pitch

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		.725 - .775					
C. Str. (10^3psi)		3.2 - 3.8					
Flex. Str. (10^3psi)		1.4 - 1.8					
Density (g/cc)		1.52 - 1.56					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K) [1]		76 - 84					
S. Res. (10^{-4}ohm cm) [2]		32 - 40					

1 BTU/ft/°F
2 ohm in x 10^{-5}

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	CGE CGR	cyl 7-12"			0-6 mo

GRAPHITE PRODUCT NO. 111

Characterization

TYPE: extruded, medium grained; high strength; good electrical conductivity; good thermal conductivity; high purity; good nuclear properties; high reproducibility; high density

MFG: calcined petroleum coke; graphitized over 2500C; electric resistance furnace; impregnated in secondary processing; final product machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	.06-.08% depending on size

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
Typical		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.2		0.9			
T. Str. (10^3psi)		2.7		1.9			
C. Str. (10^3psi)		7.7-9.7		7.7-9.7			
Flex. Str. (10^3psi)							
Density (g/cc)		1.91		1.91			
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		7.9		11.0			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	Graph-I-Tite* "G90"	cyl 3-30"	$1-10/lb		

* Registered trademark

GRAPHITE PRODUCT NO. 112

Characterization

TYPE: extruded, medium grained; high strength; good electrical conductivity; good thermal conductivity; high purity; good nuclear properties; high reproducibility; high density

MFG: calcined petroleum coke; graphitized over 2500C; electrical resistance furnace; impregnated; machined; batch size 100-2000 lb

ANALYTICAL: Ash

Av. value 0.06-0.08% depending on size

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Typical							
Y. Mod. (10^6psi)		1.2		0.9			
T. Str. (10^3psi)		2.9		2.0			
C. Str. (10^3psi)		7.9-10		7.9-10			
Flex. Str. (10^3psi)							
Density (g/cc)		1.93		1.93			
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		7.9		11			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	Graph-I-Tite* "G92"	cyl 3/8 - 30" pipe 1-1/4 - 5 -1/4" OD	$1-10/lb		

* Registered trademark

GRAPHITE PRODUCT NO. 113

Characterization

TYPE: extruded, medium grained; good electrical conductor; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V
Av. value	0.30%	0.10%	0.04%	0.04%	0.03%	0.03%	70ppm
Std. dev. (%)	< 50	< 50	<40	<40	< 30	< 30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	10	1.0	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	1.2	10	1.0	10		
Density (g/cc)	(5)	1.55	2				
C. Exp. (10^{-6}/°C)	(6)	1.2	5	2.4	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Permeability (D'Arcy)		0.37	10	0.34	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes Carbon	HC	cyl 7-12"	<$1/lb	over 30 M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 114

Characterization

TYPE: extruded, medium grained; good electrical conductor; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; ground; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Ti	Na
Av. value	0.20%	0.03%	0.05%	0.03%	0.03%	0.03%	60ppm	30ppm	20ppm
Std. dev. (%)	<50	<50	<30	<50	<30	<30	<30	<20	<20

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	2.0	10	1.8	10		
Density (g/cc)	(5)	1.6	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		30%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HL	cyl 3-6" blk 3/4-6" thk x 2-18" width	<$1/lb	over 30 M T/yr	2 mo
Great Lakes	HL	cyl 3-4" lengths to 100"	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 115

Characterization

TYPE: extruded, medium grained; good electrical conductor; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; ground over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Ti	Na
Av. value	0.12%	0.02%	0.04%	0.03%	0.02%	0.02%	30ppm	10ppm	10ppm
Std. dev. (%)	<50	<50	<30	<40	<50	<30	<50	<50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1200F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	2.0	10	1.8	10		
Density (g/cc)	(5)	1.6	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		30%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HL 8	cyl 3-6" blk 3/4-6" x 2-18" width	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 116

Characterization

TYPE: extruded, medium grained; good electrical conductor; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; ground; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Na
Av. value	0.10%	0.02%	0.03%	0.02%	0.01%	77ppm	12ppm	10ppm
Std. dev. (%)	<50	<50	<40	<40	<50	<50	<50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300°F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	1.2	10	1.0	10		
Density (g/cc)	(5)	1.6	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		30%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HL-9	cyl. 3-6" dia blk 3/4-6" thk x 2-18" width	<$1/lb	over 30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-38-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 117

Characterization

TYPE: extruded, medium grained; good electrical conductor; high purity; high reproducibility; long experience; large sizes; high reproduction; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	V
Av. value	0.10%	0.02%	0.02%	0.01%	1ppm
Std. dev. (%)	< 50	< 50	< 40	< 40	< 50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	2.0	10	1.8	10		
Density (g/cc)	(5)	1.6	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		30%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HL-10	cyl 3-6" blk 3/4-6" thk x 2-18" width	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 118

Characterization

TYPE: extruded, medium grained; good electrical conductivity; used for molds, jigs and fixtures, heat exchangers, sintering boats, crucibles, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.25%	0.04%	0.03%	0.06%	0.02%	0.01%	60ppm
Std. dev. (%)	<50	<40	<30	<40	<40	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8	10	1.5	10		
T. Str. (10^3psi)	(2)	1.8	10	1.5	10		
C. Str. (10^3psi)	(3)	6.5	10	6.0	10		
Flex. Str. (10^3psi)	(4)	3.0	10	2.7	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	3.3	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	11	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM	cyl 1-3" blk 1-2" thk x 2-6" width	<$1/lb	3M-30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 119

Characterization

TYPE: extruded, medium grained; good thermal conductivity; high reproducibility; used for molds, jigs and fixtures, sintering boats, crucibles, support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.25%	0.04%	0.03%	0.06%	0.02%	0.01%	60ppm
Std. dev. (%)	<50	<40	<30	<40	<40	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	1.3	10	1.0	10		
C. Str. (10^3psi)	(3)	5.3	10	5.5	10		
Flex. Str. (10^3psi)	(4)	2.6	10	2.0	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	3.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.37	10	0.26	10		
S. Res. (10^{-4}ohm cm)	(8)	10	10	14	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM	cyl 4-14" blk 2-6" x 4-6"	<$1/lb	3M-30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 120

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high reproducibility; used for molds, jigs and fixtures, heat exchangers, sintering boats, crucibles, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces.

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.40%	0.10%	0.06%	0.06%	0.04%	0.02%	0.01%
Std. dev. (%)	<50	<30	<30	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.0	10		
T. Str. (10^3psi)	(2)	1.2	10	0.9	10		
C. Str. (10^3psi)	(3)	4.8	10	5.0	10		
Flex. Str. (10^3psi)	(4)	2.1	10	1.6	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.7	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.35	10	0.33	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	9	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM	cyl 16-30" blk 8-24" x 8-48"	<$1/lb	3M-30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 121

Characterization

TYPE: extruded, medium grained; high reproducibility; long experience; used for furnace electrodes and molds for pressure casting

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.40%	0.10%	0.06%	0.06%	0.04%	0.02%	0.01%
Std. dev. (%)	<50	<40	<30	<40	<50	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	10	1.0	10		
T. Str. (10^3psi)	(2)	.85	10	.7	10		
C. Str. (10^3psi)	(3)	4.0	10	3.5	10		
Flex. Str. (10^3psi)	(4)	1.5	10	1.2	10		
Density (g/cc)	(5)	1.62	2				
C. Exp. (10^{-6}/°C)	(6)	2.0	5	2.9	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.31	10	0.29	10		
S. Res. (10^{-4}ohm cm)	(8)	10	10	14	10		
Permeability (D'Arcy)		0.30	10	0.34	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM-50	cyl 1-55" blk 1-24" x 2-48" blk 24" x 30"	<$1/lb	3 M-30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 122

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high reproducibility; used for molds, sintering boats, crucibles, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.25%	0.04%	0.03%	0.06%	0.02%	0.01%	60ppm
Std. dev. (%)	<50	<40	<30	<40	<40	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.2	10	1.8	10		
T. Str. (10^3psi)	(2)	2.4	10	2.0	10		
C. Str. (10^3psi)	(3)	8.3	10	8.0	10		
Flex. Str. (10^3psi)	(4)	4.1	10	3.5	10		
Density (g/cc)	(5)	1.83	2				
C. Exp. (10^{-6}/°C)	(6)	2.1	5	3.5	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	11	10		
Permeability (D'Arcy)		0.06	5	0.04	5		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM-85	cyl 1-3" blk 1-2" x 2-6"	<$1/lb	3M-30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

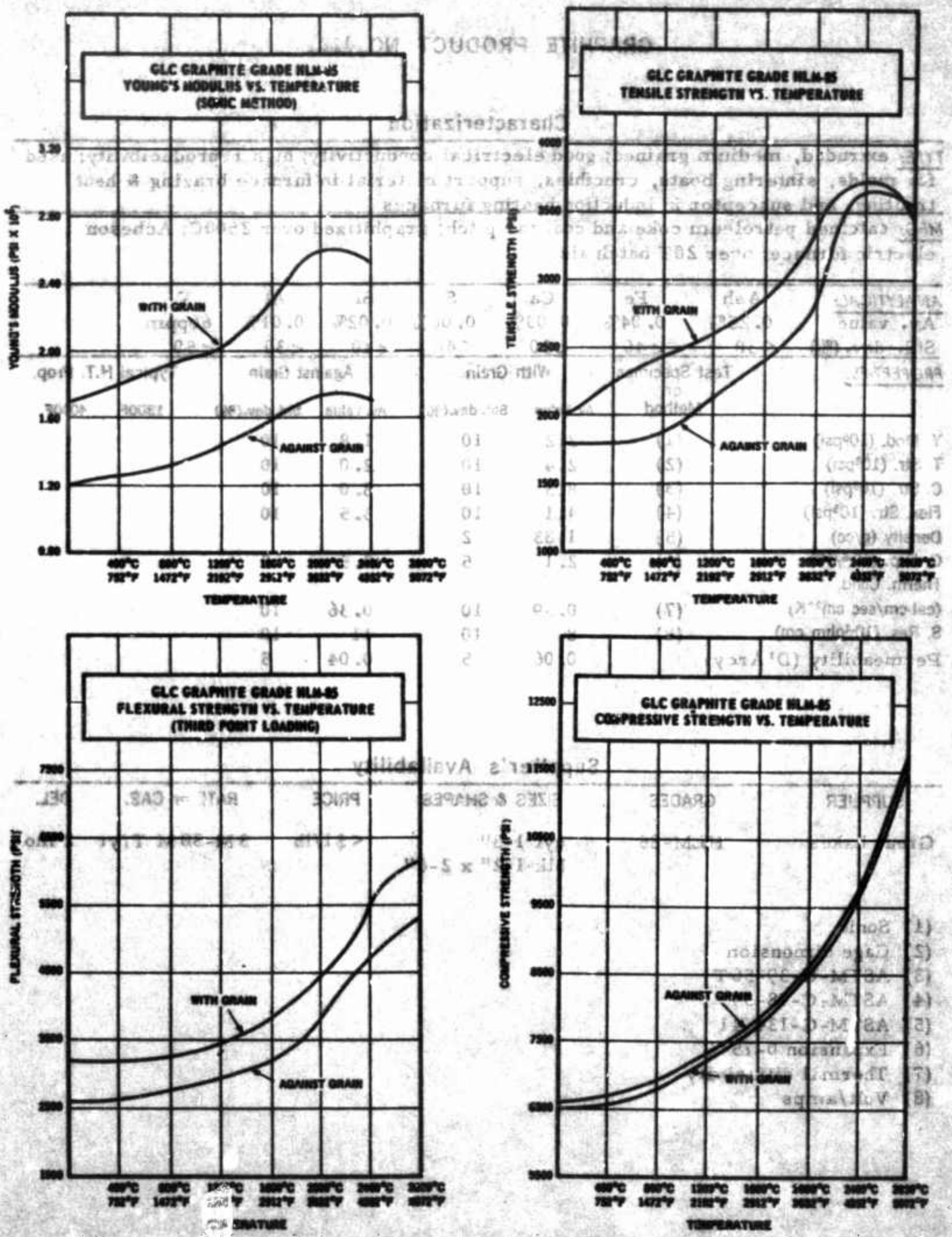
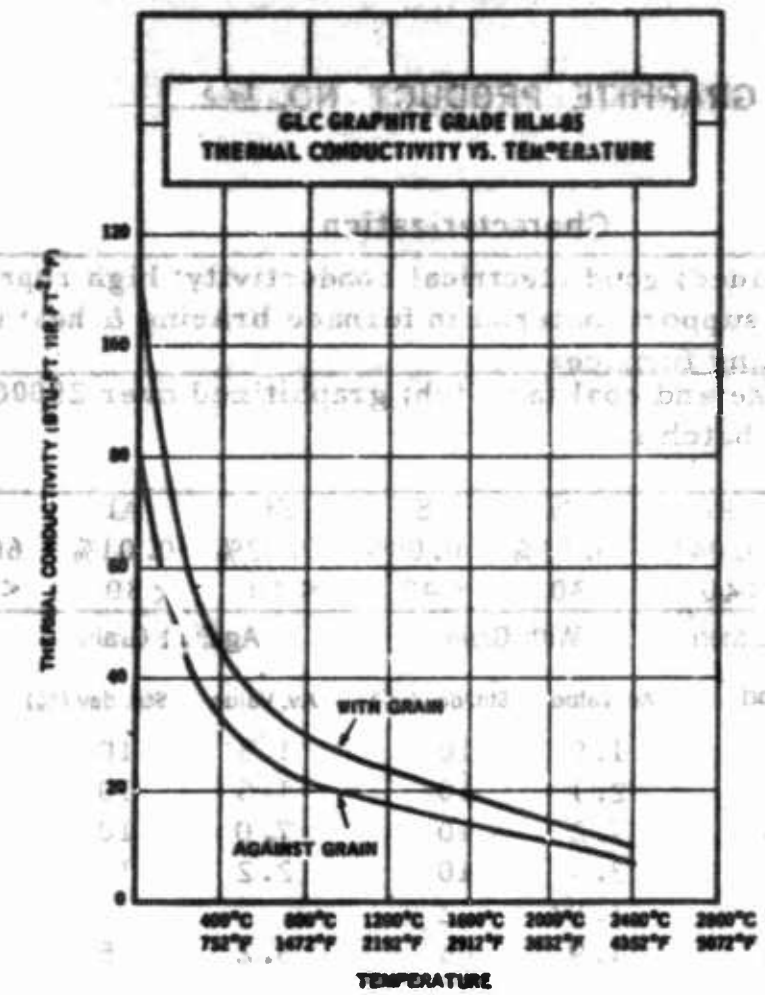


FIGURE 30 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 122
(Furnished by Great Lakes Carbon)



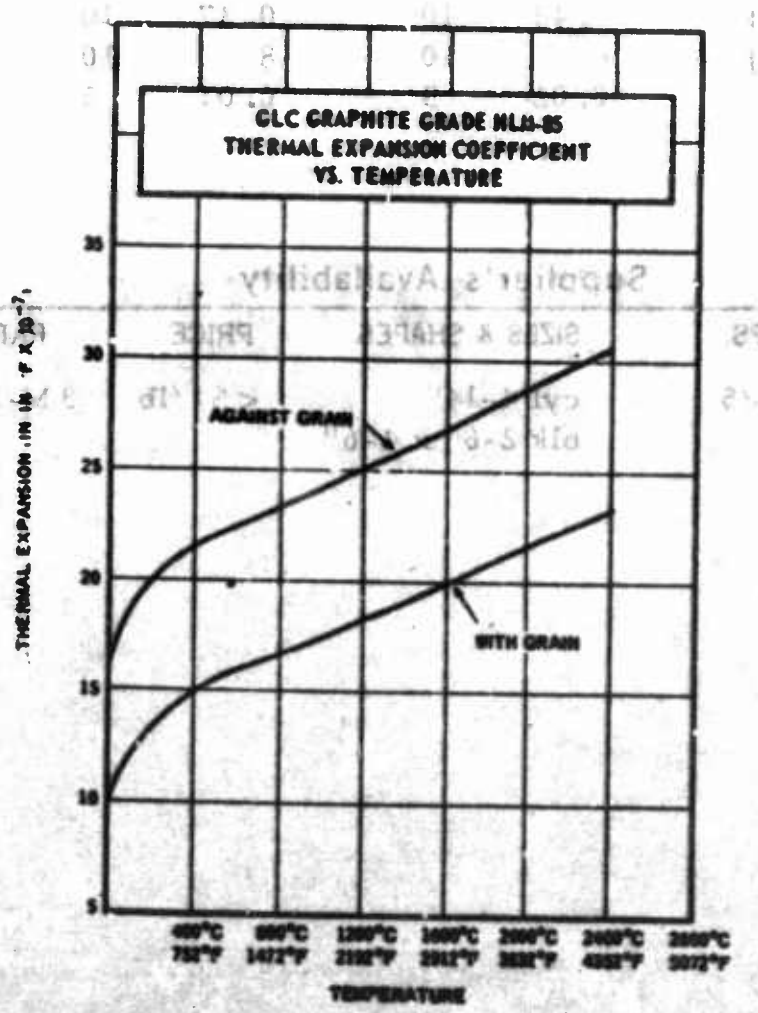


FIGURE 31 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 122
(Furnished by Great Lakes Carbon)

GRAPHITE PRODUCT NO. 123

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high reproducibility; used for rocket nozzle inserts, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.25%	0.04%	0.03%	0.06%	0.02%	0.01%	60ppm
Std. dev. (%)	<50	<40	<30	<40	<40	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.9	10	1.3	10		
T. Str. (10^3psi)	(2)	2.1	10	1.5	10		
C. Str. (10^3psi)	(3)	7.2	10	7.0	10		
Flex. Str. (10^3psi)	(4)	3.4	10	2.2	10		
Density (g/cc)	(5)	1.83	2				
C. Exp. (10^{-6}/°C)	(6)	1.9	5	3.2	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.48	10	0.37	10		
S. Res. (10^{-4}ohm cm)	(8)	6	10	8	10		
Permeability (D'Arcy)		0.02	5	0.01	5		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM-85	cyl 4-14" blk 2-6" x 4-6"	<$1/lb	3M-30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 124

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high reproducibility; used for mold stock; sintering boats, crucibles, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Fe	Ca	S	Si	Al	V
Av. value	0.40%	0.10%	0.06%	0.06%	0.04%	0.02%	0.01%
Std. dev.	<50	<30	<30	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7	10	1.2	10		
T. Str. (10^3psi)	(2)	2.0	10	1.8	10		
C. Str. (10^3psi)	(3)	6.5	10	6.6	10		
Flex. Str. (10^3psi)	(4)	3.2	10	2.6	10		
Density (g/cc)	(5)	1.83	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.9	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.44	10	0.33	10		
S. Res. (10^{-4}ohm cm)	(8)	7	10	9	10		
Permeability (D'Arcy)		0.05	5	0.05	5		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HLM-85	cyl 16-30" blk 8-24" x 8-48"	<$1/lb	3M-30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 125

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Si	S	Fe	Ca	Al	V
Av. value	0.30%	0.04%	0.10%	0.04%	0.03%	0.03%	70ppm
Std. dev. (%)	<50	<40	<50	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	10	1.0	10		
T. Str. (10^3psi)	(2)	1.5	10	1.3	10		
C. Str. (10^3psi)	(3)	5.5	10	5.0	10		
Flex. Str. (10^3psi)	(4)	2.5	10	2.2	10		
Density (g/cc)	(5)	1.70	2				
C. Exp. (10^{-6}/°C)	(6)	2.1	5	2.5	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	11	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPC	cyl 1-3"	<$1/lb	over 30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 126

Characterization

TYPE: extruded, medium grained; good electrical conductivity; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	Si	S	Fe	Ca	Al	V
Av. value	0.30%	0.04%	0.10%	0.04%	[illegible]	0.03%	[illegible]0ppm
Std. dev. (%)	<50	<40	<50	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1200F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.1	10		
T. Str. (10^3psi)	(2)	1.2	10	1.0	10		
C. Str. (10^3psi)	(3)	5.4	10	5.0	10		
Flex. Str. (10^3psi)	(4)	2.3	10	2.0	10		
Density (g/cc)	(5)	1.70	2				
C. Exp. (10^6/°C)	(6)	2.2	5	2.5	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^4ohm cm)	(8)	8	10	11	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPC	cyl 3-3/4-6" cyl 7", 8", 9", 12" blk 1-8" x 2-8"	<$1/lb	over 30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 127

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Ti	Na
Av. value	0.20%	0.02%	0.05%	0.03%	0.03%	0.03%	60ppm	30ppm	20ppm
Std. dev. (%)	<50	<50	<90	<40	<30	<30	<50	<50	<50

PROPERTIES.	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.1	10		
T. Str. (10^3psi)	(2)	1.3	10	1.1	10		
C. Str. (10^3psi)	(3)	4.5	10	4.5	10		
Flex. Str. (10^3psi)	(4)	2.5	10	2.3	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.6	5	2.0	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	12	10		
Apparent porosity		25%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPL	cyl 3-6" blk 3/4-6"x 2-8"	<$1/lb	over 30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 128

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Ti	Na
Av. value	0.12%	0.02%	0.04%	0.03%	0.02%	0.02%	30ppm	10ppm	10ppm
Std. dev. (%)	<50	<50	<30	<40	<50	<30	<50	<50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.1	10		
T. Str. (10^3psi)	(2)	1.3	10	1.1	10		
C. Str. (10^3psi)	(3)	4.5	10	4.5	10		
Flex. Str. (10^3psi)	(4)	2.5	10	2.3	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.6	5	2.0	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	12	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPL-8	cyl 3-6" blk 3/4-6" x 2-18"	<$1/lb	over 30M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 129

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Na
Av. value	0.10%	0.02%	0.03%	0.02%	0.01%	77ppm	12ppm	10ppm
Std. dev. (%)	<50	<50	<40	<40	<50	<50	<50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.1	10		
T. Str. (10^3psi)	(2)	1.3	10	1.1	10		
C. Str. (10^3psi)	(3)	4.5	10	4.5	10		
Flex. Str. (10^3psi)	(4)	2.5	10	2.3	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.6	5	2.0	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	12	10		
Apparent porosity		25%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPL 9	cyl 3-6" blk 3/4-6" x 2-18"	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 130

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	V
Av. value	0.10%	0.02%	0.02%	0.01%	1ppm
Std. dev. (%)	<50	<50	<40	<40	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3	10	1.1	10		
T. Str. (10^3psi)	(2)	1.3	10	1.1	10		
C. Str. (10^3psi)	(3)	4.5	10	4.5	10		
Flex. Str. (10^3psi)	(4)	2.5	10	2.3	10		
Density (g/cc)	(5)	1.75	2				
C. Exp. (10^{-6}/°C)	(6)	1.6	5	2.0	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.39	10	0.36	10		
S. Res. (10^{-4}ohm cm)	(8)	8	10	12	10		
Apparent porosity		25%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HPL-10	cyl 3-6" blk 3/4-6" x 2-18"	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 131

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; high reproducibility; long experience; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Co	Pb	Ca	Al	Na	Mg
Av. value	0.20%	0.10%	0.05%	0.03%	0.05%	0.04%	0.03%	0.03%	20%	20%
Std. dev. (%)	< 50	< 50	<40	< 40	<40	<50	< 30	< 30	< 50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	10	1.2	10		
T. Str. (10^3psi)	(2)	0.8	10	0.6	10		
C. Str. (10^3psi)	(3)	3.5	10	3.5	10		
Flex. Str. (10^3psi)	(4)	2.0	10	1.8	10		
Density (g/cc)	(5)	1.7	2				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		16%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	TL	cyl 3-6" blk 3/4-6" x 2-18"	< $1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-56T
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 132

Characterization

TYPE: extruded, medium grained; high strength; good electrical conductivity; high purity; high reproducibility; low porosity; long experience; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Co	Pb	Ca	Al	V	Ti	Mn	Ni
Av. value	0.20%	0.01%	0.05%	0.03%	0.05%	0.04%	0.03%	0.03%	80ppm	50ppm	35ppm	30ppm
Std. dev. (%)	<50	<50	<40	<40	<40	<40	<30	<30	<50	<50	<50	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	10	1.2	10		
T. Str. (10^3psi)	(2)	1.2	10	1.0	10		
C. Str. (10^3psi)	(3)	4.5	10	4.5	10		
Flex. Str. (10^3psi)	(4)	2.6	10	2.4	10		
Density (g/cc)	(5)	1.78	2				
C. Exp. (10^{-6}/°C)	(6)	2.0	5	2.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.39	10	0.36	5		
S. Res. (10^{-4}ohm cm)	(8)	8	10	12	10		
Apparent porosity		13%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	TPL	cyl 3-6" blk 3/4-6" x 2-48"	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 133

Characterization

TYPE: extruded, medium grained; low coeff. therm. exp.; good el. trical and thermal conductor; long experience; high production; used for furnace electrodes, mold stock, sintering boats, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash
Av. value	< 1.0%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.0			
T. Str. (10^3psi)	(2)	1.5		1.0		2.1	3.8
C. Str. (10^3psi)	(3)	5.6		5.85		4.8	7.3
Flex. Str. (10^3psi)	(4)	3.3		2.4		4.0	6.2
Density (g/cc)	(5)	1.77					
C. Exp. (10^{-6}/°C)	(6)	2.5		4.5			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.23	
S. Res. (10^{-4}ohm cm)	(8)	6.5					
Scleroscope Hardness		35					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	700	cyl 3-7"	<$1/lb	100-3 M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps

GRAPHITE PRODUCT NO. 134

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; low porosity; chemical resistant; high production; long experience; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash	Fe
Av. value	0.08%	<200ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	1.0					
C. Str. (10^3psi)	(2)	5.5					
Flex. Str. (10^3psi)	(3)	2.5					
Density (g/cc)	(4)	1.64					
C. Exp. (10^{-6}/°C)	(5)	2.4		4.5			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	7.2					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	700	cyl 8", 9", 10" dia	<$1/lb	3M-30M T/yr	0-2 mo

(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Volt/amps

GRAPHITE PRODUCT NO. 135

Characterization

TYPE: extruded, medium grained; low coeff. of therm. exp., good electrical conductivity; high temperature oxidation resistant; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash
Av. value	< 1.0%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	.55					
T. Str. (10^3psi)	(2)	4.5					
C. Str. (10^3psi)	(3)	2.0					
Flex. Str. (10^3psi)	(4)	8.2					
Density (g/cc)	(5)	1.64					
C. Exp. (10^{-6}/°C)	(6)	2.4		3.4			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	10.9					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	700	cyl 12" & 14" dia x 60-96" long	<$1/lb	100-3 M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 136

Characterization

TYPE: extruded, medium grained; high strength; low coeff. of therm. exp.; high purity; good nuclear properties; high temperature oxidation resistant; long experience; used for molds, jigs, fixtures, moderators for nuclear piles, and rocket nozzle inserts

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash	Al	B	Ca	Fe	Mg	Ni	Si	Ti	V
Av. value	100ppm max	< 10ppm	<1ppm	<1ppm	5ppm	<1ppm	<10ppm	30ppm	<10ppm	1ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.1			
T. Str. (10^3psi)	(2)	1.6		1.4		2.0	4.0
C. Str. (10^3psi)	(3)	6.4		6.8		6.2	9.6
Flex. Str. (10^3psi)	(4)	3.2		2.6		3.8	5.8
Density (g/cc)	(5)	1.77					
C. Exp. (10^{-6}/°C)	(6)	2.4		4.2			
Therm. Cond. (cal-cm/sec cm²°K)	(7)					0.23	
S. Res. (10^{-4}ohm cm)	(8)	6.35				6.25	10.3

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	873RL	cyl 14" max dia	<$1/lb	100-3 M T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C

GRAPHITE PRODUCT NO. 137

Characterization

TYPE: extruded, medium grained; high strength; low coeff. of therm. exp.; long experience; used for mold stock, jigs and fixtures, rocket nozzle inserts, sintering boats, heater elements, crucibles, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; 1-20 T batch size

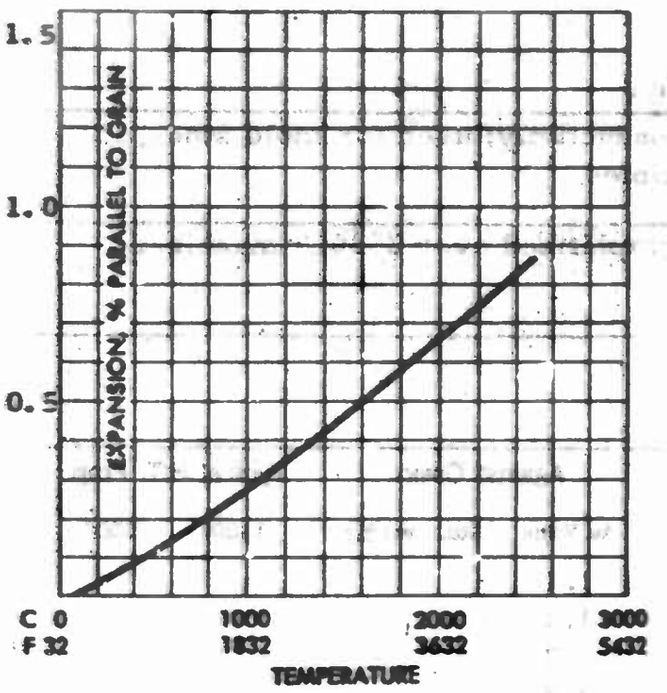
ANALYTICAL: Ash
Av. value 0.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prep.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.1			
T. Str. (10^3psi)	(2)	1.6		1.4		2.0	4.0
C. Str. (10^3psi)	(3)	6.4		6.8		6.2	9.6
Flex. Str. (10^3psi)	(4)	3.2		2.6		3.8	5.8
Density (g/cc)	(5)	1.77					
C. Exp. (10^{-6}/°C)	(6)	2.4		4.2			
Therm. Cond. (cal-cm/sec cm^2°K)	(7)					0.23	
S. Res. (10^{-5}ohm cm)	(8)	6.4				6.25	10.8
Scleroscope Hardness		38					
Permeability cm^2/sec		2.6-5.9		0.5-8.8			

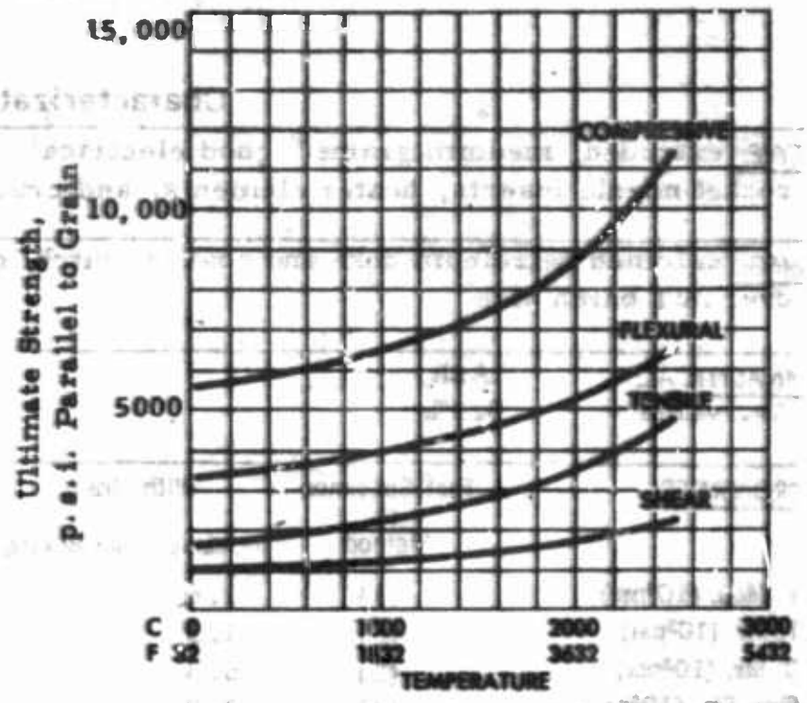
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	873S	cyl 12-16"	<$1/lb	100-3 M T/yr	0-2 mo

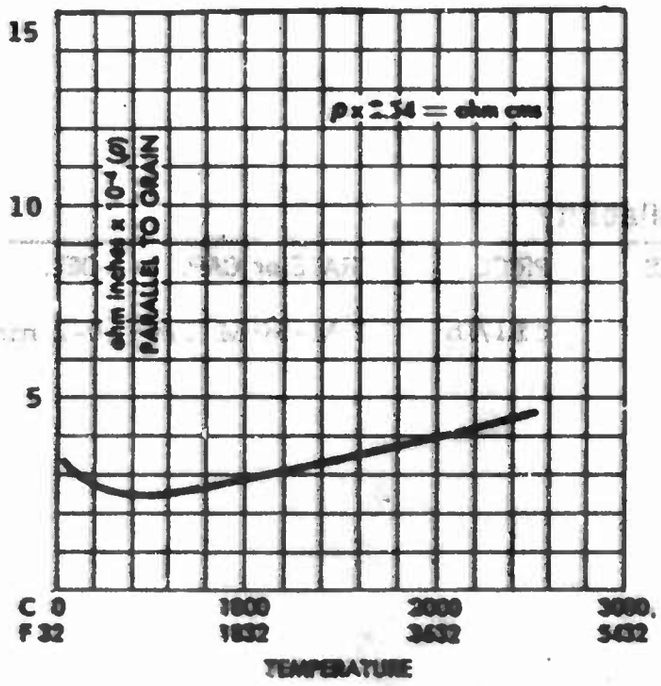
(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Guarded hot plate
(8) Volt/amps



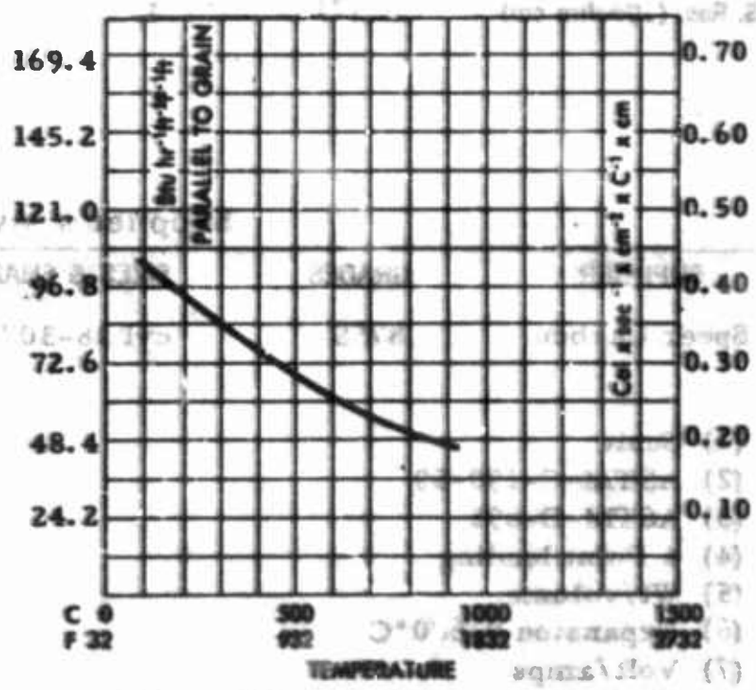
Thermal Expansion vs. Temperature
Grade 873S



Ultimate Strength vs. Temperature
Grade 873S



Electrical Resistivity - Grade 873S



Thermal Conductivity - Grade 873S

FIGURE 32 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 137
(Furnished by Speer Carbon)

GRAPHITE PRODUCT NO. 138

Characterization

TYPE: extruded, medium grained; good electrical conductivity; used for mold stock, rocket nozzle inserts, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.3%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1900F	4000F
Y. Mod. (10^6psi)	(1)	1.6		1.1			
T. Str. (10^3psi)	(2)	1.3		1.1			
C. Str. (10^3psi)	(3)	5.3		6.2			
Flex. Str. (10^3psi)	(4)	2.8		2.4			
Density (g/cc)	(5)	1.72					
C. Exp. (10^{-6}/°C)	(6)	2.6		4.2			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	7.1					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	875S	cyl 18-30"	~$1/lb	3M-30M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 139

Characterization

TYPE: extruded, medium grained; high reproducibility; long experience; used for molds, jigs, fixtures, sintering boats, crucibles, support material in furnace brazing & heat treating, and susceptor in induction heating furnaces

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	0.9		0.8			
C. Str. (10^3psi)	(2)	4.0		2.8			
Flex. Str. (10^3psi)	(3)	2.0		1.2			
Density (g/cc)	(4)	1.60					
C. Exp. (10^{-6}/°C)	(5)	2.1		3.5			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(6)	9.4					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	896G	cyl 9-20" blk 16" x 16"	<$1/lb	100-3 M T/yr	0-2 mo

(1) ASTM-C-190-59
(2) ASTM-D-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Volt/amps

GRAPHITE PRODUCT NO. 140

Characterization

TYPE: extruded, medium grained; good electrical conductivity; low porosity; chemical resistant; long experience; high production; used for electrolytic anodes, jigs, fixtures, heater elements, sintering boats, and support material in furnace brazing & heat treating

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	2600					
Density (g/cc)	(2)	1.7					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(3)	6.5					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	900	blk to 30 sq in	<$1/lb	3M-30M T/yr	0-2 mo

(1) 4 Point loading
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 141

Characterization

TYPE: extruded, medium grained; good electrical conductivity; low porosity; long experience; high production; used for electrolytic anodes, mold stock, jigs, fixtures, support material in furnace brazing & heat treating, sintering boats, heater elements

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash
Av. value	< 0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.2			
T. Str. (10^3psi)	(2)	1.5		1.0			
C. Str. (10^3psi)	(3)	5.6		5.8			
Flex. Str. (10^3psi)	(4)	3.3		2.4			
Density (g/cc)	(5)	1.7					
C. Exp. (10^{-6}/°C)	(6)	2.2		3.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	6.1					
Scleroscope Hardness		35					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	900	to 60 sq in cross section	<$1/lb	3M-30M T/yr	0-2 mc

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 142

Characterization

TYPE: extruded, medium grained; good electrical conductivity; high purity; good nuclear properties; low porosity; highly oriented; chemical resistant; long experience; high production; used for electrolytic anodes and moderators for nuclear piles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash	V
Av. value	<.02%	< 2ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.1			
T. Str. (10^3psi)	(2)	1.5		1.3			
C. Str. (10^3psi)	(3)	5.6		5.9			
Flex. Str. (10^3psi)	(4)	3.3		2.6			
Density (g/cc)	(5)	1.77					
C. Exp. (10^{-6}/°C)	(6)	2.2		4.2			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	7.5					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	900	to 60 sq in cross section	< $1/lb	3M-30M T/yr	0-4 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 143

Characterization

TYPE: extruded, medium grained; high reproducibility; used for mold stock, susceptor in induction heating furnaces, crucibles, and electronic tube anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

	Ash
Av. value	0.01%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	2.1					
Density (g/cc)	(2)	1.62					
C. Exp. (10^{-6}/°C)	(3)	1.9		3.4			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	7.9					
Scleroscope Hardness		37					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	7479	cyl 2-3/4"-14"	<$1/lb	10-100 T/yr	1 mo

(1) 4 Point loading
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 144

Characterization

TYPE: extruded, medium grained; high strength; high reproducibility; high production; recommended as a substrate grade

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 1-20T batch size

ANALYTICAL:

	Ash
Av. value	0.09%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.6		1.3			
T. Str. (10^3psi)	(2)	1.8		1.7			
C. Str. (10^3psi)	(3)	7.1		7.8			
Flex. Str. (10^3psi)	(4)	3.5		3.2			
Density (g/cc)	(5)	1.73					
C. Exp. (10^{-6}/°C)	(6)	4.1		5.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(7)	9.1					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	SX-4	cyl 14" dia blk 4" x 22"	$1-10/lb	10-100 T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 145

Characterization

TYPE: extruded, medium grained; high strength; used as a substrate grade

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	2.4		1.7			
C. Str. (10^3psi)	(2)	8.3		9.8			
Flex. Str. (10^3psi)	(3)	4.6		4.3			
Density (g/cc)	(4)	1.73					
C. Exp. (10^6/°C)	(5)	5.4		6.0			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)	(6)	9.7					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	SX-5	blk 3-1/2" x 17-3/4"	$1-10/lb	10-100 T/yr	0-6 mo

(1) ASTM-C-190-59
(2) ASTM-C-695
(3) 4 Point loading
(4) Wt/volume
(5) Expansion 0-600°C
(6) Volt/amps

GRAPHITE PRODUCT NO. 146

Characterization

TYPE: extruded, medium grained; good electrical conductor; good thermal conductor; long experience; high production; used for electrolytic anodes, mold stock, rocket nozzle inserts, fluxing tubes, sintering boats, heater elements, pistons, and valves

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	.06%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	Sonic	1.2		0.9			
T. Str. (10^3psi)							
C. Str. (10^3psi)	NEMA	5.3		4.4			
Flex. Str. (10^3psi)	NEMA	3.0		2.5			
Density (g/cc)	NEMA	1.68					
C. Exp. (10^{-6}/°C)	NEMA	2.9		3.8			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	NEMA	3.7		4.2			
Hardness	35 (Scleroscope)						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	HB 1-4	cyl 1/8 - 5-1/2" (up to 80" lg) blk 1 - 4" rod 10 mil-1/8" plt 1/16 - 1"	<$1/lb	100-3 M T/yr	

GRAPHITE PRODUCT NO. 147

Characterization

TYPE: extruded, medium grained; good electrical conductor; good thermal conductor; high reproducibility; long experience; high production; used for mold stock, jigs and fixtures, electrolytic anodes, fluxing tubes, and sintering boats

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	.08%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	Sonic	1.5		0.9			
T. Str. (10^3psi)							
C. Str. (10^3psi)	NEMA	3.7		3.6			
Flex. Str. (10^3psi)	NEMA	2.4		1.9			
Density (g/cc)	NEMA	1.61					
C. Exp. (10^{-6}/°C)	NEMA	2.1		4.1			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	NEMA	2.7		5.0			
Hardness	35 (Scleroscope)						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	HBX	cyl 1/8-5-1/2" (up to 80" lg) blk 1-4" rod 10 mil-1/8" plt <1/16-1"	<$1/lb	100-3 m T/yr	

GRAPHITE PRODUCT NO. 148

Characterization

TYPE: extruded, medium grained; high purity; long experience; good nuclear properties; boron content carefully controlled; recommended where application requires low neutron capture cross section

MFS: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:	Ash	B
Av. value	< 0.1%	< 0.8ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5		1.1			
T. Str. (10^3psi)	(2)	1.4		1.3			
C. Str. (10^3psi)	(3)	6.0		6.0			
Flex. Str. (10^3psi)	(4)	2.4		2.0			
Density (g/cc)	(5)	1.70					
C. Exp. (10^{-6}/°C)	(6)	2.2		3.8			
Therm. Cond. (cal-cm/sec cm^2°K)		.42		.33			
S. Res. (10^{-4}ohm cm)	(7)	7.3		9.4			
Thermal neutron absorbtion Cross section (millibarns)		4.5					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	AGOT	blk 4-20"	<$1/lb	10-100 T/yr	100-3 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 149

Characterization

TYPE: extruded, medium grained; long experience; large and small sizes; high production; thermal shock resistant; used for furnace electrodes and electrolytic anodes

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.30%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	10	0.8	14		
T. Str. (10^3psi)	(2)	1.1	15	.76	23		
C. Str. (10^3psi)	(3)	4.4	19	4.0	15		
Flex. Str. (10^3psi)	(4)	2.2	14	1.4	25		
Density (g/cc)	(5)	1.58	2				
C. Exp. (10^{-6}/°C)	(6)	1.38	15				
Therm. Cond. (cal-cm/sec cm^2°K)		0.36		0.24			
S. Res. (10^{-4}ohm cm)	(7)	8.6	8	12.8	8		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGR AGSR AGLR	cyl 3" - 5-3/4" plts 3/4 - 5-3/4" thk	<$10/lb	100-3 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-190-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 150

Characterization

TYPE: extruded, medium grained; long experience; high production; used for furnace electrodes, electrolytic anodes, mold stock, sintering boats, heater elements, crucibles, thermocouple sheaths, and end plates

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.42%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev (%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.6	12	0.9	8		
T. Str. (10^3psi)	(2)	1.4	16	1.0	14		
C. Str. (10^3psi)	(3)	5.6	24	5.3	22		
Flex. Str. (10^3psi)	(4)	2.7	17	1.8	25		
Density (g/cc)	(5)	1.69	1.5				
C. Exp. (10^{-6}/°C)	(6)	1.6	12				
Therm. Cond. (cal-cm/sec cm^2°K)		0.38		0.22			
S. Res. (10^{-4}ohm cm)	(7)	8.2	12	13.9	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGX AGSX AGLX	cyl 3" - 5-3/4" plt 3/4 - 1" blk 1 - 5"	< $1/lb	100-3 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 151

Characterization

TYPE: extruded, medium grained; long experience; high production; used for furnace electrodes, electrolytic anodes, and mold stock

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.68%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	9	1.0	9		
T. Str. (10^3psi)	(2)	1.3	17	1.2	19		
C. Str. (10^3psi)	(3)	5.2	12	5.2	12		
Flex. Str. (10^3psi)	(4)	2.4	16	1.8	18		
Density (g/cc)	(5)	1.71	2				
C. Exp. (10^{-6}/°C)	(6)	1.9	12	3.39	7		
Therm. Cond. (cal-cm/sec cm^2°K)		0.378		0.306			
S. Res. (10^{-4}ohm cm)	(7)	8.2	12	10.1	14		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGX AGSX AGLX	cyl 6 - 12" blk 6 - 12" thk	<$1/lb	100-3M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 152

Characterization

TYPE: extruded, medium grained; long experience; large and small sizes; high production; thermal shock resistant; used for furnace electrodes and electrolytic anodes

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.79%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	14	0.8	14		
T. Str. (10^3psi)	(2)	.88	18	.81	20		
C. Str. (10^3psi)	(3)	3.7	19	3.8	17		
Flex. Str. (10^3psi)	(4)	1.7	18	1.5	12		
Density (g/cc)	(5)	1.57	2				
C. Exp. (10^{-6}/°C)	(6)	1.9	14	3.0	6		
Therm. Cond. (cal-cm/sec cm^2°K)		0.35		0.28			
S. Res. (10^{-4}ohm cm)	(7)	8.9	7	11.1	8		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGR AGSR AGLR	cyl 6 - 12" blk 6 - 12" thk	< $10/lb	3 M-30 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 153

Characterization

TYPE: extruded, medium grained; long experience; large sizes; high production; used for molds, jigs and fixtures, susceptor in induction heating furnaces, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	1.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	6	1.1	7		
T. Str. (10^3psi)	(2)	1.3	13	1.2	15		
C. Str. (10^3psi)	(3)	5.5	11	5.0	15		
Flex. Str. (10^3psi)	(4)	2.2	15	1.9	18		
Density (g/cc)	(5)	1.70	1				
C. Exp. (10^{-6}/°C)b	(6)	2.7	9	3.8	5		
Therm. Cond. (cal-cm/sec cm^2°K)		0.38		0.29			
S. Res. (10^{-4}ohm cm)	(7)	8.9	13	10.7	20		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	ATL	cyl 20"x 24" dia blk 20 x 20" cross section blk 24 x 24" cross section blk 24 x 30" cross section	<$1/lb	over 30 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 154

Characterization

TYPE: extruded, medium grained; high purity; long experience; large and small sizes; used for molds, jigs and fixtures, susceptor in induction heating furnaces, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.7	11	0.9	11		
T. Str. (10^3psi)	(2)	1.2	18	0.9	20		
C. Str. (10^3psi)	(3)	4.6	17	4.6	13		
Flex. Str. (10^3psi)	(4)	2.9	29	1.7	18		
Density (g/cc)	(5)	1.68	3				
C. Exp. (10^{-6}/°C)	(6)	1.1	25	3.4	4		
Therm. Cond. (cal-cm/sec cm^2°K)		0.39		0.25			
S. Res. (10^{-4}ohm cm)	(7)	7.9	10	12.3	8		

Low gas evolution
Guaranteed max ash 0.08%, ave 0.03%

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AUC	cyl 1-1/4 - 8"	<$1/lb	3M-30M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 155

Characterization

TYPE: extruded, medium grained; high purity; long experience; large and small sizes; used for molds, jigs and fixtures, susceptor in induction heating furnaces, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.03%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.4	14	1.0	9		
T. Str. (10^3psi)	(2)	1.1	17	1.1	18		
C. Str. (10^3psi)	(3)	3.9	18	4.4	20		
Flex. Str. (10^3psi)	(4)	2.2	20	1.9	19		
Density (g/cc)	(5)	1.66					
C. Exp. (10^{-6}/°C)	(6)	1.8	20	3.3	11		
Therm. Cond. (cal-cm/sec cm^2°K)		0.40		0.321			
S. Res. (10^{-4}ohm cm)	(7)	7.7	4	9.8	11		

Low gas evolution
Guaranteed max ash 0.08%, ave. 0.03%

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AUC	cyl 20 - 24"	< $1/lb	3 M-30 M T/yr	1 mo
		cyl 9 - 18"	< $ 1/lb	3 M-30 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTm-C-78-49
(5) Wt/volume
(6) bar 5/16" 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 156

Characterization

TYPE: extruded, medium grained; long experience; high production; used for mold stock, rocket nozzle inserts, susceptor in induction heating furnace, continuous casting dyes, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace;impregnated in secondary processing; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8	3				
T. Str. (10^3psi)	(2)	1.4	16				
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(3)	2.8	14	1.3	25		
Density (g/cc)	(4)	1.68	2				
C. Exp. (10^{-6}/°C)	(5)	1.35	11				
Therm. Cond. (cal-cm/sec cm²°K)		0.381		0.241			
S. Res. (10^{-4}ohm cm)	(6)	8.19	15	13.1	14		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CS	cyl 1 - 2-3/4"	< $1/lb	over 30M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-78-54T
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) Volt/amps

GRAPHITE PRODUCT NO. 157

Characterization

TYPE: extruded, medium grained; long experience; high production; used for rocket nozzle inserts, susceptor in induction heating furnaces, continuous casting dyes, heater elements, and crucibles

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	1.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5	9	1.1	8		
T. Str. (10^3psi)	(2)	1.4	18	1.3	25		
C. Str. (10^3psi)	(3)	6.0	11	6.0	15		
Flex. Str. (10^3psi)	(4)	2.4	21	2.0	26		
Density (g/cc)	(5)	1.72	2				
C. Exp. (10^{-6}/°C)	(6)	2.2	17	3.8	11		
Therm. Cond. (cal-cm/sec cm^2°K)		0.36		0.28			
S. Res. (10^{-4}ohm cm)	(7)	8.6	9	11.0	12		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CS	cyl 12 - 18" blk 16-3/8 - 17-3/8"	<$1/lb	over 30 M T/yr	1 mo
	CS	cyl 3 - 11" blk 2 - 12" ave Ash 0.1%	<$1/lb	over 30 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 158

Characterization

TYPE: extruded, medium grained; high purity; long experience; good nuclear properties; boron content and total ash are extremely low; used in applications requiring low neutron capture cross section and low gas evolution (max 100 ppm Ash)

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; purified during secondary processing for low gas content; 1-20T batch size

ANALYTICAL:	Ash	B
Av. value	<.01%	< 0.2ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.5		1.1			
T. Str. (10^3psi)	(2)	1.4		1.3			
C. Str. (10^3psi)	(3)	6.0		6.0			
Flex. Str. (10^3psi)	(4)	2.4		2.0			
Density (g/cc)	(5)	1.71					
C. Exp. (10^{-6}/°C)	(6)	2.2		3.7			
Therm. Cond. (cal-cm/sec cm²°K)		0.33		0.26			
S. Res. (10^{-4}ohm cm)	(7)	9.3		11.9			
Thermal neutron absorbtion Cross section (millibarns)		3.9					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	TSX	blk up to 8"x8"x60"	< $1/lb	10-100 T/yr	100-3 M T/yr	4 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8"x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 159

Characterization

TYPE: extruded, medium grained; long experience; low cost; low Vanadium; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; over 20T batch size

ANALYTICAL:	Ash	V
Av. value	60ppm	2ppm or less

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod (10^6psi)	(1)	1.5		1.0			
T. Str. (10^3psi)	(2)	1.3		1.2			
C. Str. (10^3psi)	(3)	5.2		5.2			
Flex. Str. (10^3psi)	(4)	2.4		1.8			
Density (g/cc)	(5)	1.71					
C. Exp. (10^{-6}/°C)	(6)	2.0		3.4			
Therm. Cond. (cal-cm/soc cm^2°K)		0.381		0.311			
S. Res. (10^{-4}ohm cm)	(7)	8.2		10.0			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	YBF	blk 4-13/16 x 12-7/16 x 30" blk 6-7/8 x 9-9/10 x 50"	<$1/lb	10-100 T/yr	2-5 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 160

Characterization

TYPE: extruded, medium grained; high purity; long experience; used for jigs and fixtures

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	25ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.7		0.9			
T. Str. (10^3psi)		1.2		0.9			
C. Str. (10^3psi)		4.6		4.6			
Flex. Str. (10^3psi)		2.9		1.7			
Density (g/cc)		1.68					
C. Exp. (10^{-6}/°C)		1.1		3.4			
Therm. Cond. (cal-cm/sec cm²°K)		0.39		0.25			
S. Res. (10^{-4}ohm cm)		8.0		12.3			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	CCH	as finished machined parts. Max size 6-1/2" dia x 24" lg	$1-10/lb	< 10 T/yr	2-5 mo

GRAPHITE PRODUCT NO. 161

Characterization

TYPE: extruded, coarse grained; max grain size 0.13"

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		.50-.60					
C. Str. (10^3psi)		1.8-2.2					
Flex. Str. (10^3psi)		1.0-1.2					
Density (g/cc)		1.52-1.56					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)[1]		76-84					
S. Res. (10^{-4}ohm cm)[2]		32-34					

1 BTU/ft/°F
2 ohm in x 10^{-5}

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	CGE CGR	cyl 14"			0-6 mo

GRAPHITE PRODUCT NO. 162

Characterization

TYPE: extruded, coarse grained; max grain size 0.26"

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		.35-.45					
C. Str. (10^3psi)		1.6-2.0					
Flex. Str. (10^3psi)		.8-1.0					
Density (g/cc)		1.52-1.56					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)[1]		72-78					
S. Res. (10^{-4}ohm cm)[2]		36-40					

1 BTU/ft/°F
2 ohm in x 10^{-5}

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	CGE CGR	cyl 16 - 24"			0-6 mo

GRAPHITE PRODUCT NO. 163

Characterization

TYPE: extruded, coarse grained; low coeff. of therm. exp.; good electrical conductor; high temperature oxidation resistant; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash	Fe	Si
Av. value	0.45%	600ppm	300ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.6					
T. Str. (10^3psi)	(2)	6.0		4.0		6.0	1.0
C. Str. (10^3psi)	(3)	2.2		2.2		2.4	3.6
Flex. Str. (10^3psi)	(4)	9.1		8.2		1.3	2.1
Density (g/cc)	(5)	1.59					
C. Exp. (10^{-6}/°C)	(6)	1.4		2.9			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(7)	8.6		15.2			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	700	cyl 16-24" dia x 60-96" lg	<$1/lb	3M-50M T/yr	0-2 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-C-695
(4) 4 Point loading
(5) Wt/volume
(6) Expansion 0-600°C
(7) Volt/amps

GRAPHITE PRODUCT NO. 164

Characterization

TYPE: extruded, coarse grained; low coeff. therm. exp.; good electrical conductor; good thermal conductor; low cost; long experience; high production; used for furnace electrodes, and mold stock

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash
Av. value	1.0%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(2)	1.6					
Density (g/cc)	(3)	1.62					
C. Exp. (10^{-6}/°C)	(4)	2.5		4.2			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(5)	9.8					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	700	cyl 8-10" dia	<$1/lb	100-3 M T/yr	0-2 mo

(1) Sonic
(2) 4 Point loading
(3) Wt/volume
(4) Expansion 0-600°C
(5) Volt/amps

GRAPHITE PRODUCT NO. 165

Characterization

TYPE: extruded, coarse grained; good electrical conductor; long experience; high production; used for furnace electrodes, sintering boats, crucibles, and support material in furnace brazing & heat treating

MFG: calcined petroelum coke and coal tar pitch; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V
Av. value	0.30%	0.10%	0.04%	0.04%	0.03%	0.03%	70ppm
Std. dev. (%)	<50	<50	<40	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.2	10	1.0	10		
T. Str. (10^3psi)	(2)	0.6	10	0.5	10		
C. Str. (10^3psi)	(3)	2.0	10	2.0	10		
Flex. Str. (10^3psi)	(4)	0.9	10	0.8	10		
Density (g/cc)	(5)	1.55	2				
C. Exp. (10^{-6}/°C)	(6)	1.1	5	2.1	5		
Therm. Cond. Th. (cal-cm/sec cm^2°K)	(7)	0.33	10	0.30	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Permeability (D'Arcy)		0.65	10	0.47	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HC	cyl 14" dia	<$1/lb	over 30 M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 166

Characterization

TYPE: extruded, coarse grained; good electrical conductor; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V
Av. value	0.30%	0.10%	0.04%	0.04%	0.03%	0.03%	70ppm
Std. dev. (%)	<50	<50	<40	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.1	10	0.9	10		
T. Str. (10^3psi)	(2)	0.4	10	0.3	10		
C. Str. (10^3psi)	(3)	1.8	10	1.8	10		
Flex. Str. (10^3psi)	(4)	0.8	10	0.7	10		
Density (g/cc)	(5)	1.55	2				
C. Exp. (10^{-6}/°C)	(6)	0.9	5	1.8	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.31	10	0.28	10		
S. Res. (10^{-4}ohm cm)	(8)	10	10	12	10		
Permeability (D'Arcy)		0.80	10	0.74	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HC	cyl 16-24" dia	<$1/lb	over 30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 167

Characterization

TYPE: extruded, coarse grained; good electrical conductor; high purity; high reproducibility; long experience; large sizes; high production; used for electrolytic anodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V	Ti	Na
Av. value	0.20%	0.03%	0.05%	0.03%	0.03%	0.03%	60ppm	30ppm	20ppm
Std. dev. (%)	<50	<50	<30	<50	<30	<30	<30	<20	<20

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.9	10	0.8	10		
T. Str. (10^3psi)	(2)	0.5	10	0.5	10		
C. Str. (10^3psi)	(3)	2.5	10	2.5	10		
Flex. Str. (10^3psi)	(4)	1.0	10	0.9	10		
Density (g/cc)	(5)	1.60	2.0				
C. Exp. (10^{-6}/°C)	(6)	1.8	5	2.2	5		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.31	10	0.28	10		
S. Res. (10^{-4}ohm cm)	(8)	9	10	12	10		
Apparent porosity		28%					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HL	cyl 16", 17", 19" dia lengths to specification	<$1/lb	over 30 M T/yr	2 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 168

Characterization

TYPE: extruded, coarse grained; long experience; large and small sizes; high production; thermal shock resistant; used for furnace electrodes

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; over 20T batch size

ANALYTICAL:	Ash
Av. value	0.96%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.5	13	0.5	21		
T. Str. (10^3psi)	(2)	.44	17	.42	11		
C. Str. (10^3psi)	(3)	1.9	22	2.0	18		
Flex. Str. (10^3psi)	(4)	.84	17	.84	17		
Density (g/cc)	(5)	1.54	2.5				
C. Exp. (10^{-6}/°C)	(6)	1.2	31	1.9	16		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.32		0.27			
S. Res. (10^{-4}ohm cm)	(8)	9.6	10	11.3			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	AGR AGSR	cyl 14-35" dia blk 20-24" (blks to 24"x24"x 100" in size)	<$10/lb	over 30 M T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Thermal diffusivity
(8) Volt/amps

GRAPHITE PRODUCT NO. 169

Characterization

TYPE: extruded, very coarse grained; max grain size 0.52"

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		.6-.7					
C. Str. (10^3psi)		2.5-3.5					
Flex. Str. (10^3psi)		.12-.17					
Density (g/cc)		1.59-1.63					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K) [1]		65-70					
S. Res. (10^{-4}ohm cm) [2]		42-46					

1 BTU/ft/°F
2 ohm in x 10^{-5}

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	CGE CGR	cyl 30 - 56"			0-6 mo

GRAPHITE PRODUCT NO. 170

Characterization

TYPE: extruded, very coarse grained; good electrical conductor; long experience; high production; used for furnace electrodes

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; over 20T batch size

ANALYTICAL:	Ash	S	Si	Fe	Ca	Al	V
Av. value	0.30%	0.10%	0.04%	0.04%	0.03%	0.03%	70ppm
Std. dev. (%)	<50	<50	<40	<40	<30	<30	<50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.9	10	0.8	10		
T. Str. (10^3psi)	(2)	0.6	10	0.6	10		
C. Str. (10^3psi)	(3)	3.0	10	3.0	10		
Flex. Str. (10^3psi)	(4)	1.0	10	0.8	10		
Density (g/cc)	(5)	1.60	2				
C. Exp. (10^{-6}/°C)	(6)	2.4	5	2.8	5		
Therm. Cond. (cal-cm/sec cm²°K)	(7)	0.27	10	0.25	10		
S. Res. (10^{-4}ohm cm)	(8)	7.5	10	10	10		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Great Lakes	HC	cyl 30-56" dia	<$1/lb	over 30M T/yr	1 mo

(1) Sonic
(2) Gage dimension
(3) ASTM-C-39-56T
(4) ASTM-C-78-59
(5) ASTM-C-134-41
(6) Expansion 0-75°C
(7) Thermal diffusivity
(8) Volt/amps

Hot Worked Graphite Products (Nos. 171 through 173)

At this time there are two producers and suppliers of hot worked graphite products; namely, Union Carbide, Carbon Products Division, and Duramic Products. Union Carbide commonly refers to its products as "high density graphite -"Z" series grades." Since hot worked graphite is characterized by high density, approaching theoretical, this class has been subdivided into two subclasses: very high density, over 2.0 g/cc (No. 171) and high density, 1.85 to 2.0 g/cc (Nos. 172, 173).

Hot worked graphite products are unique in many respects, as compared to molded or extruded graphite products. For example, bulk densities as high as 2.2 g/cc, which is within a few percent of real density, are available. Accompanying this high density is a significant increase in strength, decrease in permeability, increase in thermal conductivity, absence of structural macroflaws, and capability of taking a fine surface finish to close tolerances. Other effects in connection with compact structure are thermal stability and resistance to creep at high temperature. A wide range of anisotropic properties is available in the hot worked graphite products.

However, the unique and desirable properties mentioned above apply principally to "with the grain" values. It must be remembered that the high anisotropic characteristics of the hot worked graphite products would tend to provide some poorer cross-grain properties. This is clearly evident for mechanical properties such as Young's modulus, tensile strength, and flexural strength.

The unique characterization of hot worked graphite products offers interesting possibilities for applications to military system components. For example, hot worked graphites are candidate materials for rocket nozzles and nose cones in the missile field where resistance to erosion at high temperatures is most important. Also, applications in other areas, such as the nuclear metallurgy fields, are indicated.

GRAPHITE PRODUCT NO. 171

Characterization

TYPE: hot worked; very high density; high reproducibility; high strength; good thermal conductivity; highly oriented; low porosity; used in the aerospace field where resistance to erosion is critical; special applications in nuclear and metallurgical fields

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C and finally hot worked; 100-2000 lb batch size

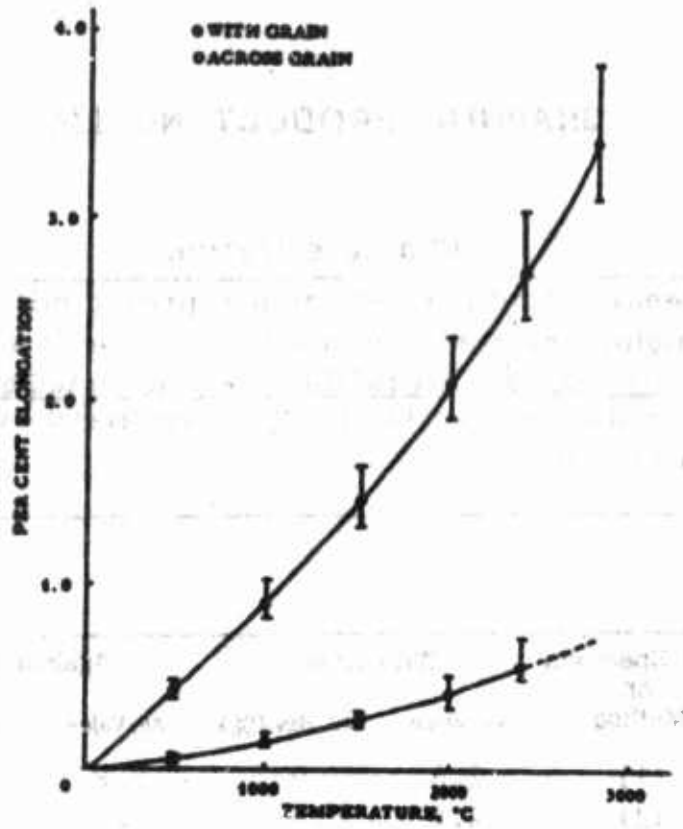
ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	3.4		0.8			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	9.1		1.3			
Flex. Str. (10^3psi)	(3)	6.2		2.5			
Density (g/cc)	(4)	2.0					
C. Exp. (10^{-6}/°C)	(5)	0.6		8.6			
Therm. Cond. (cal-cm/sec cm²°K)	(6)	0.47		0.17			
S. Res. (10^{-4}ohm cm)	(7)	6.7		19.7			

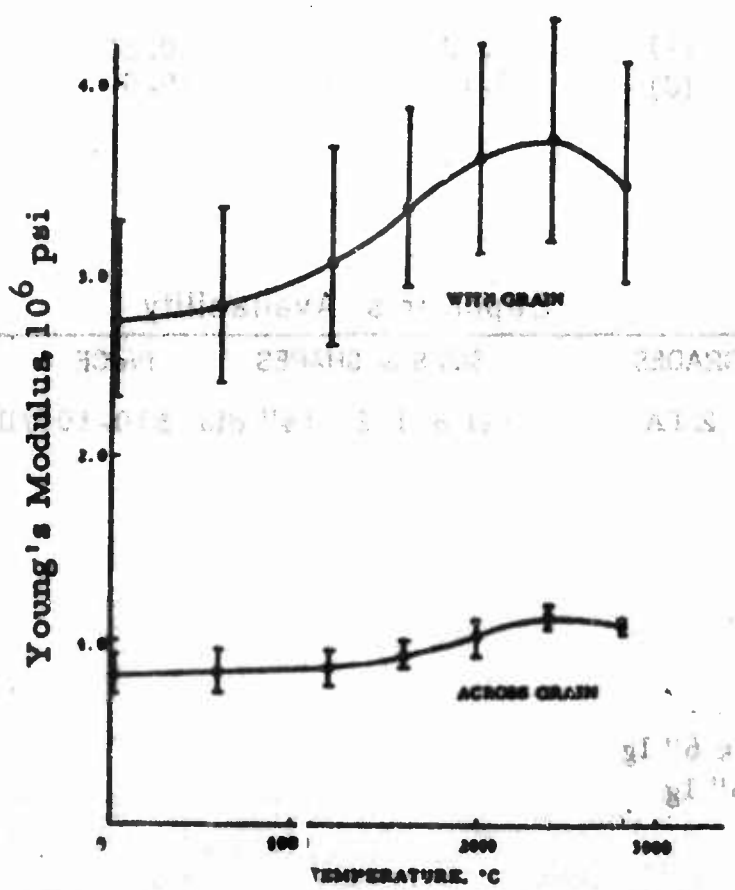
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	ZTB	cyl 8-1/2 - 14" dia	$10-100/lb	10-100 T/yr	4 mo

(1) Sonic
(2) ASTM-C-109-54T
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) cyl 1/2-1" dia x 6" lg
(7) Volt/amps



Thermal Expansion vs. Temperature, ZTB Graphite, 8-1/2" dia. x 11"



Young's Modulus vs. Temperature, ZTB Graphite, 8-1/2" dia. x 11"

FIGURE 33 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 171 (Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 172

Characterization

TYPE: hot worked; high density; fine grained; high reproducibility; high strength; good thermal conductivity; highly oriented; low porosity; grade is certified to be free of internal cracks, voids, or other structural defects as detected by radiographic inspection

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; and hot worked; 100-2000 lb batch size

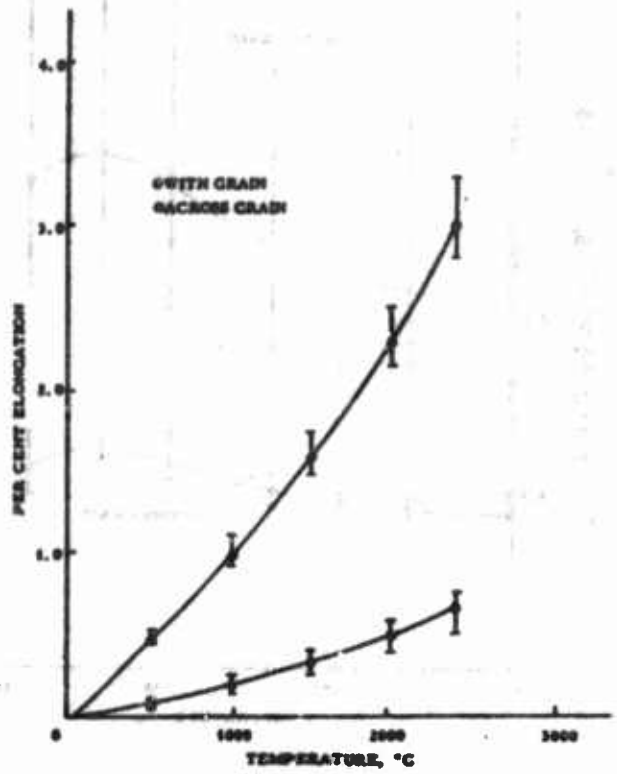
ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.6	9	0.8	5		
T. Str. (10^3psi)	(2)	4.0	15	1.2	14		
C. Str. (10^3psi)	(3)	7.2	18	1.2	13		
Flex. Str. (10^3psi)	(4)	5.4	14	2.4	14		
Density (g/cc)	(5)	1.95	1.5				
C. Exp. (10^{-6}/°C)	(6)	0.7	.35	8.2	4		
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	0.52		0.20			
S. Res. (10^{-4}ohm cm)	(8)	7.1	7	19.9	7		

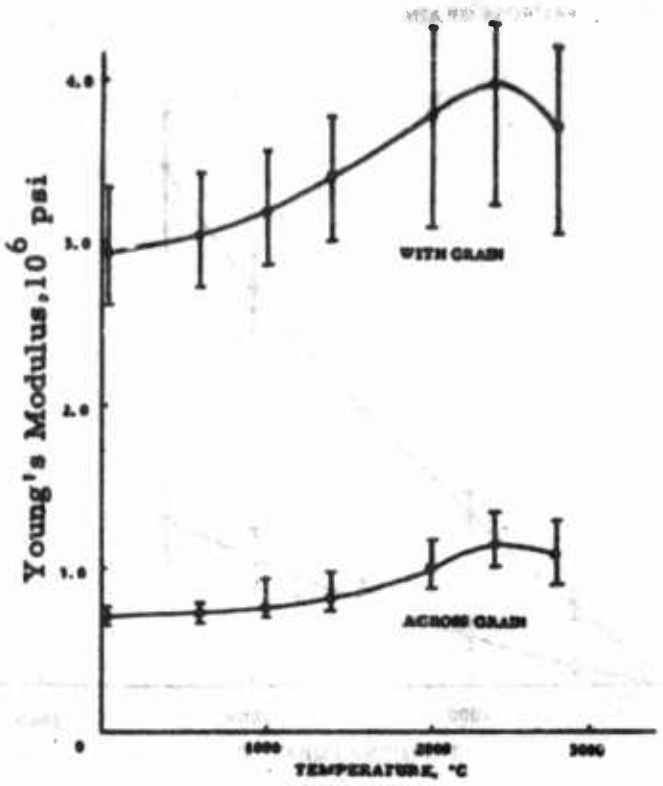
Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	ZTA	cyl 8-1/2 - 14" dia	$10-100/lb	10-100 T/yr	1 mo

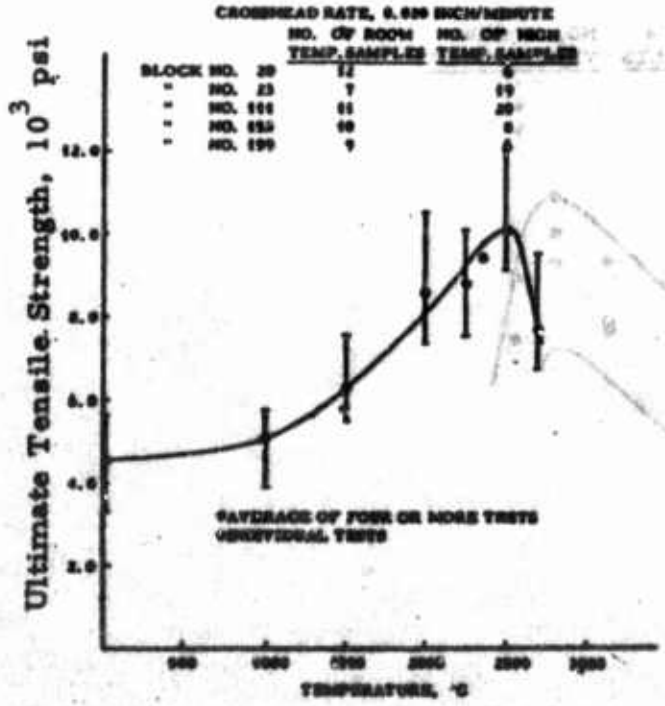
(1) Sonic
(2) cyl 1/4" dia
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6" lg
(7) cyl 1/2-1" dia x 6" lg
(8) Volt/amps



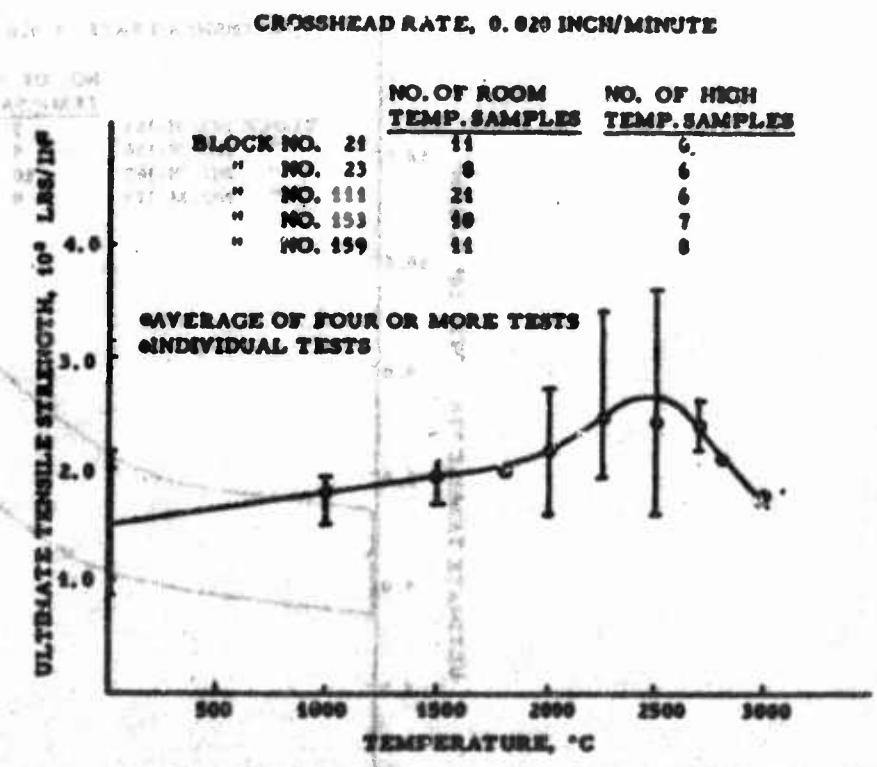
Thermal Expansion vs. Temperature, ZTA Graphite, 14" dia. x 10"



Young's Modulus vs. Temperature, ZTA Graphite, 14" dia. x 10"

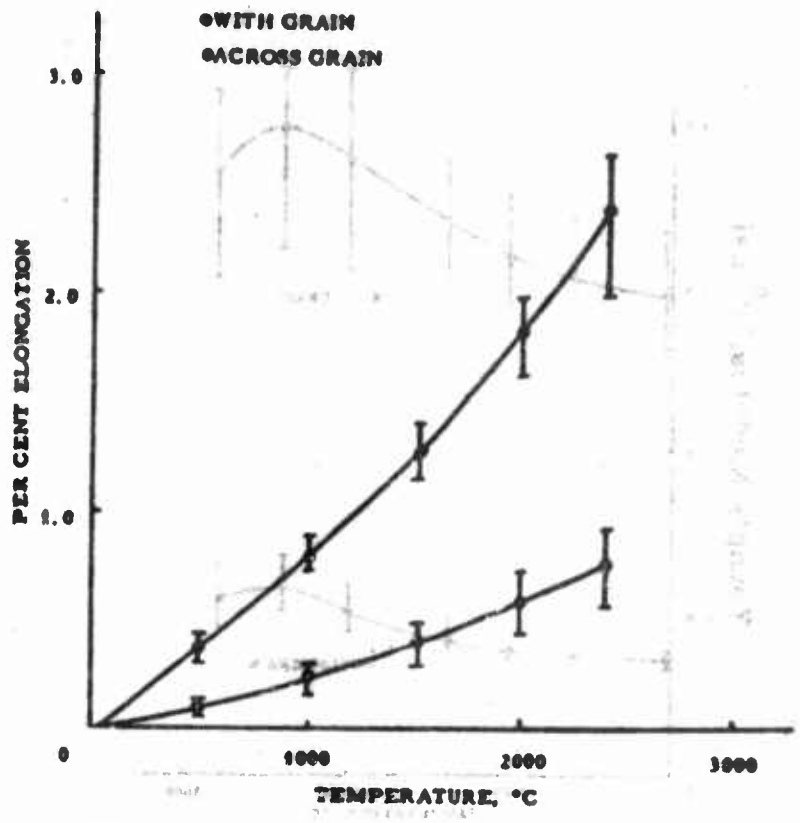


With-Grain Ultimate Tensile Strength vs. Temperature, ZTA Graphite, 14" dia. x 10"

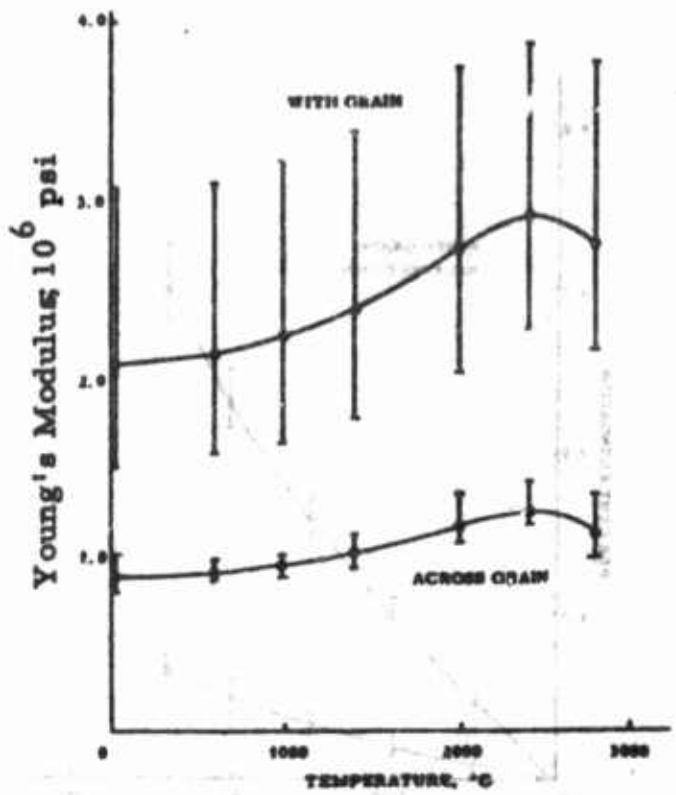


Across-Grain Ultimate Tensile Strength vs. Temperature, ZTA Graphite, 14" dia. x 10"

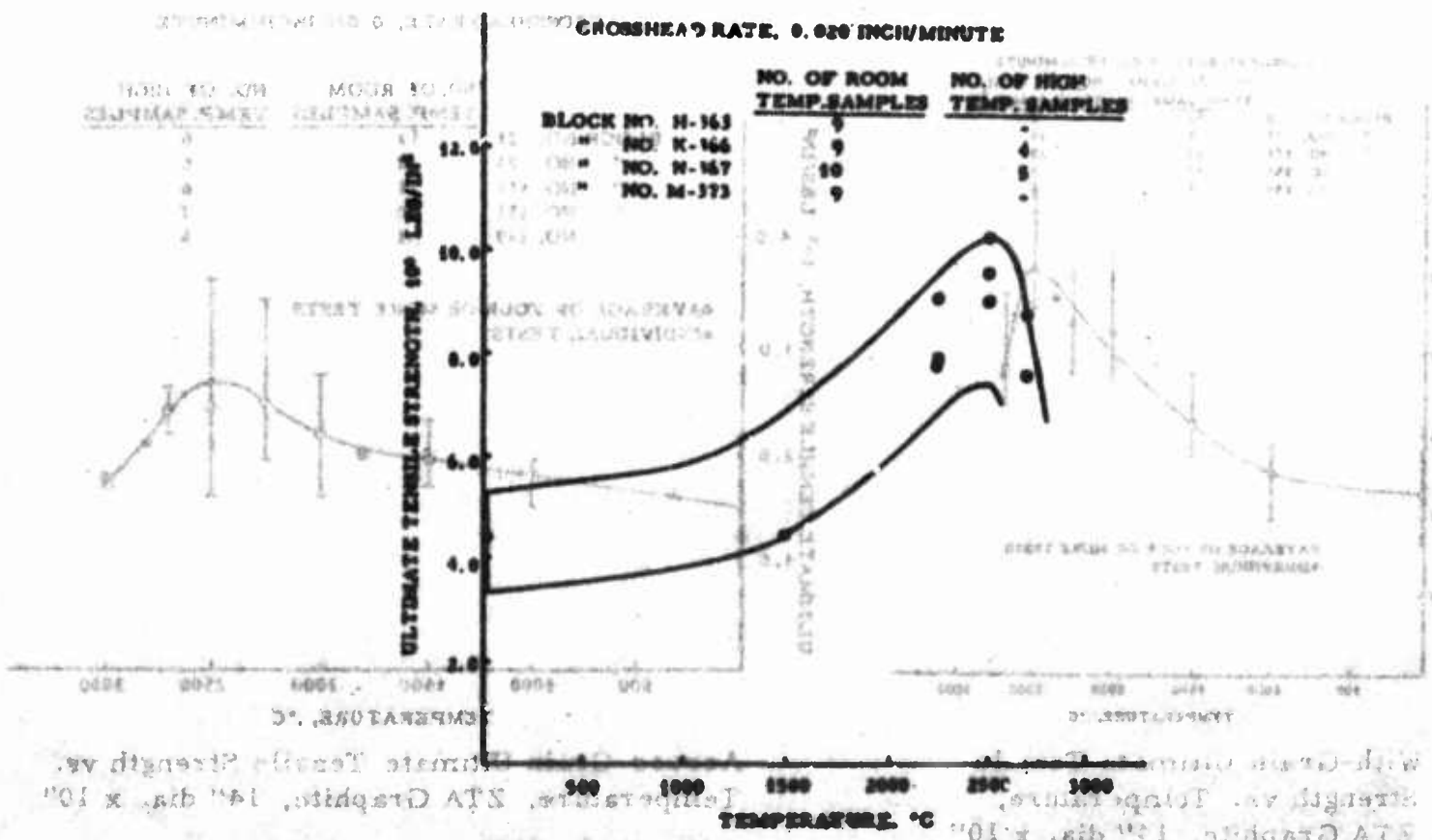
FIGURE 34 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 172 (Furnished by Union Carbide)



Thermal Expansion vs. Temperature, ZTA Graphite, 8-1/2" dia. x 11"



Young's Modulus vs. Temperature, ZTA Graphite, 8-1/2" x 11"



With-Grain Ultimate Tensile Strength vs. Temperature, ZTA Graphite, 8-1/2" dia. x 11"

FIGURE 35 HIGH TEMPERATURE PROPERTIES FOR GRAPHITE PRODUCT NO. 172 (Furnished by Union Carbide)

GRAPHITE PRODUCT NO. 173

Characterization

TYPE: hot worked; high density; low porosity; used for jigs and fixtures, and heater elements; also available in purified grade 50ppm total impurities

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:	Ni	Ca	Fe	Si	Al	Co	Mo	Ti	Na
Av. value	200ppm	200ppm	100ppm	75ppm	75ppm	25ppm	10ppm	10ppm	100ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.1	15	1.9	15	2.2	2.8
T. Str. (10^3psi)	(2)	5.0	20	4.9	20	5.0	9.0
C. Str. (10^3psi)	(3)	20.0	20	19.0	20	20.5	25.0
Flex. Str. (10^3psi)	(4)	10.0	20	9.5	20	10.1	14.0
Density (g/cc)		1.85	5				
C. Exp. (10^{-6}/°C)		4.2	5	4.1	5	5.4	
Therm. Cond. (cal-cm/sec cm²°K)		.30	15	.29	15		
S. Res. (10^{-4}ohm cm)		15.0	1	15.5	1		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Duramic Products	D-857	up to 15"x6"x3"	$10-100/lb	<10 T/yr	1 mo

(1) Sonic
(2) ASTM-C-565-65T
(3) ASTM-C-528-63T
(4) ASTM-C-328-56T

Pyrolytic Graphite Products (Nos. 174-180)

Pyrolytic graphite is still a relative newcomer in the field of graphite products and although there are many types reported in the literature and a great deal has been done on a laboratory or pilot scale, only a few graphite products are commercially available. The unusual properties of pyrolytic graphite, particularly its very high density, high purity, and high degree of orientation, has excited the imagination of design engineers for use in advanced military and aerospace systems. However, it must be recognized that there is a limited amount of experience and familiarity, together with limitations on manufacturing capabilities for wide ranges of sizes, and these factors have handicapped widespread application.

All pyrolytic graphite is formed by carbon deposition on a surface by decomposition of a carbonaceous gas, such as methane, in a process carried out at very high temperatures, usually above 4000F. The resulting product is polycrystalline and behaves like a metal in the basal plane (parallel to the surface of deposition-with grain), but acts like a ceramic material across these planes (against grain).

This section of graphite products is limited to pyrolytics available in free standing and of massive form, which are essentially pure carbon-containing materials. Other graphite products in this directory, which are produced by a pyrolytic technique, are described under "pyrolytic tape," "metallo-pyrolytic," and "graphite foams." The composites of pyrolytic graphite deposited on conventional graphite are not included in this directory.

GRAPHITE PRODUCT NO. 174

Characterization

TYPE: pyrolytic graphite; good thermal conductivity; high purity; high density; low porosity; used for moderators for nuclear piles, rocket nozzle inserts, susceptor in induction heating furnaces, and crucibles

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL: C 99.99%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Atomergic Chemetals	Pyrolytic Graphite	powder rods plts	$10-100/lb	< 10 T/yr	0 mo

GRAPHITE PRODUCT NO. 175

Characterization

TYPE: pyrolytic graphite; high strength; low coeff. therm. exp.; good electrical and thermal conductor; good thermal insulator; high purity; good nuclear properties; high reproducibility; low porosity; highly oriented; chemical resistant

MFG: gaseous hydrocarbon; processed below 2500C; machined and ground; 100-2000 lb batch size

ANALYTICAL:

	Ash
Av. value	0.0038±0.0026%

PROPERTIES:

	Test Specimen or Method	With Grain c - direction Av. Value	Std. dev.(%)	Against Grain a-b - direction Av. Value	Std. dev.(%)	Typical H.T. Prop. 1300F	4000F
Y. Mod. (10^6psi)	Fig 25-3-4*	1.7		4.4	6		
T. Str. (10^3psi)	Fig 25-3-4	1.25	20	18.5	10		
C. Str. (10^3psi)		68		14			
Flex. Str. (10^3psi)		1.5		21.3	10		
Density (g/cc)		2.212	1				
C. Exp. (10^6/°C)		19.44 @ 500F		0.36 @ 500F			
Therm. Cond.						(c).003	.003
(cal-cm/sec cm²°K)		0.004 @ 500F		0.826 @ 500F		(ab).371	.210
S. Res. (10^4ohm cm)		4840		4.29	6	(c)2540	-
						(ab)2.03	3.82

* All figs. from GE "Pyrolytic Graphite Engineering Handbook"

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Detroit MPD	pyro	Special Shapes (up to 45") plt < 1/16-1" pipe <1/2->10" flexibles > 144 sq in	$10-100/lb		3 mo
GE - Detroit MPD	pyro (nonfree standing)	Special Shapes (up to 45") plt <1/16-1" pipe <1/2-10"	$10->100/lb		1-4 mo

GRAPHITE PRODUCT NO. 176

Characterization

TYPE: pyrolytic graphite; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high electrical resistance; good thermal insulator; high purity; good nuclear properties; low porosity; highly oriented

MFG: gaseous hydrocarbon; processed below 2500C; machined; less than 100 lb batch size

ANALYTICAL: C 99.99%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	4.4				1.89	
T. Str. (10^3psi)	(2)	18.7		.5		22.500	25.000
C. Str. (10^3psi)	(3)	66.1		14.5	7		
Flex. Str. (10^3psi)	(4)	23.5		2.0	10	31.000	
Density (g/cc)	(5)	2.20		2.20			
C. Exp. (10^{-6}/°C)	(6)	1.30		23.7		to 1000°C	
Therm. Cond. (cal-cm/sec cm²°K)	(7)	1.24		002		0.39	0.0015
S. Res. (10^{-4}ohm cm)	(8)	4.79		8000		2.50 1690	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Raytheon Co.	Pyrolytic Graphite	plts & other geometric shapes	$10-100/lb	< 10 T/yr	

(1) Static & dynamic
(2) Tensile blank
(3) Beam
(4) Bar
(5) Wt/volume
(6) Expansion
(7) Absolute
(8) Volt/amps

GRAPHITE PRODUCT NO. 177

Characterization

TYPE: pyrolytic graphite; bulk or massive free standing; high strength; purity, density, and reproducibility; good electrical conductor, thermal conductor, thermal insulator, and nuclear properties; highly oriented; low porosity; chemical and abrasion resistant

MFG: gaseous hydrocarbon; processed to graphite below and above 2500C; no secondary processing; finishing operations including machining and grinding; less than 100 lb batch size

ANALYTICAL: Ash 0.01% max Metallic impurities total less than 20ppm

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		2-5	10-20	1-4	10-20	same	decrease
T. Str. (10^3psi)		10-30	5-10	0.5	10-20	same	increase
C. Str. (10^3psi)		10-45	5-10	60	10-20	same	same
Flex. Str. (10^3psi)		15-25	10-20	-	10-20	same	increase
Density (g/cc)		2-2.2	5-10	-	-	same	-
C. Exp. (10^{-6}/°C)		2	5-10	20	5-10	same	same
Therm. Cond. (cal-cm/sec cm²°K)		1	5-10	0.1	5-10	decrease	decrease
S. Res. (10^{-4}ohm cm)		1.0	10-20	2000	10-20	-	-

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Space Age Matl's	100	plt 1/16- 1-1/4" up to 40" x 70"	$10-100/lb	10-100 T/yr	1 mo
	101A	plt 1/16 - 1-1/4" up to 8" x 12"	>$100/lb	< 10 T/yr	1-2 mo
	110	Special Shapes	$10-100/lb	< 10 T/yr	1-2 mo

GRAPHITE PRODUCT NO. 178

Characterization

TYPE: pyrolytic graphite; high strength; low coeff. therm. exp.; good electrical and thermal conductor; high purity and resistance; good nuclear properties; high reproducibility; low friction; low porosity; chemical resistant; low hardness; mechanical applications

MFG: gaseous hydrocarbon; graphitized over 2500C; machining and grinding; 100-2000 lb batch size

ANALYTICAL: Av. value

Al .01ppm	*Co .100ppm	*Mg .001ppm	*Zn .1ppm
*B .01ppm	Cu .01ppm	*Nb .07ppm	*Ta 1.00ppm
*Ca .007ppm	Fe .40ppm	Ti .01ppm	* Not detected less than

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		2-5	10-20				
T. Str. (10^3psi)		10-30	5-10	<1	5-10	16	24
C. Str. (10^3psi)		10-50	>20	>50	<5		
Flex. Str. (10^3psi)		>20	10-20			20	27
Density (g/cc)		2-2.2	<1				
C. Exp. (10^{-6}/°C)		<2	<2	10-20	<2	.7	1.6
Therm. Cond. (cal-cm/sec cm^2°K)		.5-1		<.1		.6	.2
S. Res. (10^{-4}ohm cm)		<1	<5	>2000	<5	3.7	5
Emissivity		.8 at 2000F					

Thermal neutron abs cross section 3.4 mb

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Super-Temp	Pyrolytic Graphite	plt material 1/16-1" thk up to 16" x 65" cyl 1/4-20" dia up to 36" lg	$10-100/lb	< 10 T/yr	1-2 mo

GRAPHITE PRODUCT NO. 179

Characterization

TYPE: pyrolytic reinforced graphite; high strength; high electrical resistant; good thermal insulator; high purity; good nuclear properties; used for heater elements, crucibles, high temperature insulation, and reentry aids

MFG: gaseous hydrocarbon; synthetic fiber, cellulose fiber; processed below 2500C; machining and grinding; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		.4-2		.2-1.5			
C. Str. (10^3psi)		27.0		16.3			
Flex. Str. (10^3psi)		.5-17.0		3.5			
Density (g/cc)		.2-2.0					
C. Exp. (10^{-6}/°C) *							
Therm. Cond.* (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

This class of material is manufactured by infiltrating and coating individual fibers of a felt or clothlike material with pyrolytic carbon or graphite. The process can be adapted to overcoating the infiltrated material with oxidation resistant materials such as boron nitride, silicon carbide, and niobium carbide. Bulk density can be varied over a wide range as indicated above.

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Super-Temp	Reinforced Pyrolytic Graphite	pl: 1/4"-1" blk 1-3"	$10-100/lb	< 10 T/yr	1-2 mo

* Thermal Cond. and C. Exp. vary with density. Materials with low density have thermal properties similar to those of substrate material. Materials with high densities have thermal properties similar to graphite.

GRAPHITE PRODUCT NO. 180

Characterization

TYPE: pyrolytic graphite; high strength; low coeff. therm.exp.; good electrical and thermal conductor; good electrical resistance; good thermal insulator; high purity; good nuclear properties; high density; low porosity; highly oriented; chemical resistant

MFG: gaseous hydrocarbon; processed below 2500C; electric resistance furnace; machined and ground; less than 100 lb batch size

ANALYTICAL:	Ash	Fe	V	S	B
Av. value	< 1%	< .05%	< 005%	< .01%	< 1ppm
Std. dev. (%)	3[illegible]	40			

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		4	15		3	3.5	2.8
T. Str. (10^3psi)		15	<5	1	< 20	15	30
C. Str. (10^3psi)		13	<10	50	< 10		
Flex. Str. (10^3psi)		14	<10	19	< 10	14	14
Density (g/cc)		2.2	<5				
C. Exp. (10^{-6}/°C) (1)		4		60			
Therm. Cond. (2) (cal-cm/sec cm²°K)		200	<15	1.4	< 15	0.8	0.3
S. Res. (10^{-4}ohm cm)		.05	<15	5000	< 15	0.4	0.5

(1) Total value in mils/in to 4000°F
(2) Units BTU-Ft/Hr Ft^2 °F

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Pyrolytic	plt 1/16-1" pipe 1/2-10"	$10-100/lb >$100/lb	< 10 T/yr	1 mo

Fibrous Products (Nos. 181 through 193)

Fibrous products in this directory are classified into two subclasses: yarns, which are made up of fibers of various sizes twisted together (Nos. 186-193); and fibers, based on ASTM Standards D-123 which contains a specific definition for a fiber wherein the length is stated as being at least 100 times its diameter or width (Nos. 181-185). From a length viewpoint, fibers are classified as either staple (chopped) or filaments, wherein filament implies continuous length. There are no graphite monofilaments (over 2" length) commercially available.

Most all of the fibrous materials available are graphitized from man-made textile type fibers, such as rayon. Advancements have been made in determining the crystal structure and lattice spacing for fibrous products through the use of x-ray diffraction techniques.

There have been major advancements in the utilization of fibrous products. Chopped fibers are commonly used for reinforcing resin composites, for making electrically conductive resin or rubber composites, and for fabrication of "paper" type materials. Yarns are now commonly used for fabrication into rope or braided structures for use as mechanical pump packing, sealing and lubrication materials, and reinforcement for resin composites fabricated by filament winding processes. Yarns are usually put in the form of cloth, woven or unwoven, which is described in the next section of graphite products titled "flexible products."

Fibrous products, particularly in the form of yarns, have been produced on a commercial basis for years. Major advancement is being made and numerous applications for fibrous products, as indicated above, are common. Yarns with filament properties of 25×10^6 lbs/in^2 elastic modulus and 180,000 lbs/in^2 tensile strength are commercially available.

GRAPHITE PRODUCT NO. 181

Characterization

TYPE: chopped fibers; high purity; high reproducibility; chemical resistant

MFG: cellulose fiber; processing above and below 2500C; electric resistance furnace

ANALYTICAL: Ash

Av. value 0.5% max (carbon)
0.03% max (graphite)

PROPERTIES:

	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	chopped fibers-carbon or graphite		$10-100/lb		

GRAPHITE PRODUCT NO. 182

Characterization

TYPE: chopped fibers; up to 1 mil. diameter; good thermal conductor; high purity; chemical resistant; high temperature oxidation resistant; used in molding compounds as filler

MFG: cellulose fiber; final temperature over 2500C; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.5					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
HITCO	GFA 1/4 GFA 1/2	1/4" long fiber	$10-100/lb	< 10 T/yr	1 mo

GRAPHITE PRODUCT NO. 183

Characterization

TYPE: chopped fibers, carbon-nitrogen polycrystalline

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL: C
99 +%

PROPERTIES:

	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prep. 1300F	Typical H.T. Prep. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		.3					

Fiber type 720 filaments/end

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
3 M Co.	"Pluton" D	chopped fibers 0.00035 dia x 1/4" lg	$10-100/lb		0-1 mo

GRAPHITE PRODUCT NO. 184

Characterization

TYPE: fiber, continuous filaments

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL: C 98.3%

PROPERTIES:

	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.82					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Denier 600
Fiber dia 0.00034"
Break. str. lbs/end 1.3

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
3 M Co.	"Pluton" H Roving	bundle of single end yarns	$10-100/lb		0-1 mo

GRAPHITE PRODUCT NO. 185

Characterization

TYPE: chopped fibers; used for rocket nozzle inserts; electrical characteristics and reinforcements of resins

MFG: cellulose fiber graphitized over 2500C

ANALYTICAL: C
99% min

PROPERTIES:

Fiber Density (g/cc)	1.5
Denier/Filament (g/9000M)	0.7
Filament Dia. (in)	.0003
Resistance (ohm-cm)	.005

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	WFA	chopped fibers 1/4-2" lengths	$10-100/lb	<10 T/yr	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 186

Characterization

TYPE: carbon yarn; high strength; high reproducibility; resistance elements

MFG: cellulose fiber; carbonized under 2500C; electric resistance furnace

ANALYTICAL:	Ash
Av. value	0.5%

PROPERTIES:

Typical	2 ply*	5 ply*	10 ply*	30 ply*
Denier	500/530			
Plys/yarn	2	5	10	30
Yarn dia	1/32"			1/8"

* 720 filaments/ply; 5 ply-480 filaments/ply also available

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	GSCY-2	2 ply	$10-100/lb		
	GSCY-5	5 ply			
	GSCY-10	10 ply			
	GSCY-30	30 ply			

GRAPHITE PRODUCT NO. 187

Characterization

TYPE: graphite yarn; high purity; high reproducibility and chemical resistance; used for heat exchangers and heater elements; braiding into mechanical pump packing

MFG: cellulose fiber; graphitized over 2500C in an electric resistance furnace

ANALYTICAL:

	Ash
Av. value	.5%

PROPERTIES:

Typical	2 ply*	5 ply*	10 ply*	30 ply*
Yield				
Denier	600/2	600/5	600/10	600/30
Break Str.	4 lb	10 lb		35 lb
Plys/yarn	2	5	10	30
Yarn dia	1/32"			1/8"
Elec. Res.	12.5 ohm/in			0.9

* 720 filaments/ply; 5 ply-480 filaments/ply

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum	GSGY -2	yarns	$10-100/lb		
	GSGY -5				
	GSGY -10				
	GSGY -30				

GRAPHITE PRODUCT NO. 188

Characterization

TYPE: graphite yarn; high strength; good electrical and thermal conductor; high purity; high reproducibility; low porosity; chemical resistant; high temperature oxidation resistance; abrasion resistant; used for seals, heater elements, & speciality textiles

MFG: cellulose fiber; graphitized over 2500C; electric resistance furnace; less than 100 lb batch size

ANALYTICAL:	Ash	Fe	B	Na	K	Ca	Mg
Av. value	.1%	5ppm	1ppm	4ppm	2ppm	24ppm	23ppm
Std. dev. (%)	30	40	50	50	50	70	50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.5					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							
Emissivity		.9					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
HITCO	GY 2-1	0.03 in (10 micron filaments)	$10-100/lb	<10 T/yr	3 mo
	GY 7-1	0.05 in (10 micron filaments)			
	GC 20-1	0.08 in (10 micron filaments)			

GRAPHITE PRODUCT NO. 189

Characterization

TYPE: yarn; electrically conductive; for electrical and ablative applications

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:

C	N
98%	1.1%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							
Filaments/end		720					
Denier		1250					
Tenacity		2.5					
Break str. lbs/in		6.5					
Electrical resist. ohm/in		12.5					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
3 M Co.	"Pluton" H-31	Yarn, 2 ply	$10-100/lb		0-1 mo

GRAPHITE PRODUCT NO. 190

Characterization

TYPE: yarn; used for electrical properties and as reinforcement of resined matrices

MFG: cellulose fiber; processed below 2500C; 100-2000 lb batch size

ANALYTICAL:

C
>90%

PROPERTIES:

	Yarn		Filament
Yield (yds/lb)	2080	T. Stg. (lbs/in^2)	100,000
Denier (g/9000 M)	2150	Y. Mod. (10^6 lbs/in^2)	6.9
Break Str. (lbs)	17	Diameter (in)	.0004
Plys/Yarn	5		
Fil/Ply	480		
Yarn Dia (in)	.04		
Elec. Res. (ohm/ft)	90		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	VYB 105-1/5	Available on spools and roving packages of 1/10 and 1 each. Sizing on request	$10-100/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 191

Characterization

TYPE: graphite yarn; used for electrical characteristics and reinforcement of resin matrices, seals and high temperature steam turbine seals

MFG: cellulose fiber; processed below 2500C; 100-2000 lb batch size

ANALYTICAL:

	C
Av. value	90% min

PROPERTIES:

	Yarn		Filament
Yield (yds/lb)	3350	T. Stg. (lbs/in^2)	100,000
Denier (g/9000 M)	1340	Y. Mod (10 lbs/in^2)	6.9
Break Str. (lbs)	10	Diameter (in)	.0004
Plys/Yarn	2		
Fil/Ply	720		
Yarn Dia (in)	0.03		
Elec. Res. (ohm/ft)	200		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	VYB 70-1/2	Available on spools and roving packages of 1/10 and 1 each	$10-100/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 192

Characterization

TYPE: graphite yarn; extremely high strength to weight and modules to weight ratio; provides low density composites

MFG: cellulose fiber; graphitized over 2500C; 100-2000 lb batch size

ANALYTICAL:

	C
Av. value	>99%

PROPERTIES:

	Yarn		Filament
Yield (yds/lb)	5600	T. Stg. (lbs/in^2)	180,000
Denier (g/9000 M)	800	Y. Mod. ($10^6 lbs/in^2$)	25×10^6
Break Str. (lbs)	8	Density (g/cc)	1.42
Plys/Yarn	2	Diameter (in)	.0002
Fil/Ply	720		
Yarn Dia (in)			
Elec. Res (ohm/ft)			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Thornel 25 WYD 115-1/2	1# spools and roving packages PVA sizing	>$100/lb	<10 T/yr	1 mo

GRAPHITE PRODUCT NO. 193

Characterization

TYPE: graphite yarn; used for electrical characteristics and reinforcement of resin matrices, and high temperature steam turbine seals

MFG: cellulose fiber; graphitized over 2500C; 100-2000 lb batch size

ANALYTICAL:

	C
Av. value	> 99%

PROPERTIES:

	Yarn		Filament
Yield (yds/lb)	2500	T. Stg. (lbs/in^2)	70,000
Denier (g/9000 M)	1750	Y. Mod ($10^6 lbs/in^2$)	9
Break Str. (lbs)	9.5	Density (g/cc)	
Plys/Yarn	5	Diameter (in)	.0003
Fil/Ply	480		
Yarn Dia (in)	.040		
Elec. Res. (ohm/ft)	75		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	WYB 125-1/5	Yarn in continuous lengths on spools and roving packages of 1/10 and 1 each. Sizing on request.	$10-100/lb	10-100 T/yr	1 mo

Flexible Products (Nos. 194 through 208)

The flexible products are divided into three subclasses: woven cloth (Nos. 194-204); nonwoven cloth (Nos. 205, 206); and graphite tape (Nos. 207, 208).

Woven graphite cloth is usually produced from woven textiles consisting of man-made fibers such as rayon. Nonwoven cloth could be made up from graphite fibers using equipment and techniques similar to paper-making processes. Graphite tape is produced by a pyro process from gaseous hydrocarbons. As in the case of fibrous products, the crystal structure and lattice spacing for flexible products have been determined through the use of x-ray diffraction techniques.

Major advancements have been made towards applications of flexible products. Cloth is now well established for such uses as reinforcing high temperature resins for missile and reentry ablative components, and as electric heater components. Nonwoven products such as felt and paper are widely used for electric furnace insulation and other forms of thermal barriers. Flexible graphite tape is presently used for high temperature insulation because of its low "C" direction or across grain thermal conductivity, and for sealing and gasketing applications.

GRAPHITE PRODUCT NO. 194

Characterization

TYPE: plain woven carbon cloth (7.9 oz/yd); high strength; high reproducibility; chemical resistant; low ash content; used for mechanical or structural purposes

MFG: cellulose fiber; carbonized under 2500C; electric resistance furnace

ANALYTICAL:

PROPERTIES:

Typical	Plain Weave Warp	Plain Weave Fill	8 Hardness Satin Warp	8 Hardness Satin Fill
Wt. (oz/yd)	7.5		7.91	7.91
Thick. (in)	.0175		0.017	0.017
Count.	27	23	51	51
T. Str. (lb/in)	110	90	131	156
Elec. Res.	.54		0.512	0.512
Weave	Plain			
Ash				0.181

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	GSCC-2	(all up to 42" x 75 yds)	$10-100/lb		
	GSCC-8	(all up to 42" x 75 yds)	$10-100/lb		

GRAPHITE PRODUCT NO. 195

Characterization

TYPE: woven cloth fabric; graphitized from woven rayon; used for mechanical or structural purposes; unique because of small sizes available, particularly thinness and flexibility; plain weave and 8 hardness satin; 7.5 oz/sq yd

MFG: cellulose fiber in woven condition; graphitized over 2500C; electric resistance furnace; cleaned in secondary processing

ANALYTICAL:	Ash
Av. value	.03% max

PROPERTIES:

	Plain Weave		8 Hardness Satin	
Typical	Warp	Fill	Warp	Fill
Wt. (oz/yd^2)	7.5		7.5	7.5
Thick. (in)	.0176		0.018	0.018
Count (yarns/in)	27	23	53	52
T. Str. (lbs/in)	101	71		
Elec. Res. (ohm/in)	.49		0.54	0.54

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Graphite Products Division, Carborundum Co.	GSGC-2	(all up to 45" x 75 yds)	$10-100/lb		
	GSGC-8	(all up to 36" x 75 yds)	$10-100/lb		

GRAPHITE PRODUCT NO. 106

Characterization

TYPE: graphite woven cloth; high strength; good electrical and thermal conductor; high purity; high reproducibility; low friction; low porosity; chemical resistant; high production; used for heater elements and resin reinforcement

MFG: cellulose fiber; graphitized over 2500C in electric resistance furnace; 100-2000 lb batch size

ANALYTICAL:	Ash	Fe	B	Na	Ka	Ca	Mg
Av. value	.1%	5ppm	1ppm	4ppm	2ppm	24ppm	23ppm
Std. dev. (%)	30	40	50	50	50	70	50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.5					
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							
Oxidation rate in air	nil to 600°F						
Emissivity		.9					
Surface elec. resistance		.35	.6 ohms/sq in				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
HITCO	G 1550	NOMINAL thickness .015 width 34" roll length 70 yd-8 hardness satin weight 7.9 oz/yd²	$10-100/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 197

Characterization

TYPE: cloth, amorphous carbon with substantial amounts of boron, phosphorous, and nitrogen; inert; insoluble; low thermal conductor; good wettability

MFG: plain weave; manufacturing methods claimed to be proprietary

ANALYTICAL:

	Ash	
Av. value	10%	Also high purity available

PROPERTIES:

		Warp	Fill
Helium density	1.86		
S. Res. (10^{-4} ohm cm)	.05		
Yarn count		32	32
Denier		700	840
Breaking strength (lbs/in)		20	15
Gauge (in)	.019		
Denier, filament	0.7		

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
3 M Co.	"Pluton" B	up to 32" wide x 150 yds lg	$10-100/lb		0-1 mo

GRAPHITE PRODUCT NO. 198

Characterization

TYPE: cloth, amorphous

MFG: plain weave; manufacturing methods claimed to be proprietary

ANALYTICAL:	Ash	Na
Av. value	0.5%	70ppm

PROPERTIES:

		Warp	Fill
Helium density	1.85		
Wt. (oz/yd^2)	4		
Yarn count		29	30
Gauge (in)	.019		
Breaking str. (lbs/in)		22	17

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
3 M Co.	"Pluton" H-1	up to 32" width	$10-100/lb		0-1 mo

GRAPHITE PRODUCT NO. 199

Characterization

TYPE: woven cloth; high reproducibility; long experience; used for reinforcing high temperature plastics and rocket nozzle inserts

MFG: cellulose fiber; processed below 2500C; 1-20T batch size

ANALYTICAL:

	C
Av. value	99% min

PROPERTIES:

	Warp	Fill
Wt. (oz/yd^2)	8.5	
Thk. (in)	0.020	
Count (yarns/in)	40	35
T. Str. (lbs/in)	32	37
Elec. Res. (ohm/sq)	0.41	0.42
Fiber Den. (g/cc)	1.50	
Weave	5 Hardness satin	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	VCK	43" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3 M T/yr	1 mo

GRAPHITE PRODUCT NO. 200

Characterization

TYPE: woven cloth; used to reinforce high temperature plastics

MFG: cellulose fiber; processed below 2500C; 1-20Tbatch size

ANALYTICAL:

	C
Av. value	99% min

PROPERTIES:

	Warp	Fill
Wt. (oz/yd^2)	7.6	
Tkn. (in)	0.017	
Count (yarns/in)	52	50
T. Str. (lbs/in)	40	50
Elec. Res. (ohm/sq)	0.40	0.45
Fiber Den. (g/cc)	1.50	0.45
Weave	8 Hardness Satin	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	VCL	43" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3M T/yr	1 mo

GRAPHITE PRODUCT NO. 201

Characterization

TYPE: woven cloth; high reproducibility; used for reinforcement of high temperature plastics and electrical heaters, rocket nozzle inserts, and heater elements

MFG: cellulose fiber; processed over 2500C; 1-20 T batch size

ANALYTICAL:

	C
Av. value	99.9% min

PROPERTIES:

	Warp	Fill
Wt. (oz/yd^2)	7.6	
Tkn. (in)	0.025	
Count (yarns/in)	27	23
T. Str. (lbs/in)	27	24
Elec. Res. (ohm/sq)	0.47	0.51
Diber Den (g/cc)	1.42	
Weave	Square	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	WCA	43" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3 M T/yr	1 mo

GRAPHITE PRODUCT NO. 202

Characterization

TYPE: woven cloth; used to reinforce high temperature plastics and for electrical heaters

MFG: cellulose fiber; processed over 2500C; 1-20T batch size

ANALYTICAL:

	C
Av. value	99.9% min

PROPERTIES:

	Warp	Fill
Wt. (oz/yd^2)	3.2	
Tkn. (in)	0.014	
Count (yarns/in)	34	32
T. Str. (lbs/9n)	18	15
Elec. Res. (ohm/sq)	0.93	1.01
Fiber Den. (g/cc)	1.50	
Weave	Square	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE OF CAP.		DEL.
Union Carbide	WCG	43" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3 M T/yr	1 mo

GRAPHITE PRODUCT NO. 203

Characterization

TYPE: woven cloth; used to reinforce high temperature plastics and for electrical heaters

MFG: cellulose fiber; processed below 2500C; 1-20T batch size

ANALYTICAL:	C
Av. value	99.9%

PROPERTIES:

	Warp	Fill
Wt/ (oz/yd^2)	2.2	
Tkn. (in)	0.013	
Count (yarns/in)	24	24
T. Str. (lbs/in)	16	26
Elec. Res. (ohm/sq)	1.45	1.46
Fiber Den. (g/cc)	1.50	
Weave	Square	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	WCJ	14" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3M T/yr	1 mo

GRAPHITE PRODUCT NO. 204

Characterization

TYPE: woven cloth; used to reinforce high temperature plastics, and rocket nozzle inserts

MFG: cellulose fiber; processed over 2500C; 1-20T batch size

ANALYTICAL:

	C
Av. value	99.8% min

PROPERTIES:

	Warp	Fill
Wt. (oz/yd^2)	7.2	
Tkn. (in)	0.023	
Count (yarns/in)	51	49
T. Str. (lbs/in)	85	75
Elec. Res. (ohm/sq)	0.46	0.50
Fiber Den (g/cc)	1.50	
Weave	8 Hardness satin	

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	WCL	43" wide up to 170 yds lg	$10-100/lb	10-100 T/yr	100-3M T/yr	1 mo

GRAPHITE PRODUCT NO. 205

Characterization

TYPE: graphite non-woven cloth; high strength; high purity; high reproducibility; low bulk density; chemical resistant; high temperature oxidation resistance; used for seals, and support material in furnace brazing & heat treating

MFG: cellulose fiber; graphitized over 2500C; electric resistance furnace; less than 100 lb batch size

ANALYTICAL:	Ash
Av. value	.1%
Std. dev. (%)	50

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							
Oxidation rate in air	nil to 600F						
Emissivity	.9						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
HITCO	GF-1558	NOMINAL	$10-100/lb	< 10 T/yr	1 mo
		144 sq in rolls	10-100/lb		
		length	20 yds		
		width	34 in		
		thickness	.20 in		

GRAPHITE PRODUCT NO. 206

Characterization

TYPE: graphite felt; good thermal insulator; low density; used for furnace insulation

MFG: cellulose fiber; processed over 2500C; 1-20T batch size

ANALYTICAL:

	C
Av. value	99.9% min

PROPERTIES:

Tkn (in)	0.21
T. Str. (lbs/in width)	1.0
Bulk Den (lbs/ft^3)	5.3
Elec. Res. (ohm/sq)	0.6

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	WDF	43" wide up to 25 yds lg	$10-100/yd	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 207

Characterization

TYPE: pyrolytic graphite tape; low coeff. therm. exp.; electrical and thermal conductor; high electrical resistance; good thermal insulator; high purity; good nuclear properties; high reproducibility; low density; low porosity; highly oriented; chemical resistant

MFG: machined; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		0.1					
T. Str. (10^3psi)		1.2	<10				
C. Str. (10^3psi)							
Flex. Str. (10^2psi)		1.0-1.3					
Density (g/cc)		1.1					
C. Exp. (10^{-6}/°C)				2			
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Grafoil Tape	2' x 100' length	$10-100/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 208

Characterization

TYPE: pyrolytic tape; low coeff. therm. exp.; good electrical and thermal conductor; high electrical resistance; good thermal insulator; hgih purity; good nuclear properties; high reproducibility; low density; low porosity; highly oriented; chemical resistant

MFG: machined; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		.15					
T. Str. (10^3psi)		3					
C. Str. (10^3psi)		15					
Flex. Str. (10^3psi)		5					
Density (g/cc)		1.1					
C. Exp. (10^{-6}/°C)				60			
Therm. Cond. (cal-cm/sec cm^2°K)		100		2.2		50	11
S. Res. (10^{-4}ohm cm)		7		5000			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Grafoil Laminate	plt up to 18" x 24" x 1/2" cyls 1-3" dia up to 72" lg Odd shapes	$10-100/lb	10-100 T/yr	1 mo

Composite Graphite Products (Nos. 209 through 251)

In the case of graphite products, "composite" is not commonly employed to describe commercially available products. However, composite type materials, including composites containing graphite, are becoming more important, and this class can not be overlooked. For the purpose of clarifying the term, composite, subclasses have been set up in accordance with dimensional definitions. In general, however, the composite material consists of two distinguishable phases combining to impart properties to the materials significantly different from those of each phase separately.

Microcomposites in this directory (Nos. 209-213) are defined as a graphite body containing a second dispersed phase of less than 1 micron in size; or, they could be dispersions of graphite of less than 1 micron in size in the matrix of another body. In either case, the graphite should be either the major material or the continuous phase. A classical example of a similar type material is SAP aluminum, which contains finely dispersed aluminum oxide of less than 1 micron dimension within the aluminum metal lattice.

Macrocomposites in this directory (Nos. 214-245) are defined as graphite bodies containing phases of 1 micron to 1 mil in dimension. This is the most popular class of composite and it includes most of the impregnated bodies, as well as the graphite-metal systems. The latter are analogous to the so-called cermets, where sintered carbide tools, such as tungsten carbide cemented with cobalt-nickel, are good examples. Also, this dimensional category of composites would include the very popular filamentary reinforced category where glass fiber-reinforced plastic is a good example.

Finally, gross composites in this directory (Nos. 246-251) are defined as those graphite bodies containing phases exceeding 1 mil in any dimension. This class includes laminates, sandwich construction, and others of this type.

From the definitions given above, it is obvious that many composites could be classified elsewhere in this directory and that other graphite products could be classified as composites. For example, many of the products contained in the section, "alloyed graphite products," such as graphite-boron, could be classified as microcomposite or macrocomposites. However, by proper use of the indexes, it should not be difficult to find needed information, regardless of classification.

GRAPHITE PRODUCT NO. 209

Characterization

TYPE: microcomposite; high strength; good thermal conductor; ligh purity; high density; low porosity; chemical resistant; small sizes; used for rocket nozzle inserts, heat exchangers, crucibles, and reentry bodies

MFG: gaseous hydrocarbon, cellulose fiber, and resin; graphitized over 2500C; impregnated in secondary processing; machining; less than 100 lb batch size

ANALYTICAL:	Ash
Av. value	< 0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		4					
T. Str. (10^3psi)		5					
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		15					
Density (g/cc)		1.5					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
HITCO	Pyrocarb*	cyl up to 18" dia x 36" lg	>$100/lb	<10 T/yr	3 mo

* Application has been made for a registered trade mark.

GRAPHITE PRODUCT NO. 210

Characterization

TYPE: microcomposite; particle size 1 micron as dispersion; synthetic bond graphite; soft; no impregnation; used for mechanical applications such as gasoline valve seats, dash pot plungers and small instrument bearings; can be molded to complex shapes

MFG: graphite, resin; not graphitized; no secondary processing; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	7.3%
Std. dev. (%)	< 30

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		2					
T. Str. (10^3psi)		3					
C. Str. (10^3psi)		6					
Flex. Str. (10^3psi)		7.5					
Density (g/cc)		2					
C. Exp. (10^{-6}/°C)		2					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		75					
Hardness		15S					
Abrasion res.		5 Hr/mil					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP	DEL.
Pure Carbon	G-1	cyl 1/8-6" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-6"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 211

Characterization

TYPE: microcomposite; graphite resin; high strength; low coeff. therm. exp.; good electrical conductivity; high reproducibility; low friction; long experience; low hardness; used for brushes, heater elements

MFG: graphite, resin; not graphitized; no secondary processing; finishing operations as required; 100-2000 lb batch size

ANALYTICAL: Ash
Av. value 0.3%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		7.5	15				
Density (g/cc)		1.7	1.5				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		1000	720				
Hardness		37S	14				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	G-32	cyl 1/8-6" blk 1-6" rod .01-1/8" plt <1/16-1" pipe <1/2-6"	$1-10/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 212

Characterization

TYPE: microcomposite; high electrical resistance; low density; low porosity; used for electrodes for fuel cells

MFG: graphite and pitch; not graphitized; finishing operations as required; < 100 lb batch size

ANALYTICAL:	Ash
Av. value	10%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1.6					
Density (g/cc)		0.90					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		200					
Hardness		40S					
Surface area, M^2/gm		600					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	FC-13	cyl 1/8-8" blk 1-6" rod .01-8" plt < 1/16-1" pipe <1/2-8"	$10-100/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 213

Characterization

TYPE: microcomposite; molded; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; high reproducibility; high density; low porosity; chemical resistant; high temperature oxidation resistant

MFG: graphite and inorganic salt; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)		7					
C. Str. (10^3psi)		25					
Flex. Str. (10^3psi)		11					
Density (g/cc)		2.35					
C. Exp. (10^{-6}/°C)		4.0					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		6.3					
Hardness		50S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	GC-95	cyl 1/8-8" blk 1-6" rod .01-8" plt <1/16-1" pipe <1/2-8"	$10-100/lb	< 10 T/yr	3 mo

GRAPHITE PRODUCT NO. 214

Characterization

TYPE: macrocomposite; high strength; good electrical conductor; high purity; good nuclear properties; high reproducibility; high density; low porosity; highly oriented; chemical resistant; used for electrolytic anodes, moderators, crucibles, and heater elements

MFG: gaseous hydrocarbon, artificial graphite; processed to graphite below 2500C; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Detroit MPD	Processed Graphite	Special Shapes (up to >45") plt < 1/16-1" pipe < 1/2 - 10"	$10- > 100/lb		4 mo

GRAPHITE PRODUCT NO. 215

Characterization

TYPE: macrocomposite, maximum particle size .005"; carbon-graphite

MFG: calcined petroleum coke and artificial graphite with coal tar pitch binder; processed at less than 1500C; 100-2000 lb batch size

ANALYTICAL:

	Ash
Av. value	$>$ .5%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1-2	<10				
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		5-10	5-10				
Density (g/cc)		1.5-1.65					
C. Exp. (10^{-6}/°C)		2-10					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		10-50	5-10				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	ME12	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	<$1/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 216

Characterization

TYPE: macrocomposite; resin bonded graphite; max particle size .003"

MFG: graphite and resin; processed at less than 2500C; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	>.5%

PROPERTIES:	Test Specimen Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		5-10					
Density (g/cc)		1.75					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		76					
Hardness		40S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	R310	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 217

Characterization

TYPE: macrocomposite; molded; max grain size .007"; graphite, boron, vanadium, molybdenum; used primarily for aircraft brushes

MFG: graphite, MoS_2, coal tar pitch, boron, resin; molded; heat treated at less than 1500C

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1-5	5-10				
Density (g/cc)		1.8					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		33	5-10				
Hardness		52S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	R776	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 218

Characterization

TYPE: macrocomposite; graphite-resin; max particle size .003"

MFG: calcined petroleum coke and coal tar pitch; molded and graphitized at over 2500C; resin impregnated as secondary operation

ANALYTICAL:	Ash
Av. value	.1-.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	2800F	4000F
Y. Mod. (10^6psi)		2-5	<10				
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		5-10	5-10				
Density (g/cc)		1.65-1.8					
C. Exp. (10^{-6}/°C)		2-10					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		10-50	5-10				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	T117	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 219

Characterization

TYPE: macrocomposite; high strength; low coeff. therm. exp.; high reproducibility; low friction; low porosity; high temperature oxidation resistant; long experience; used for high temperature applications such as seals, hot air valve seats

MFG: lamp black, pitch, inorganic salt; molded; graphitized; chemical salt impregnated in secondary processing; finishing operations as required; < 100 lb batch size

ANALYTICAL:	Ash
Av. value	4%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		4.5					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		8	15				
Density (g/cc)		1.70	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		30					
Hardness		62S	7				
Abrasion res.		25 Hr/mil		60			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	56-HT	cyl 1/8-19" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-10"	$1-10/lb	10-100 T/yr	2 mo
GE, Schenectady	ME 53	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 220

Characterization

TYPE: macrocomposite; carbon-graphite-inorganic salt; molded; for bearings and seals exposed to ultra dry air, cryogenic liquids, or high vacuums

MFG: coke, pitch, inorganic salt; coke and pitch molded and baked but not graphitized fully, formed carbon graphite impregnated with inorganic salt in secondary processing; finishing operations as required; less than 100 lb batch size

ANALYTICAL:	Ash
Av. value	16%
Std. dev. (%)	< 30

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		15					
Density (g/cc)		1.9	> 2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		75					
Hardness		68S	14				
Abrasion res.		16 Hr/mil					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-9N	cyl 1/8-8" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-3"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 221

Characterization

TYPE: macrocomposite; graphite-metal-carbon; babbitt impregnated; high strength; long experience; limited to 350F; molded to size; for mechanical applications

MFG: graphite, pitch, metal; not graphitized; molded to size; impregnated with babbitt as secondary processing after formed; finishing operations as required; less than 100 lb batch size

ANALYTICAL:	Ash
Av. value	50% (including metal impregnation)
Std. dev. (%)	20

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1200F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		7.5	7.5				
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)		15	15				
Density (g/cc)		> 2.8	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		30	15				
Hardness		70S	15				
Abrasion res.		7 Hr/mil	40				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-11	cyl 1/8-8" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-8"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 222

Characterization

TYPE: macrocomposite; carbon graphite-metal (copper); copper-lead impregnated; medium hard; not good for moldability to size; temperature limited to 550F in use in oxidizing atmosphere; for mechanical applications such as seals, bearings, low porosity

MFG: graphite; pitch; molded and baked but not to graphitizing temperature; impregnated with metal (copper-lead) as secondary processing; finishing operations as required; less than 100 lb batch size

ANALYTICAL:	Ash	Fe	Cu	Si	Cu-Pb-Fe-Si
Av. value	>.5%	high	high	high	45%
Std. dev. (%)	<30				11

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev. (%)	Av. Value	Std. dev. (%)	1300F	4000F
Y. Mod. (10^6psi)		3.5					
T. Str. (10^3psi)		7.5	<5				
C. Str. (10^3psi)		30	15				
Flex. Str. (10^3psi)		15	15				
Density (g/cc)		>2.2	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		6					
Hardness		76S	10				
Abrasion res.		6 Hr/mil	33				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-59L	cyl 1/8-8" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-8"	$1-10/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 223

Characterization

TYPE: macrocomposite; high strength; low coeff. therm. exp.; good electrical and thermal conductivity; good thermal insulator; high reproducibility; low friction; low porosity; long experience; high hardness; used for mechanical applications

MFG: natural and artificial graphite, pitch coke; resin; impregnated in secondary processing; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	8%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.5					
T. Str. (10^3psi)		10					
C. Str. (10^3psi)		30					
Flex. Str. (10^3psi)							
Density (g/cc)		1.9	1.5				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		75					
Hardness		80S					
Abrasion res.	8 Hr/mil		37				
Admittance	very low, less than 10^{-6} D'Arcy						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	P-692	cyl 1/8-8" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-8"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 224

Characterization

TYPE: macrocomposite; carbon graphite-silver impregnated; high strength; high reproducibility; high density; long experience; used for brushes and electrical service such as on commutators and slip rings

MFG: graphite, pitch; molded and baked but not to graphitizing temperature; impregnated with silver in secondary processing; finishing operations as required; less than 100 lb batch size

ANALYTICAL:	Ash	Ag
Av. value	>.5%	about 50%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		6.5					
Density (g/cc)		3.2	2				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		6					
Hardness		30S					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	SK-45	cyl 1/8-8" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe < 1/2-8"	$10-100/lb	10-100 T/yr	3 mo

GRAPHITE PRODUCT NO. 225

Characterization

TYPE: macrocomposite; molded, fine grained; good electrical conductor; high reproducibility; long experience; used for brushes

MFG: natural graphite; processed below 2500C; copper impregnated, machined, 100-2000 lb batch size

ANALYTICAL:	Cu
Av. value	30%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.7	20				
Density (g/cc)	(2)	2.36	1				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	6.0	1				
Scleroscope Hardness		27.9	6				
Rockwell Hardness (R)		85					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	661	blk<12"x12"x2-1/2" Fabricated brushes only	1-10/lb	10-100 T/yr	1 mo

(1) Single Point
(2) Wt/Volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 226

Characterization

TYPE: macrocomposite; molded, fine grained; long experience; used for brushes

MFG: natural graphite; copper impregnated; processed below 2500C; machined; 1-20T batch size

ANALYTICAL: Av. value — Cu 45%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.5	20				
Density (g/cc)	(2)	2.76	1				
C. Exp. (10^{-6}/°C)	(3)	2.2		10.9			
Therm. Cond. (cal cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(4)	4.9	16				
Scleroscope Hardness		25.9	7				
Rockwell Hardness (L)		55					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	669	blk <12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Expansion 0-600°C
(4) Volt/amps

GRAPHITE PRODUCT NO. 227

Characterization

TYPE: macrocomposite; molded, fine grained; good electrical conductor; high reproducibility;long experience; used for brushes

MFG: natural graphite; processed below 2500C; copper impregnated; machined; 100-2000 lb batch size

ANALYTICAL:	Cu
Av. value	40%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	4.0	18				
Density (g/cc)	(2)	2.68	1				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	3.3	2				
Scleroscope Hardness		26.2	10				
Rockwell Hardness (R)		90					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	672	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 228

Characterization

TYPE: macrocomposite; molded, fine grained; good electrical conductor; high reproducibility; long experience; used for brushes

MFG: natural graphite; processed below 2500C; copper impregnated; machined; 100-2000 lb batch size

ANALYTICAL:	Cu
Av. value	50%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	3.3	26				
Density (g/cc)	(2)	2.83	2				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(3)	2.4	20				
Scleroscope Hardness		24	10				
Rockwell Hardness (L)		48					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	673	blk < 12"x12"x2-1/2" Fabricated brushes only	$1-10/lb	10-100 T/yr	1 mo

(1) Single point
(2) Wt/volume
(3) Volt/amps

GRAPHITE PRODUCT NO. 229

Characterization

TYPE: macrocomposite; molded, fine grained; high reproducibility; low friction; low porosity; abrasion resistant; long experience; high production; used for mechanical applications such as seals, bearings, blades, end plates, pistons, and valves

MFG: natural graphite and lead; processed under 2500C; machined; 100-2000 lb batch size

ANALYTICAL:	Pb
Av. value	30%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.7					
T. Str. (10^3psi)	(2)	2.2					
C. Str. (10^3psi)	(3)	14.0					
Flex. Str. (10^3psi)	(4)	7.5					
Density (g/cc)	(5)	2.34					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							
Scleroscope Hardness		62					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Speer Carbon	5473	blk 8-3/4x6-5/8 x 1-1/4	$1-10/lb	10-100 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-59
(3) ASTM-D-695
(4) 4 Point loading
(5) Wt/volume

GRAPHITE PRODUCT NO. 230

Characterization

TYPE: macrocomposite; molded; max grain size .015"; graphite-boron-barium fluoride; long experience; high production; recommended for bearings and brushes

MFG: lamp black, petroleum coke, boron, pitch; mixed hot; molded; baked and graphitized; barium fluoride impregnated; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	BaF_2
Av. value	6.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	2.6					
Density (g/cc)	NEMA	1.71					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	6.5					

Hardness 45 (Scleroscope)

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	51	cyl 1/8-3/4" blk 3/4" max rod 10 mil-1/8" plt 1/4-3/4" pipe 1/2-3/4"	$1-10/lb	10-100 T/yr	

GRAPHITE PRODUCT NO. 231

Characterization

TYPE: macrocomposite; molded; max grain .003"; high strength; high reproducibility; chemical resistant; long experience; high production; used for mechanical applications; such as seals, bearings, blades, plates, pistons, and valves

MFG: calcined petroleum coke and coal tar pitch; not graphitized; resin impregnated; finishing operations as required; batch size 100-2000 lb

ANALYTICAL:	Ash
Av. value	<0.5%

PROPERTIES:	Test Spacimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.3		1.7			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	27		25			
Flex. Str. (10^3psi)	(3)	11		11			
Density (g/cc)	(4)	1.85		1.85			
C. Exp. (10^{-6}/°C)	(5)	3.6					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	21					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	304	blk 12"x12"x3" max	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 232

Characterization

TYPE: macrocomposite; max grain size .015"; high reproducibility; long experience; high production; used for mechanical applications, high temperature steam turbine seals, sintering boats, and crucibles

MFG: calcined petroleum coke and coal tar pitch; not graphitized; final temperature under 2500C; finishing as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.45%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	2.1		1.5			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	13		11.5			
Flex. Str. (10^3psi)	(3)	6.5		6			
Density (g/cc)	(4)	1.72		1.72			
C. Exp. (10^{-6}/°C)	(5)	4.0					
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	(6)	25					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	378	cyl 1/8-3" blk 1-3" rod 10 mil-1/8" plt <1/16-1" pipe < 1/2-3"	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic-1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 233

Characterization

TYPE: macrocomposite; molded; max grain size .015"; low friction; long experience; high production; recommended for bearings and brushes

MFG: lamp black, petroleum coke, MoS_2, boron, pitch, resin; pulverized and mixed hot; molded; baked but not graphitized; no impregnation; finishing operations as required; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1200F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	5					
Density (g/cc)	NEMA	1.8					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	NEMA	7.5					
Hardness	54 (Scleroscope)						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	423	cyl 1/8-3" blk 1-3" rod 10 mil-1/8" plt < 1/16-1" pipe <1/2-3"	$1-10/lb	10-100 T/yr	

GRAPHITE PRODUCT NO. 234

Characterization

TYPE: macrocomposite; molded; max grain size .15"; graphite-boron-molybdenum; low friction; long experience; high production; recommended for bearings and brushes

MFG: lamp black, coal tar pitch; artificial graphite, boron resin; not graphitized; machining and grinding as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	3.6					
Density (g/cc)	NEMA	1.77					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	7.1					
Hardness	50 (Scleroscope)						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	605	cyl 1/8-3" blk 1-3" rod 10 mil-1/8" plt <1/16-1" pipe < 1/2-3"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 235

Characterization

TYPE: macrocomposite; max grain size .003"; high reproducibility; low friction; high temperature oxidation resistant; long experience; high production; used for high temperature application such as seals, hot air valve seats, and rocket nozzle inserts

MFG: lamp black and coal tar pitch; graphitized over 2500C; impregnated; machining and grinding as required; 1002-000 lb batch size

ANALYTICAL:	Ash
Av. value	.2%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.3		1.1			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	21		22			
Flex. Str. (10^3psi)	(3)	8.3		7.3			
Density (g/cc)	(4)	1.77		1.77			
C. Exp. (10^{-6}/°C)	(5)	5.1					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(6)	28					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	741	blk 12"x12"x12"max	$1-10/lb	10-100 T/yr	3 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) NEMA

GRAPHITE PRODUCT NO. 236

Characterization

TYPE: macrocomposite; molded; max grain size .015"; graphite-copper-resin; good electrical conductor; good thermal conductor; long experience; high production; used for bearings and brushes

MFG: 50% copper, graphite, resin; copper powder mixed cold with resin, molded, then baked; no impregnation; 100-2000 lb batch size

ANALYTICAL:	Cu
Av. value	50%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value*	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	3.5					
Density (g/cc)	NEMA	3.13, 3.1					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	0.5					
Hardness	Scleroscope	15, 17					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	774	cyl 1/8-1-1/4" max blk 1-1-1/4" rod 10 mil-1/8" plt <1/16-1" pipe < 1/2 - 1-1/4"	$1-10/lb	10-100 T/yr	1 mo
GE, Schenectady	456	cyl 1/8-45" blk 1-6" rod 1/16-1/8" plt 1/16-1"	$1-10/lb	100-3M T/yr	3 mo

* First number refers to first product

GRAPHITE PRODUCT NO. 237

Characterization

TYPE: macrocomposite; molded; max grain size .015"; graphite-silver-resin; good electrical conductor; good thermal conductor; long experience; high production; recommended for brushes and bearings

MFG: 50% silver, graphite, resin; silver powder mixed cold with resin, molded, then baked; no impregnation; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ag
Av. value	50%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	5.2					
Density (g/cc)	NEMA	3.37					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	0.35					
Hardness	Scleroscope	20					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	SG211	cyl 1/8 - 1-1/4 max blk 1 - 1-1/4" rod 10 mil-1/8" plt < 1/16-1" pipe < 1/2 - 1-1/4"	$1-10/lb	10-100 T/yr	

GRAPHITE PRODUCT NO. 238

Characterization

TYPE: macrocomposite; max grain size less than .015"; high reproducibility; high density; low friction; low porosity; long experience; small sizes; high production; used for bearings, brushes, blades

MFG: graphite resin; processed at less than 2500C; finishing as required; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	4.0		3.5			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	19.8		20.0			
Flex. Str. (10^3psi)	(3)	8					
Density (g/cc)	(4)	1.92					
C. Exp. (10^{-6}/°C)	(5)	22					
Therm. Cond. (cal-cm/sec cm^2°K)	(6)	.03					
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	SK217B	blk 12"x6"x15/16" max	$1-10/lb	10-100 T/yr	4 mo

(1) Sonic 1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry
(6) @ 300°F

GRAPHITE PRODUCT NO. 239

Characterization

TYPE: macrocomposite; molded; max grain .003"; high strength; high reproducibility; chemical resistant; long experience; high production; used for mechanical applications

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; resin impregnated; finishing as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	0.1%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	1.8		1.2			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	17		17.7			
Flex. Str. (10^3psi)	(3)	7.9		7.6			
Density (g/cc)	(4)	1.83		1.83			
C. Exp. (10^{-6}/°C)	(5)	1.9					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	SK314	blk 12"x 12" x 3" max	$1-10/lb	10-100 T/yr	0-3 mo

(1) Sonic-1/2" cube
(2) 1/4" cube
(3) NEMA
(4) NEMA
(5) Dilatometry

GRAPHITE PRODUCT NO. 240

Characterization

TYPE: macrocomposite; molded; max grain size .015"; graphite-copper-resin; good electrical conductor; good thermal conductor; long experience; high production; used for bearings and brushes

MFG: 45% copper, graphite, resin; copper powder mixed cold with resin, molded, then baked; no impregnation; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	45%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	6.7					
Density (g/cc)	NEMA	3.0					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	NEMA	1.0					
Hardness	Scleroscope	26					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole Carbon	X84S	cyl 1/8 - 1-1/4" max blk 1 - 1-1/4" rod 10 mil-1/8" plt 1/16 - 1" pipe 1/2 - 1-1/4"	$1-10/lb	10-100 T/yr	

GRAPHITE PRODUCT NO. 241

Characterization

TYPE: macrocomposite; high strength; high temperature oxidation resistance; used for rocket nozzle inserts

MFG: calcined, petroleum coke, Zirconium Diboride, and Silicon; graphitized over 2500C; hot worked in secondary processing; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	(1)	2.0		10.0			
Density (g/cc)	(2)	3.2					
C. Exp. (10^{-6}/°C)	(3)	5.0		6.5			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(4)	1.7		4.0			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	JTA	cyl 3-14" dia	$10-100/lb	< 10 T/yr	1-4 mo

(1) ASTM-C-78-49
(2) Wt/volume
(3) 5/16" x 5/8" x 3" specimen
(4) 1/2" x 1/2" x 4" specimen

GRAPHITE PRODUCT NO. 242

Characterization

TYPE: macrocomposite, fiber based; has unusually high resistance to thermal shock with high temperature strength; used for rocket nozzle inserts

MFG: coal tar pitch and cellulose fibers; graphitized over 2500C; impregnated in secondary processing; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		1.8		1.2			
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		4.7		2.5			
Density (g/cc)		1.54					
C. Exp. (10^{-6}/°C)		1.6		3.5			
Therm. Cond. (cal-cm/sec cm^2°K)		0.18		0.13			
S. Res. (10^{-4}ohm cm)		16		26			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	PT0178	9" x 6" cyl formed to shape	$10-100/lb	10-100 T/yr	1-3 mo

GRAPHITE PRODUCT NO. 243

Characterization

TYPE: macrocomposite, fiber based; low density; used for rocket nozzle inserts; has unusual high resistance to thermal shock

MFG: coal tar pitch and cellulose fibers; graphitized over 2500C; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	90		30			
T. Str. (10^3psi)							
C. Str. (10^3psi)	(2)	2.0		2.5			
Flex. Str. (10^3psi)	(3)	2.5		.7			
Density (g/cc)	(4)	1.2					
C. Exp. (10^{-6}/°C)	(5)	1.0		2.5			
Therm. Cond. (cal-cm/sec cm²°K)	(6)	.05		.03			
S. Res. (10^{-4}ohm cm)	(7)	30		60			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	PTA	billets formed to shape 90" x 66"	$10-100/lb	10-100 T/yr	1-3 mo

(1) Sonic
(2) ASTM-C-109-54T
(3) ASTM-C-78-49
(4) Wt/volume
(5) bar 5/16" x 5/8" x 6"
(6) cyl 1/2-1" dia x 6" lg
(7) Volt/amps

GRAPHITE PRODUCT NO. 244

Characterization

TYPE: macrocomposite; fiber based; low density; has unusually high resistance to thermal shock with ultra high temperature capabilities; used for rocket nozzle inserts

MFG: coal tar pitch and cellulose fibers; graphitized over 2500C; impregnated in secondary processing; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)	(1)	2.8		1.9			
C. Str. (10^3psi)	(2)	12.6		15.0			
Flex. Str. (10^3psi)							
Density (g/cc)	(3)	1.40					
C. Exp. (10^{-6}/°C)	(4)	2.0		4.5			
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)	(5)	126.6		70.5			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	PTB	9" x 6" cyl formed to shape	$10-100/lb	10-100 T/yr	1-3 mo

(1) cyl 1/4" dia
(2) ASTM-C-109-54T
(3) Wt/volume
(4) bars 1/16" x 5/8" x 6"
(5) Volt/amps

GRAPHITE PRODUCT NO. 245

Characterization

TYPE: macrocomposite; low porosity; chemical resistant; long experience; large and small sizes; high production; useful max temperature 340F; used for heat exchangers

MFG: calcined petroleum coke and coal tar pitch; graphitized over 2500C; Acheson electric furnace; impregnated in secondary processing; machined; 100-2000 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1200F	4000F
Y. Mod. (10^6psi)		2.2					
T. Str. (10^3psi)							
C. Str. (10^3psi)		9.0					
Flex. Str. (10^3psi)		4.7					
Density (g/cc)		1.87-1.91					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Impervious (0.7% porosity)
10-13% resin content

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Karbate No. 22	pipe 1-10" ID	$1-10/lb	100-3M T/yr	1 mo

GRAPHITE PRODUCT NO. 246

Characterization

TYPE: gross composite; laminated construction; used in brushes for high commutation performance

MFG: lamp black; calcined petroleum coke, coal tar pitch; molded and graphitized; strips of differing physical properties bonded together

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)							
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	L352	Supplied only as complete brushes			3 mo

GRAPHITE PRODUCT NO. 247

Characterization

TYPE: gross composite; graphite; MoS_2 inserts; used for bearings and other mechanical parts

MFG: calcined petroleum coke; coal tar pitch; molded and graphitized over 2500C; MoS_2 inserts applied as secondary operation

ANALYTICAL:	Ash
Av. value	.1-.5% (exclusive of inserts)

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1-5	5-10				
Density (g/cc)		1.65-1.8					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		10-50	5-10				
	(Exclusive of inserts)						

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	ME24	cyl 1/8-45"			3 mo

GRAPHITE PRODUCT NO. 248

Characterization

TYPE: gross composite; graphite, MoS_2 core construction

MFG: lamp black, calcined petroleum coke, boron, coal tar pitch; molded and graphitized; MoS_2 plugs inserted as secondary operation

ANALYTICAL: Ash
Av. value .1-.5% (exclusive of cores)

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		1-5	5-10				
Density (g/cc)		1.69					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)		21	5-10				
Hardness		52S					

Note: Applies to carbon prior to inserting cores

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
GE - Schenectady	T464	Supplied only as complete brushes			3 mo

GRAPHITE PRODUCT NO. 249

Characterization

TYPE: gross composite; carbon graphite-copper; powdered metal baked with graphite and pitch; used on slip rings and low voltage DC motors and as brushes

MFG: graphite, pitch, metal; molded and baked but not graphitized; not impregnated; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash
Av. value	>.5%
Std. dev. (%)	<30

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	15				
Density (g/cc)		1.9	>2				
C. Exp. (10^6/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^4ohm cm)		50	15				
Hardness		20S	13				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	G-19	cyl 1/8-6" blk 1-6" rod .01-1/8" plt < 1/16-1" pipe <1/2-6"	$1-10/lb	10-100 T/yr	2 mo

GRAPHITE PRODUCT NO. 250

Characterization

TYPE: gross composite; graphite-metal-resin; powdered copper mixed with graphite and resin and molded to size; for brushes in low voltage field on such applications as heater motors, electric trucks, battery charges, and light plants for farms

MFG: graphite, resin, copper powder; molded and baked below melting point of copper; not impregnated; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash	Cu
Av. value	>.5%	30% (as ash)
Std. dev. (%)	<30	17

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		3.5					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	>20				
Density (g/cc)		>2.2	>2				
C. Exp. (10^{-6}/°C)		6					
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		5	15				
Hardness		15S	40				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	M-30	cyl 1/8-6" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-6"	$1-10/lb	10-100 T/yr	1 mo

GRAPHITE PRODUCT NO. 251

Characterization

TYPE: gross composite; graphite-metal-resin; powdered silver mixed with graphite and resin and molded to size; sintered type; for brushes

MFG: graphite-resin-silver powder; molded and baked below melting point of silver; not impregnated; finishing operations as required; 100-2000 lb batch size

ANALYTICAL:	Ash	Ag
Av. value	>.5%	55%
Std. dev. (%)	<30	18

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		3	15				
Density (g/cc)		>2.2	>2				
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)		6	20				
Hardness		27S	15				

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Pure Carbon	S-50	cyl 1/8-6" blk 1-6" rod .01-1/8" plt <1/16-1" pipe < 1/2-6"	$10-100/lb	10-100 T/yr	2 mo

Alloyed Graphite Products (Nos. 252 through 256)

As in metal systems, there appears to be a potential for an almost limitless number of graphite-base alloy systems. However, this category of material has not been fully exploited and relatively few graphite products in this class are contained in this directory. For the requirements of this directory, alloyed graphite products are defined as a graphite-base body containing more than 50 percent graphite and at least one other component which is either partially or wholly "soluble" in the graphite matrix. Also, for simplicity, alloyed graphite products are limited to two subclasses.

Metallo-pyrolytic graphite alloy (No. 252), as the name implies, is produced by a pyrolytic method wherein gaseous hydrocarbons are decomposed together with metallic compounds such as metal halides. The properties of this type of material are similar to pyrolytic graphite but modified by the addition of one or more components.

Graphite-boron alloy type (Nos. 253-256) is proving to be very popular and is produced by molding or extruding techniques. After final graphitization, the boron may be present as boron carbide which is a separate, distinguishable phase from the graphite lattice. Although this makes the graphite-boron system appear as a composite, it is classified in the directory as an alloyed graphite product.

GRAPHITE PRODUCT NO. 252

Characterization

TYPE: graphite alloy; metallo-pyrolytic; good electrical conductivity; good thermal conductivity; high purity; good nuclear porperties; low porosity; chemical resistant; high temperature oxidation resistant

MFG: manufacturing methods claimed to be proprietary

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1200F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.3-1.5					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)		.01-.02					
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Atomergic Chemetals	Vitreous Carbon	plt <1/4" pipe	>$100/lb	<10 T/yr	6 mo

GRAPHITE PRODUCT NO. 253

Characterization

TYPE: graphite alloy; molded; max grain size .015"· graphite-boron; low friction; long experience; high production; used for bearings, brushes, blades, pistons, and valves

MFG: lamp black, petroleum coke, boron, pitch, ; pulverized and mixed hot; molded; baked and graphitized; no impregnation; finishing operations as required; 1-20T batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)	NEMA	2.4					
Density (g/cc)	NEMA	1.59					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)	NEMA	6.5					
Hardness	Scleroscope	45					

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Stackpole	417	cyl 1/8-3" blk 1-3" rod 10 mil-1/8" plt 1/16-1" pipe 1/2-3"	$1-10/lb	10-100 T/yr	

GRAPHITE PRODUCT NO. 254

Characterization

TYPE: pyrolytic boron nitride, graphite alloy; low coeff. therm. exp.; high strength; high electrical resistance; good thermal insulator and conductor; high purity; high density; low porosity; highly oriented; chemical resistant; high temperature oxidation resistant

MFG: inorganic salt; machined and ground; less than 100 lb batch size

ANALYTICAL:
Less than 100 ppm total impurities

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)		3					
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)		15					
Density (g/cc)		2.0-2.15					
C. Exp. (10^{-6}/°C)		1		25			
Therm. Cond. (cal-cm/sec cm^2°K)		0.15		25			
S. Res. (10^{-4}ohm cm)							

Oxidation resistance in moving air at one atmosphere less than 0.001 in. per hr. at 1300C. No oxidation below 700C. Inert to almost all reagents at room temperature. Inert to a large number of reagents at temperatures over 1000C.

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Super-Temp	Pyrolytic Boron Nitride	plt .030-500" up to 6" x 9" cyl 1/4-6" dia up to 9" lg	$10-100/lb	<10 T/yr	1-2 mo

GRAPHITE PRODUCT NO. 255

Characterization

TYPE: graphite-boron alloy; used for nuclear reactor shielding

MFG: calcined petroleum coke and coal tar pitch, boron; graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:	B
Av. value	5% min

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1800F	4000F
Y. Mod. (10^6psi)	(1)	1.2		0.8			
T. Str. (10^3psi)	(2)	.88		.81			
C. Str. (10^3psi)	(3)	3.7		3.8			
Flex. Str. (10^3psi)	(4)	1.7		1.3			
Density (g/cc)	(5)	1.57					
C. Exp. (10^{-6}/°C)	(6)	1.9		3.0			
Therm. Cond. (cal-cm/sec cm²°K)		0.35		0.28			
S. Res. (10^{-4}ohm cm)	(7)	8.8		11.1			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DEL.
Union Carbide	CGC	blk up to 12 x 12	$1-10/lb	10-100 T/yr	100-3M T/yr	4 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

GRAPHITE PRODUCT NO. 256

Characterization

TYPE: graphite-boron alloy; used for nuclear reactor shielding

MFG: calcined petroleum coke and coal tar pitch, boron; graphitized over 2500C; Acheson electric furnace; 1-20T batch size

ANALYTICAL:

	B
Av. value	7% min

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1200F	4000F
Y. Mod. (10^6psi)	(1)	1.2		0.8			
T. Str. (10^3psi)	(2)	.88		.81			
C. Str. (10^3psi)	(3)	3.7		3.8			
Flex. Str. (10^3psi)	(4)	1.7		1.3			
Density (g/cc)	(5)	1.57					
C. Exp. (10^{-6}/°C)	(6)	1.9		3.0			
Therm. Cond. (cal-cm/sec cm²°K)		0.35		0.28			
S. Res. (10^{-4}ohm cm)	(7)	8.8		11.1			

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.		DCL.
Union Carbide	CGD	blk up to 12"x12"	$1-10/lb	10-100 T/yr	100-3 M T/yr	4 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) Volt/amps

Foamed Graphite Products (Nos. 257 through 262)

The term, "foamed" graphite, refers to graphite bodies with densities less than 1.2 g/cc or a porosity exceeding 50 percent voids by volume and which are produced by a foaming process. Only a few graphite products of this type are included in the directory and these are mostly pyrolytic graphite foams.

The pyrolytic graphite foams are pure, highly oriented materials with similar anisotropic properties characteristic of pyrolytic graphite. They have high temperature stability, chemical inertness, and low thermal conductivity, making them attractive for potential applications for use as bulk insulation in environments of both high temperature and cryogenic conditions.

It is also practical to produce foamed graphite products by techniques other than pyrolytic and three such products are shown.

The unique characteristics of foamed graphite products with respect to high and low temperature insulation are very interesting for components exposed to severe environmental situations in military and aerospace missions.

GRAPHITE PRODUCT NO. 257

Characterization

TYPE: pyrolytic graphite foam; good thermal insulator; high purity;low density; highly oriented; chemical resistant; low hardness; used for insulation

MFG: gaseous hydrocarbon; graphitized over 2500C; impregnated; machined; less than 100 lb batch size

ANALYTICAL:

	Ash
Av. value	0.05% 300ppm impurities

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		0.2 gm/cc					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Space Age Matl's	Foamite LD	chopped and block foam	>$100/lb	<10 T/yr	2-3 mo

GRAPHITE PRODUCT NO. 258

Characterization

TYPE: graphite foam; good thermal insulator; high reproducibility; high porosity; chemical resistant; high permeability; long experience; used as filters and diffusers

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:

	Ash
Av. value	.1-.5%

PROPERTIES:

	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.2					
T. Str. (10^3psi)	(2)	.07					
C. Str. (10^3psi)	(3)	0.4					
Flex. Str. (10^3psi)	(4)	0.2					
Density (g/cc)	(5)	1.03					
C. Exp. (10^{-6}/°C)	(6)	2.0					
Therm. Cond. (cal-cm/sec cm^2°K)	(7)	16					
S. Res. (10^{-4}ohm cm)	(8)	38.0					
% Porosity		48					

Ave. permeability - water (at 70F, 5 psi) 1" thk. plt - 90 gal/ft^2/min

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Porous Graphite 25	cyl 7-1/4" blk 9'x 14'x 14" pipe 1-3/4" OD	$1-10/lb	10-100 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) cyl 1/2-1" dia x 6" lg
(8) Volt/amps

GRAPHITE PRODUCT NO. 259

Characterization

TYPE: graphite foam; good thermal insulator; high reproducibility; high porosity; chemical resistant; high permeability; long experience; used as filters and diffusers

MFG: calcined petroleum coke; graphitized over 2500C;;Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	.1-.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.3					
T. Str. (10^3psi)	(2)	.07					
C. Str. (10^3psi)	(3)	0.5					
Flex. Str. (10^3psi)	(4)	0.3					
Density (g/cc)	(5)	1.04					
C. Exp. (10^{-6}/°C)	(6)	2.0					
Therm. Cond. (cal-cm/sec cm²°K)	(7)	.18					
S. Res. (10^{-4}ohm cm)	(8)	33.0					
% Porosity		48					

Ave. permeability - water (at 70F, 5 psi) 1" thk. plt - 30 gal/ft^2/min

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Porous Graphite 45	cyl 7-1/4" blk 9"x 14"x 14" pipe 1-3/4" OD	$1-10/lb	10-100 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-54T
(4) ASTM-C-78-49
(5) Wt/volume
(6) bar 5/16" x 5/8" x 6"
(7) cyl 1/2-1" dia x 6" lg
(8) Volt/amps

GRAPHITE PRODUCT NO. 260

Characterization

TYPE: graphite foam; good thermal insulator; high reproducibility; high porosity; chemical chemical resistant; high permeability; long experience; used as filters and diffusers

MFG: calcined petroleum coke; graphitized over 2500C; Acheson electric furnace; machined; 1-20T batch size

ANALYTICAL:	Ash
Av. value	.1-.5%

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)	(1)	0.3					
T. Str. (10^3psi)	(2)	0.2					
C. Str. (10^3psi)	(3)	0.6					
Flex. Str. (10^3psi)	(4)	0.4					
Density (g/cc)	(5)	1.05					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)	(6)	0.21					
S. Res. (10^{-4}ohm cm)	(7)	30.0					

% Porosity 48

Ave permeability - water (at 70°F, 5psi) 1" thk plt
10 gal/ft^2/min

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Union Carbide	Porous Graphite 60	cyl 7-1/4" blk 9x14x14" pipe 1-3/4" OD	$1-10/lb	10-100 T/yr	1 mo

(1) Sonic
(2) ASTM-C-190-49
(3) ASTM-C-109-545
(4) ASTM-C-78-49
(5) Wt/volume
(6) cyl 1/2-1" dia x 6" lg
(7) Volt/amps

GRAPHITE PRODUCT NO. 261

Characterization

TYPE: pyrolytic graphite foam; good thermal insulator; low density; highly oriented; chemical resistant; used for insulation

MFG: gaseous hydrocarbon; graphitized above 2500C; impregnated; machined and ground; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain		Against Grain		Typical H.T. Prop.	
		Av. Value	Std. dev.(%)	Av. Value	Std. dev.(%)	1300F	4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		0.8 gm/cc					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm^2°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Space Age Matl's	Foamite MD	plt chopped and blk form and molded shapes (up to 18" dia x 20" lg)	>$100/lb	< 10 T/yr	2-3 mo

GRAPHITE PRODUCT NO. 262

Characterization

TYPE: pyrolytic graphite foam; good thermal insulator; high purity; high density; low friction; low porosity; highly oriented; chemical resistant; used for sulation

MFG: gaseous hydrocarbon; graphitized over 2500C; impregnated; machined and ground; less than 100 lb batch size

ANALYTICAL:

PROPERTIES:	Test Specimen or Method	With Grain Av. Value	With Grain Std. dev.(%)	Against Grain Av. Value	Against Grain Std. dev.(%)	Typical H.T. Prop. 1300F	Typical H.T. Prop. 4000F
Y. Mod. (10^6psi)							
T. Str. (10^3psi)							
C. Str. (10^3psi)							
Flex. Str. (10^3psi)							
Density (g/cc)		1.5-2.1 gm/cc					
C. Exp. (10^{-6}/°C)							
Therm. Cond. (cal-cm/sec cm²°K)							
S. Res. (10^{-4}ohm cm)							

Supplier's Availability

SUPPLIER	GRADES	SIZES & SHAPES	PRICE	RATE or CAP.	DEL.
Space Age Matl's	Foamite HD	plt chopped and blk form and molded shapes (up to 18" dia x 20" lg)	>$100/lb	< 10 T/yr	2-3 mo

SUPPLIERS' INDEX

Numbers in parentheses show graphite product number associated with supplier's grade which precedes it. Suppliers are listed alphabetically and their grades are in either alphabetical or numerical order. A dash indicates no supplier's grade designation.

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GENERAL ELECTRIC - SCHENECTADY

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PURE CARBON COMPANY

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Eighteen categories of shapes and sizes are indicated below. If a graphite product is supplied within a given form and size range, its number is shown.

CYLINDER - - Solid Stock and Spheres, 1/8" - 3" Diameter

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CYLINDER - - Solid Stock and Spheres, 3" - 45" Diameter

5-24, 34, 35, 38, 39, 44, 63, 68, 69, 71, 72, 74-79, 82-85, 87, 89-94, 96, 98, 100-104, 110-117, 119-121, 123, 124, 126-139, 143, 144, 146, 147, 149-155, 157, 161-172, 178, 209-213, 215-224, 232-234, 236 241, 242, 244, 247, 249-251, 258-260

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BLOCK - - Rectilinear, Solid Stock, Up to 24" Wide, 6" - 24" Thick

2-23, 25-34, 36-40, 44-69, 71, 73, 75, 79, 94, 104, 105, 107, 114-119, 122, 123, 126-132, 144-148, 150, 151, 157-159, 173, 179, 210-213, 215-229, 231-240, 249-251, 253, 255, 256, 258-260

BLOCK - - Rectilinear, Solid Stock, Up to 24" Wide, 6" - 24" Thick

3, 6, 7, 64, 67-69, 71, 79, 120, 124, 126, 139, 148, 151, 152, 157-159, 168, 235

LARGE BLOCK - - Rectilinear, Solid Stock, More Than 1" Thick, 24" - 48" Wide

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LARGE BLOCK - - Rectilinear, Solid Stock, More Than 1" Thick, More Than 48" Wide

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ROD - - 10 mils - 1/16" Diameter

16-23, 63, 146, 147, 210-213, 215-224, 232-234, 236, 237, 240, 249-251, 253

ROD--1/16" - 1/8" Diameter

5, 16-23, 34, 210-213, 215-224, 232-234, 236, 237, 240, 249-251, 253

PLATE--Less Than 1/16" Thick

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PLATE--1/16" - 1/4" Thick

8-23, 34, 146, 147, 175, 177, 178, 180, 208, 210-214, 232-234, 236, 237, 240, 249-251

PLATE--1/4" - 1" Thick

8-23, 34, 63, 76, 80, 81, 109, 146, 147, 149, 150, 175, 177-180, 208, 210-214, 230, 232-234, 236, 237, 249-251, 253

PIPE & TUBE -- (Ratio of Length to Diameter at Least 3:1), Less Than 1/2" O. D.

8-12, 16-23, 63, 88-91, 175, 180, 210-213, 219-224, 232-234, 236, 237, 249-251

PIPE & TUBE -- (Ratio of Length to Diameter at Least 3:1), 1/2" - 10" O. D.

8-12, 16-23, 63, 88-91, 95, 112, 175, 180, 210-214, 219-224, 230, 232-234, 236, 237, 240, 245, 249-251, 253, 258-260

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COMPOSITE

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COST-LOW

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DENSITY-LOW

40, 205-208, 212, 243, 244, 257, 261

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13-15, 27, 28, 31-33, 37, 47-49, 51-58, 60, 176, 179, 180, 207, 208, 212, 254

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EXTRUDED

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FIBROUS

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FLEXIBLE

194-208

FOAMED

257-262

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HARDNESS-HIGH

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174-180, 252, 257, 261, 262

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13, 14, 16-25, 29, 31, 34-37, 39, 40, 42-44, 46-53, 55-69, 71, 74, 76-78, 82-85, 88-91, 94, 105, 106, 111, 112, 114-117, 119-124, 127-132, 139, 143, 144, 147, 167, 171, 172, 177, 178, 181, 186-188, 194, 196, 201, 205, 207, 208, 211, 213, 214, 219, 223-225, 227-229, 231, 232, 235, 238, 239, 258-260

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1, 16-23, 76, 88, 92, 101, 106, 111, 112, 119, 133, 146, 147, 164, 171, 172, 174-178, 180, 182, 188, 196, 207-209, 213, 223, 236, 237, 240, 252, 254

THERMAL INSULATION-GOOD

40, 175-177, 179, 180, 206-208, 223, 254, 257-262

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BARIUM FLUORIDE

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BORON

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COAL TAR PITCH

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FIBER, CELLULOSE

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PETROLEUM PITCH

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PHOSPHORUS

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PROPERTY INDEX

Listing of properties is grouped in accordance with mechanical properties, physical properties, electrical properties, and chemical properties. Graphite product numbers are identified with each property category as indicated by a range under each property. Following each property category, the graphite product numbers are shown.

YOUNG'S MODULUS - - at Room Temperature, WITH the Grain (Av. 10^6 psi)

Less than 1: 15, 19, 22, 24, 33, 35, 80, 81, 135, 163, 167, 168, 170, 207, 258, 260

1 to 2: 2-4, 6, 7, 13, 14, 16, 17, 20, 21, 23, 25, 34, 36, 40, 42, 47, 48, 59, 60, 64-71, 73, 77, 78, 82-92, 96-100, 102, 106-109, 111-121, 123-133, 136-138, 141, 142, 144, 146-160, 164-166, 175, 210, 211, 215, 219, 221, 223, 235, 239, 242, 255, 256

2 to 5: 5, 61, 72, 74, 75, 76, 103, 122, 171-173, 176-178, 180, 209, 218, 222, 229-232, 238, 245, 250, 254

5 to 10: None

10 to 20: None

Over 50: 243

YOUNG'S MODULUS - - at Room Temperature, AGAINST the Grain (Av. 10^6 psi)

Less than 1: 15, 86-89, 106, 109, 111, 112, 146, 147, 149, 150, 152, 154, 160, 166-168, 170-172, 255, 256

1 to 2: 2-4, 6, 7, 13, 14, 24, 35, 42-44, 64, 65, 67-71, 74, 77, 78, 82-85, 90-92, 103, 113-133, 136-138, 141, 142, 144, 148, 151, 153, 155, 157-159, 165, 173, 230-232, 235, 239, 242

2 to 5: 72, 175, 177, 180, 238

5 to 10: 5

10 to 50: 243

Over 50: None

TENSILE STRENGTH--at Room Temperature, WITH the Grain (Av. 10^3 psi)

Less than 1: 40, 80, 81, 110, 113-117, 121, 131, 139, 152, 161, 162, 165-170, 255, 256, 258-260
1 to 2: 2, 4, 24-26, 34-36, 38, 59, 61, 77-79, 82, 87, 89, 100-103, 107, 109, 110, 118-120, 125-130, 132-134, 136-138, 141, 142, 144, 148-151, 153-160, 175, 179, 207
2 to 5: 3, 6, 7, 16, 20, 22, 23, 41-44, 46-48, 60, 68-70, 74, 75, 83-86, 88-92, 94, 96-99, 111, 112, 122-124, 135, 145, 172, 173, 209, 210, 219, 229, 244
5 to 10: 13, 14, 21, 72, 167, 213, 221-223
10 to 30: 176-178, 180
Over 30: None

TENSILE STRENGTH--at Room Temperature, AGAINST the Grain (Av. 10^3 psi)

Less than 1: 113-117, 120, 121, 131, 139, 149, 152, 154, 160, 165-168, 170, 177-179, 255, 256
1 to 2: 2, 4, 24-26, 34, 35, 38, 44, 77-79, 82, 85-89, 96, 98, 100, 103, 111, 112, 118, 119, 122-130, 132, 133, 136-138, 141, 142, 144, 145, 148, 150, 151, 153, 155, 157-159, 172, 180, 244
2 to 5: 3, 6, 7, 42, 43, 68-70, 74, 83, 84, 90-92, 163, 173
5 to 10: 44, 72
10 to 30: 175, 209
Over 30: None

COMPRESSIVE STRENGTH--at Room Temperature, WITH the Grain (Av. 10^3 psi)

Less than 2: 101, 162, 166, 168, 239, 258-260
2 to 5: 41, 87, 89, 106, 110, 113, 115-117, 120, 121, 127-132, 135, 139, 147, 149, 152, 154, 155, 160, 161, 163, 165, 167, 169, 170, 243, 255, 256
5 to 10: 2-4, 6, 7, 9, 15, 24-26, 34-36, 38, 40, 42-44, 47, 59, 61, 68, 70, 77-79, 82-84, 86, 88, 89, 92, 96-100, 102, 103, 111, 112, 114, 118, 119, 122-126, 133, 134, 136-138, 141, 142, 144-146, 148, 150, 151, 153, 157-159, 171, 172, 210, 245
10 to 50: 12-14, 16, 20-23, 46, 48, 60, 64-67, 69, 71, 72, 74, 75, 85, 90, 91, 94, 173, 177-180, 213, 219, 221-223, 229-232, 235, 238
Over 50: 76, 175, 176

COMPRESSIVE STRENGTH--at Room Temperature, AGAINST the Grain (Av. 10^3 psi)

Less than 2: 166, 171, 172
2 to 5: 70, 87, 89, 106, 113-117, 120, 121, 125-132, 139, 146, 147, 149, 152-155, 160, 163, 165, 167, 168, 170, 179, 243, 255, 256
5 to 10: 2, 4, 6, 24, 25, 34-36, 38, 40, 42-44, 59, 61, 68, 70, 77-79, 82, 84, 86, 88, 89, 92, 96-100, 102, 103, 111, 112, 118, 119, 122, 124, 133, 136-138, 141, 142, 144, 145, 148, 150, 151, 157-159
10 to 50: 3, 7, 26, 47, 48, 60, 64-67, 69, 71, 72, 74, 83, 85, 90, 91, 94, 96, 98, 173, 175,176, 179, 180, 231, 232, 235, 238, 239
Over 50: 177, 178

FLEXURAL STRENGTH--at Room Temperature, WITH the Grain (Av. 10^3 psi)

Less than 1: 162, 165, 166, 168, 169, 179, 258-260
1 to 5: 1-4, 6-8, 10, 11, 17-19, 24-28, 30, 33-38, 40, 42-44, 47, 49-52, 54-61, 63, 67, 68, 70, 71, 74, 77-85, 92-103, 105-110, 113-134, 136-139, 141-161, 164, 167, 170, 175, 179, 212, 217, 225-228, 230, 233, 234, 236, 241-243, 245, 247-251, 253, 255, 256
5 to 10: 5, 9, 12-16, 20-23, 29, 31, 32, 39, 41, 45, 46, 48, 53, 62, 64-66, 69, 72, 73, 75, 94, 104, 135, 167, 171-173, 210, 211, 215, 216, 218, 219, 224, 229, 232, 235, 237-240
10 to 20: 76, 178-180, 213, 220-222, 231, 254
Over 20: 140, 178

FLEXURAL STRENGTH--at Room Temperature, AGAINST the Grain (Av. 10^3 psi)

Less than 1: 107, 165-168, 170, 243
1 to 5: 2-4, 6, 7, 24-26, 34-36, 38, 40, 42-44, 47, 48, 59, 60, 64, 67, 69-71, 74, 77-79, 82-85, 92, 94, 96, 98, 100-103, 109, 113-122, 124-133, 136-139, 141, 142, 144-158, 172, 179, 242, 255, 256
5 to 10: 5, 13, 65, 66, 68, 72, 163, 173, 232, 235, 239, 241
10 to 20: 16, 180, 211, 231, 244
Over 20: 175

DENSITY--at Room Temperature, (Av. g/cc)

Less than 1.50: 17, 28, 33, 37, 40, 56, 76, 80, 81, 179, 212, 243, 244, 252, 257-261

1.50 to 1.65: 3, 4, 8-10, 15, 18-20, 22, 26, 28, 35, 37, 48, 49, 51, 52, 54, 57-59, 63, 64, 86, 87, 89, 93, 95, 106, 107, 110, 113-117, 121, 134, 135, 139, 143, 147, 149, 152, 161-170, 182, 188, 196, 209, 215, 242, 253, 255, 256, 262

1.65 to 1.80: 2, 5, 6, 12, 14, 16, 21, 23-25, 27, 30-32, 34-36, 38, 39, 41-44, 46, 47, 50, 52, 53, 55, 60, 61, 65-68, 70-73, 75, 77, 79, 88, 89, 94, 96-103, 105, 108, 109, 118-120, 125-133, 136-138, 140-142, 144-146, 148, 150, 151, 153-160, 211, 216-219, 230, 232-235, 247, 248

1.80 to 2.00: 1, 7, 13, 29, 30, 45, 62, 69, 74, 78, 82-85, 90-92, 104, 111, 112, 122-124, 171-173, 179, 210, 220, 223, 231, 238, 239, 245, 249

2.00 to 2.20: 175-180, 254

Over 2.20: 11, 213, 221, 222, 224-229, 236, 237, 240, 241, 250, 251

COEFFICIENT OF THERMAL EXPANSION--at Room Temperature WITH the Grain (Av. $10^{-6}/°C$)

Less than 2: 30, 33, 69, 72, 74, 83, 84, 96, 98, 100-102, 107-109, 113-120, 123, 124, 127-131, 143, 149-152, 154-156, 160, 163, 165-168, 171, 172, 176, 178, 207, 211, 238, 239, 242, 243, 254, 255, 256

2 to 10: 2-6, 13-16, 24-27, 34-38, 40-48, 51-54, 56-61, 64-68, 70, 71, 73, 76-79, 82, 85, 92-94, 97-99, 103, 121, 122, 125, 126, 132-139, 141, 142, 144-148, 153, 157-159, 164, 170, 173, 177, 180, 210, 213, 215, 218-223, 226, 231, 232, 235, 241, 244, 250, 258, 259

10 to 20: 175

Over 20: 7

COEFFICIENT OF THERMAL EXPANSION--at Room Temperature, AGAINST the Grain (Av. $10^{-6}/°C$)

Less than 2: 76, 106, 168, 173, 175

2 to 10: 2-4, 6, 21-27, 30, 34-38, 40, 42-45, 47, 48, 51-53, 59-61, 65-72, 74, 77-85, 92-94, 96-103, 108, 113-139, 141-148, 151-155, 157-160, 163-165, 167, 170-173, 241-244, 255, 256

10 to 20: 177, 178

Over 20: 7, 176, 180, 254

THERMAL CONDUCTIVITY--at Room Temperature, WITH the Grain (Av. cal-cm/sec cm^2 °K)

Less than 0.1: 72, 76, 77, 175, 238, 243, 252
0.1 to 0.5: 2-4, 6, 7, 13-15, 68, 70, 71, 73, 74, 78-80, 82-85, 92, 107-109, 113-132, 148-160, 165-168, 170, 171, 173, 242, 254-256, 258-260
0.5 to 1.0: 172, 177, 178
Over 1.0: 81, 176, 180, 208

THERMAL CONDUCTIVITY--at Room Temperature, AGAINST the Grain (Av. cal-cm/sec cm^2 °K)

Less than 0.1: 178, 243
0.1 to 0.5: 2-4, 6, 7, 13-15, 68, 70-72, 74, 77-79, 82-85, 92, 107-109, 113-132, 148-160, 165-168, 170-173, 177, 242, 255, 256
0.5 to 1.0: 175
Over 1.0: 180, 207, 208, 254

SPECIFIC RESISTANCE--at Room Temperature, WITH the Grain (Av. 10^{-4} ohm cm)

Less than 1: 63, 80, 178, 180, 183, 236, 237
1 to 10: 11, 24, 25, 30, 34-36, 39, 43, 44, 50, 61, 62, 65, 66, 69, 77, 78, 91, 92, 95, 97-100, 102, 103, 106-109, 111, 113-118, 120-134, 136-160, 163-168, 170-172, 176, 177, 208, 213, 222, 224-228, 230, 233, 234, 240, 241, 250, 251, 253, 255, 256
10 to 50: 2-6, 8-10, 12-17, 20, 22, 23, 27, 29-31, 33, 35, 38, 42, 45, 47-49, 51-55, 59, 60, 64, 67, 68, 70, 71, 74-76, 79-90, 93, 94, 96, 98, 101, 104, 105, 119, 135, 173, 215, 217-219, 221, 231, 232, 235, 242, 243, 247-249, 258-260
50 to 100: 18, 19, 21, 26, 28, 37, 40, 49, 52, 56-58, 210, 216, 220, 223
100 to 2,000: 211, 212, 244
Over 2,000: 32, 175

SPECIFIC RESISTANCE--at Room Temperature, AGAINST the Grain (Av. 10^{-4} ohm cm)

Less than 1: None
1 to 10: 5, 70, 77, 78, 92, 120, 123, 124, 146-148, 155-157, 170, 175, 241
10 to 50: 2-4, 6, 61, 68, 69, 71, 74, 79, 82-91, 98, 107, 109, 111-119, 121, 122, 125-132, 149-154, 158-160, 163, 165-168, 171-173, 242, 255, 256
50 to 100: 243, 244
100 to 2,000: 177
Over 2,000: 176, 178, 180, 208

APPENDIX I

ORGANIZATIONS AND INDIVIDUALS CONTACTED

1. Aerojet-General Nucleonics, San Ramon, California; W. Titus, A. V. Levy

2. Atomergic Chemetals Company, Carie Place, Long Island, N. Y.; F. E. Gallard

3. Atomics International, North American Aviation, Inc., Canoga Park, California; C. M. Ladd

4. Avco Corporation, Wilmington, Massachusetts; P. J. Cambourelis

5. Beryllium Corporation, Hazelton, Pennsylvania; N. P. Pinto

6. Carborundum Company, Graphite Products Division, Sanborn, N. Y.; E. H. Wyche

7. Collier Carbon & Chemical Corporation, Los Angeles, California; C. B. Scott

8. Duramic Products, Inc., Palisades Park, N. J.; N. D. Fern

9. Joseph Dixon Crucible Co. Div., Jersey City, N. J.; R. C. Brock

10. Douglas Aircraft Co., Inc., Santa Monica, California; J. M. Tschirgi

11. Falls Industries, Inc., Solon, Ohio; J. Reys

12. General Astrometals Corp., Yonkers, N. Y.; Paul H. Smith

13. General Dynamics/Astronautics, San Diego, California; J. L. Shoffnor

14. General Dynamics/General Atomics, San Diego, California; R. A. Meyer

15. General Electric Company, Metallurgical Products Department, Detroit, Michigan; T. J. Clark

16. General Electric Company, Motor & Generator Division, Schenectady, New York; O. C. Rutledge

17. * Great Lakes Carbon Corporation, Niagara Falls, N. Y.; B. L. Bailey, A. A. Cline, W. R. Benn, R. E. Lindenmeyr (N. Y. C.)

18. HITCO, Gardena, California; R. E. Pack

19. Jet Propulsion Laboratories, Pasadena, California; D. B. Fischback

20. Lockheed Missiles & Space Co., Palo Alto, California; J. B. Rittenhouse

21. LTV Research Center, Ling-Temco-Vought, Inc., Vought Aeronautics Division, Dallas, Texas; M. W. Reed

22. Martin Company, Orlando, Florida; Ernst M. Goldstein

23. Metals and Ceramics Division, Oak Ridge National Laboratories, Oak Ridge, Tennessee; H. Beutler

24. Minnesota Mining & Manufacturing Co., St. Paul, Minnesota; C. L. Madden, Jr.

25. Morganite, Inc., Long Island City, N. Y.; S. A. Rokaw

26. Ohio Carbon Company, Cleveland, Ohio; D. I. Stoffel

27. * Pure Carbon Company, St. Marys, Pennsylvania; R. R. Paxton, H. T. Hulbert

28. Raytheon Manufacturing Company, Waltham, Mass.; Dr. S. I. Blum

29. Rensselaer Polytechnic Institute, Troy, New York; R. J. Diefendorf

30. Reynolds Metals Company, Sheffield, Alabama; V. L. Bullough, L. O. Doley

31. Space Age Materials Corp., Woodside, New York; M. Turkat

32. * Speer Carbon Company, St. Marys, Pennsylvania; E. W. Butler, I. L. Harvey, R. L. Wonner, H. Goochee, L. Simbeck

33. * Stackpole Carbon Company, St. Marys, Pennsylvania; W. E. Clancy, P. Smisko

34. Superior Carbon Products, Inc., Cleveland, Ohio; F. E. Wrikeman

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* Personally Contacted

35. Super-Temp Corp., Santa Fe Springs, California; R. M. Williams

36. Ultra Carbon Company, Bay City, Michigan; G. Sermon

37. * Union Carbide Corp., Carbon Products Division, New York, N. Y.; S. Slosarik, S. Palmer

38. U. S. Graphite, Saginaw, Michigan; R. Zemanek, E. Ruhl

39. Vitreous Carbon Corporation of America, Beverly Hills, California; A. E. Stone

40. Westinghouse Research Laboratories, Pittsburgh, Pennsylvania; E. A. Gulbranson, W. M. Hickam

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* Personally Contacted

APPENDIX II

LIST OF SALES OFFICES

ATOMERGIC CHEMETALS COMPANY

Division of Gallard-Schlesinger Chemical Manufacturing Corp.
584 Mineola Ave., Carle Place
Long Island, N. Y. 11514

THE CARBORUNDUM COMPANY

Graphite Products Division
Sanborn, N. Y. 14132

DURAMIC PRODUCTS

Kawecki Chemical Company

Room 3200
220 E. 42nd St.
New York, N. Y. 10017

2590 East Devon Ave.
Des Plaines, Ill. 60018

1500 Service Ave.
West Covina, Calif. 91790

GENERAL ELECTRIC COMPANY

Mr. Brian Scott
General Electric Company
Metallurgical Products Department
P. O. Box 237, GPO
Detroit, Mich. 48232

GENERAL ELECTRIC COMPANY

Motor and Generator Division
One River Road
Schenectady, N. Y. 12306

840 S. Canal St.
Chicago, Ill. 60680

641 Lexington Ave.
New York, N. Y. 10022

212 N. Vignes St.
Los Angeles, Calif. 90012

1860 Peachtree Road, N. W.
Atlanta, Ga. 30309

431 S. Third St.
Salt Lake City, Utah 84101

8101 Stemmons Freeway
Dallas, Texas 75247

GREAT LAKES CARBON CORPORATION

Graphite Products Division

18 E. 48th St.
New York. N. Y. 10017

300 Cedar Boulevard
Pittsburgh, Pa. 15228

Suite 101, 5015 S. W. Freeway
Houston, Texas 77006

The Hancock Building
Niagara Falls, N. Y. 14303

1515 No. Harlem Ave.
Oak Park, Ill. 60302

617 - F Oak Grove Ave.
Menlo Park, Calif. 94027

HITCO

1600 West 135th Street
Gardena, Calif.

MINNESOTA MINING & MANUFACTURING COMPANY

2501 Hudson Road
St. Paul, Minn. 55119

OHIO CARBON COMPANY

12508 Berea Road
Cleveland, Ohio 44111

POCO GRAPHITE, INC.

P. O. Box 1524
Garland, Texas 75041

714 W. Olympic Blvd.
Los Angeles, Calif. 90015

1612 K. Street, N. W.
Washington, D. C. 20006

Rockefeller Center
610 Fifth Ave.
New York, N. Y. 10020

PURE CARBON COMPANY, INC.

441 Hall Ave.
St. Marys, Pa. 15857

RAYTHEON MANUFACTURING COMPANY

Executive Office
141 Spring St.
Lexington, Mass. 02173

SPACE AGE MATERIALS CORPORATION

Pyrogenics Division
25-26 50th St.
Woodside, N. Y. 11377

SPEER CARBON COMPANY

800 Theresia St.
St. Marys, Pa. 15857

30 W. Washington St.
Chicago, Ill. 60602

1930 McGraw Ave.
Detroit, Mich. 48208

STACKPOLE CARBON COMPANY

St. Marys, Pa. 15857

SUPER-TEMP CORPORATION

11120 So. Norwalk Blvd.
Santa Fe Springs, Calif. 90670

UNION CARBIDE CORPORATION

Carbon Products Division

270 Park Ave.
New York; N. Y. 10017

875 Greentree Road
Pittsburgh, Pa. 15220

230 No. Michigan Ave.
Chicago, Ill. 60601

22 Battery St.
San Francisco, Calif. 94106

U. S. GRAPHITE COMPANY

1621 E. Holland Ave.
Saginaw, Mich. 48601

VITREOUS CARBON CORPORATION OF AMERICA

P.O. Box 157
Chatsworth, Calif 91311

APPENDIX III

SELECTED LITERATURE REFERENCES

Open Literature

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13. ABSTRACT

This directory was prepared for the purpose of assisting development, application, and design engineers in the rapid identification of graphite materials and sources of supply. This is a revision and updating of the first directory published in 1963 and it is expected that continuing revision, supplements, or new editions will be needed.

A total of 262 graphite products, available from 19 suppliers are characterized by type, manufacturing methods, analyses, and properties. For each of these products, suppliers' availability on grades, sizes and shapes, price, rate or capacity of production, and delivery times are shown. An indexing system allows for the convenient finding of information on suppliers, sizes and shapes, unique characteristics, compositions, and properties.

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