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THE EFFECTS OF PLASTIC MEDIA BLASTING PAINT REMOVAL ON THE MICROSTRUCTURE OF GRAPHITE/EPOXY COMPOSITE MATERIALS

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Plastic Media Blasting (PMB) has been assessed as a paint removal method for AS4/3501-6 and IM6/3501-6 graphite/epoxy (Gr/Ep) composite materials. Microstructural effects on these composite materials were evaluated after repeated paint/blast cycles. Polyester (type I) and urea formaldehyde (type II) plastic media materials were used in a variety of blast conditions. Ultrasonic inspection, optical microscopy and scanning electron microscopy were used to assess the damage induced during paint removal. After one paint/blast cycle, most of the blast conditions caused little or no visual damage to the composite substrates. After four paint/blast cycles, several of the conditions caused minimal visual damage. Paint removal by sanding caused more visual damage after one paint removal cycle than any of the repeat blast conditions that were evaluated.

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1.0 ABSTRACT

Plastic media blasting (PMB) has been assessed as a paint removal method for AS4/3501-6 and IM6/3501-6 graphite/epoxy (Gr/Ep) composite materials. Microstructural effects on these composite materials were evaluated after repeated paint/blast cycles. Polyester (type I) and urea formaldehyde (type II) plastic media materials were used in a variety of blast conditions. Ultrasonic inspection, optical microscopy and scanning electron microscopy were used to assess the damage induced during paint removal. After one paint/blast cycle, most of the blast conditions caused little or no visual damage to the composite substrates. After four paint/blast cycles, several of the conditions caused minimal visual damage. Paint removal by sanding caused more visual damage after one paint removal cycle than any of the repeat blast conditions that were evaluated.

2.0 INTRODUCTION

Fiber reinforced composite materials are currently being used on Navy aircraft as flight critical and secondary structure. During the operating lifetime of an aircraft, paint stripping and recoating of its exterior surfaces are periodically required. Typical paint systems include coatings for corrosion protection, visual camouflage, walkway surfaces, and rain erosion protection. Historically, paint removal has been achieved with the use of chemical strippers which contain toxic components such as methylene chloride and phenol [1,5]. This process generates hazardous waste which requires expensive disposal procedures [2,3]. The chemicals used are health hazards because they add to the total toxic organic waste water load and produce volatile organic compound pollutants. Recent legislation has made disposal restrictions on these wastes more stringent. In addition, the use of chemical solvents can cause resin plasticization

and result in strength losses in organic matrix composite materials [4]. Alternatives to chemical paint removal from composite surfaces of aircraft include scuff sanding, laser paint stripping and plastic media blasting (PMB). Sanding with abrasive paper or cloth is laborious, time consuming and impractical for complete paint removal of large areas; however, scuff sanding the topcoat on naval aircraft is an accepted interim procedure during the preparation of composite structure for repainting. Laser removal methods offer the potential for rapid, automated coating removal from aircraft surfaces; however, this process has not yet been developed sufficiently for large scale stripping nor has its effects on materials been determined. PMB has the potential for efficient removal of coatings from a variety of substrates without hazardous waste disposal problems or loss of strength to the structure. PMB equipment is currently available for large scale paint stripping. However, the conditions for blasting Gr/Ep components have not been optimized. Specifically, it has not been shown that Gr/Ep composites can be blasted repeatedly without deleterious effects to the microstructure or mechanical properties.

The objective of this study was to identify the parameters that can be used to remove paint repeatedly from Gr/Ep substrates by direct pressure blasting while inducing little or no damage to the material's microstructure. In phase I of this study, the effects of nozzle pressure, angle of attack, stand-off distance, media material and particle size distribution were investigated. During phase II, six of the phase I conditions were selected to assess the effects of four paint/blast cycles on the microstructure of Gr/Ep.

3.0 EXPERIMENTAL APPROACH

3.1 PHASE I - PROCESS PARAMETER SCREENING: ONE BLAST CYCLE

The effects of blast parameters on the microstructure of AS4/3501-6 Gr/Ep composites were investigated during the first phase of this study and compared with sanding to the substrate. Two media materials were evaluated: polyester (type I) and urea formaldehyde (type II). Previous studies have shown that for a given media flow rate, the coating removal rate depends on the blast media material, media size, nozzle pressure, angle of attack and distance of the nozzle from the substrate [5-16]. Although some of these studies included work with Gr/Ep composites, they did not provide an adequate evaluation of the microstructural effects caused by PMB. For this study, a test matrix was developed for an unrecycled 30-40 U.S. sieve size blast media (.015-.023 in.). The test matrix represents a two-level full factorial experimental design without replication and is shown in Table 1. Another test matrix was used to assess the effects of an unrecycled 20-30 U.S. sieve size (.021-.038 inch) particle size and is shown in Table 2. Additional tests were run to evaluate the effects of extended dwell time. The increased dwell time was achieved by increasing the PMB exposure by a factor of five for selected conditions. These conditions are shown in Table 3.

The effects on the composite surfaces were assessed using both optical and scanning electron microscopy (SEM). Optical microscopy was also used to examine the material cross-section for evidence of subsurface damage.

3.2 PHASE II - EFFECTS OF REPEAT BLASTING: FOUR BLAST CYCLES

Six blast conditions from phase I were used for the repeat blast evaluation in phase II. These conditions, shown in Table 4, were selected based on the extent of damage and the time to remove the paint.

After each blast cycle, the panel surfaces were examined by optical microscopy and then repainted. Upon completion of all four blast cycles, panel damage was assessed using ultrasonic C-scan inspection, SEM, and optical microscopy of specimen cross-sections.

4.0 EXPERIMENTAL PROCEDURE

4.1 SPECIMEN PREPARATION

Two Gr/Ep materials were selected as substrates for paint removal testing. AS4/3501-6 unidirectional tape was chosen for evaluation in phase I and phase II because of its structural applications on AV-8B and F/A-18 aircraft. IM6/3501-6 unidirectional tape was evaluated in the second phase of this study due to its proposed use on the tilt rotor V-22 aircraft and the A-6 rewing. Eight ply [0/90]2s laminates were fabricated for phases I and II using hand layup techniques. The AS4/3501-6 material was bagged and cured according to the McDonnell Douglas Process Specification 14240 [17] which governs the cure of AV-8B parts and is shown in figure 1. The IM6/3501-6 material was cured according to the Bell Process Specification No. 299-947-330 [18] used to process V-22 composite parts and is shown in figure 2. The quality of the laminates was assessed after cure by pulse echo ultrasonic C-scan inspection using a 25 MHz transducer at a 0.015 inch increment. The composite laminates were then cut into 6 inch by 6 inch test panels on a band saw with a diamond grit blade. Test panels were painted with solvent-borne epoxy/polyamide primer (MIL-P-23377) to a dry film thickness of approximately one mil and topcoated with aliphatic urethane (MIL-C-83286, Color No. 36440) to a total paint system film thickness of approximately three mils. Painted panels were dried at ambient laboratory conditions for seven days and then baked for seven days at 150°F to eliminate solvent plasticization of the paint film.

4.2 PMB EQUIPMENT AND PAINT REMOVAL PROCESS

Plastic media blasting was performed by the Manufacturing Technology Department at Boeing Helicopter Company using a Caber, Inc. "Becuna" plastic media blasting machine as shown in figure 3. New media was processed through the machine to eliminate contaminants before it was used in the paint removal process. Dust and light particles were removed in an air wash and cyclone swirl chamber. The material was then passed through a vibrating screen separator, which removed oversize particles on a 16 mesh screen. A 60 mesh screen was also used to remove undersized particles. The media was then passed over a magnetic trap with deflectors, which forced all particles to pass within 0.5 inches of powerful magnets for removal of ferromagnetic contaminants. A sifting type of distribution onto the magnets precluded abrasion and pull-off of trapped particles. An additional air wash and heavy particle separation was then performed by metering the media in the moving air stream. This process lifted the media 10 feet, passed it through another cyclone swirl baffle chamber and into a reservoir. The media fell from the reservoir into a pressure vessel through a mushroom valve. The vessel was pressurized by closing the mushroom valve and filling the vessel with air. Two separate regulators, one controlling vessel pressure and the other air line pressure, maintained the proper overbalance to assist media flow through an adjustable restriction and into the moving air stream when blasting commenced. The combined air-media mixture was transported through 50 feet of 1.25 inch diameter hose to a 0.5 inch diameter Venturi nozzle.

All air was delivered through a water/oil trap and through a regenerative dryer/filter. Pressure settings were measured by means of a needle pressure gage which was inserted in the line just before the nozzle. Media flow rates were determined by blasting for a measured period of time into a baffled

collector, weighing the collected media and calculating the flow rate. Fine tuning of the flow rate was accomplished by means of an adjustable restriction at the bottom of the pressure vessel. Flow rates were kept between 600 and 800 lb./hr. for phase I and maintained at 700 lb./hr. +/- 5% for phase II. In order to control the duration of blasting, a "dead-man" switch at the nozzle was used to control a pneumatic pinch valve located in the air-media flow stream. Operation of the equipment for the plastic media blasting tests was intended to simulate the conditions which would exist in blasting an aircraft surface. A cabinet configuration was not used in this study so that flow disruption caused by media rebound from the walls of the box could be eliminated.

The test panels were held in an aluminum frame which was designed to minimize specimen flexure during blasting and to eliminate edge effects. The angle of attack was estimated and the nozzle distance from the specimen was measured. The time to remove the topcoat and primer was recorded.

For purposes of comparison, panels were sanded by Manufacturing Technology personnel at Boeing Helicopter Company with a 180 grit "jitterbug" sander normally used for aircraft paint removal. The instructions given to the operator were to remove all topcoat and primer from the laminate.

4.3 MICROSTRUCTURAL EVALUATION

Nondestructive inspection, optical microscopy and scanning electron microscopy were used to evaluate the effects of PMB on the composite materials. Pulse echo ultrasonics were used to scan the composite specimens after PMB paint removal and compared to the results obtained before painting. A Nikon Optiphot-M optical microscope was used to examine both the surfaces and the cross-sections of the specimens before and after PMB paint removal. Samples used for cross-sectional examination were cut on a milling machine with a diamond grit blade before being mounted and polished to insure that no

damage was induced during cutting. The surface samples were also evaluated with a scanning electron microscope (SEM). These samples were cleaned with an ultrasonic vibration technique and sputter coated with gold before examination from 20x to 1000x on an AMRAY model 1000A SEM.

5.0 RESULTS AND DISCUSSION

Many of the PMB process conditions studied in phase I and phase II caused minor damage to the Gr/Ep substrates after primer/topcoat removal. Surface and subsurface damage was evaluated with optical microscopy, scanning electron microscopy, and NDI. The surface damage was qualitatively assessed and the results have been categorized as follows: 0 - control material, no visible signs of damage; 1 - minor surface abrasion, release ply pattern clearly visible, no fiber damage; 2 - extensive resin abrasion, release ply pattern visible, minor fiber damage; 3 - release ply pattern no longer visible, extensive fiber damage; 4 - damage extends into the second ply.

An example of a control panel is shown in figure 4; no painting and blasting was performed on the control specimens. The resin "cross-hatch" pattern from the release ply is clearly visible in figure 4(a).

A composite surface that is typical of category 1, the category of least damage, is shown in figure 5. Minor surface abrasion can be seen when figure 5(a) is compared to figure 4(a). Note that the release ply pattern is clearly visible in figure 5(a) and no damage to the graphite fibers can be seen.

Under more severe PMB conditions, increased resin abrasion and a small amount of localized fiber damage occurs. This type of damage is typical of category 2 and is shown in figure 6. The release ply pattern is still visible in figure 6(a) and some scattered areas of fiber fracture can also be seen. A higher magnification photomicrograph of one of these fiber fracture areas is

shown in figure 6(b); however, most of the surface does not contain fiber damage.

The type of damage grouped into category 3 is shown in figure 7. Increased abrasion of the surface has occurred and the release ply pattern can not be recognized in figure 7(a). Unlike category 2, the damage to the graphite fibers in category 3 is much more extensive and occurs over most or all of the surface of the laminate. A typical fiber fracture area is shown in figure 7(b).

Under extreme PMB process conditions, damage can extend through the first ply and into the second ply in some localized areas of the laminate. If the second ply was visible anywhere on the surface of the specimen, the PMB condition was grouped into the fourth category. An example of this category is shown in figure 8. Note that the fibers in the second ply are visible and can be distinguished from the fibers in the first ply because they have an orientation perpendicular to the surface ply fibers.

5.1 PHASE I - PROCESS PARAMETER SCREENING: ONE BLAST CYCLE

The phase I PMB test results are presented in Table 1 and Table 2. Most of the conditions caused only minor surface abrasion without fiber damage after one PMB cycle and were grouped into category 1. This type of damage is shown in figure 5. Some of the laminates exhibited category 1 damage in some areas while showing more severe category 2 damage in other areas. These processes were rated 1-2 to reflect the variation in damage on the surface of the 6 inch by 6 inch composite panel. The resin abrasion and minor fiber fracture typical of category 2 are shown in figure 6. The effect of changing the blast angle from 90 degrees to 45 degrees had a more significant effect on the surface damage than did varying the stand-off distance from 24 inches to 12 inches or than varying the nozzle pressure from 25 psi to 35 psi Although it took less time to remove the primer/topcoat with the type II media, the type II media was

found to be more aggressive to the composite surface than was the type I media. Most of the damage induced during 45 degree angle testing with type II media was typical of category 2.

The results of the extended dwell testing are presented in Table 3. When specimens were blasted with the type II media, the surface resin was completely removed and extensive fiber damage occurred. In some cases, the damage extended through the first ply into the second ply. This type of damage is shown in the SEM photomicrograph of figure 8. Extended blasting with the type I media did not result in such extensive deterioration. The composite surface became warm from blasting, but the surface damage did not extend beyond the stage of mild abrasion.

No subsurface damage was evident in any of the laminates tested under phase I blast conditions. Ultrasonic C-Scan showed no evidence of damage when compared to the results obtained before blasting. Cross-sectional optical microscopy of blasted specimens up to 400x magnification showed that none of the process parameters evaluated in this study caused any subsurface delaminations or microcracking. A cross-section of a control sample is shown in figure 9 and a cross-section that was blasted under the worst set of PMB parameters is shown in figure 10. Note that this is the same sample as that shown in figure 8 where damage extended into the second ply. The blasted surface is shown at the top of the photograph and it can be seen that the damage did not occur beneath the surface. All of the PMB process conditions that were investigated result in a surface erosion effect on Gr/Ep materials without causing subsurface damage.

Examination of the panels after sanding revealed that paint removal was non-uniform. The samples had areas of complete coating removal and other areas with the primer remaining. SEM photomicrographs of the surface are

shown in figure 11. The lower photomicrograph, taken at 500x, shows that considerable fiber damage has occurred. The surface damage rating for this paint removal method falls into category 3 since the release ply pattern is no longer visible and extensive fiber damage is evident.

5.2 PHASE II - EFFECTS OF REPEAT BLASTING: FOUR BLAST CYCLES

The average paint removal rates from the four blast cycles and the phase II results obtained from optical and scanning electron microscopy are shown in Table 4. The phase II blast conditions caused little damage to the Gr/Ep composite materials after four paint/blast cycles; in fact, they caused less damage than sanding to the substrate a single time (figure 11). Photomicrographs of Gr/Ep materials blasted with the type II media are shown in figures 12 and 13. Most of these conditions caused extensive resin abrasion from the surface and some fiber fracture. The type I media caused less damage to the composite substrates than the type II media did. Specimens blasted with the type I media are shown in figures 14 and 15. The damage consisted mainly of abrasion to the surface resin with only minor fiber fracture. One of the conditions blasted with type I showed no evidence of fiber fracture at all. Some small cracks were apparent at 500x in the surface of the composites which did not exist after one cycle (figure 14b). These small cracks were further assessed in the subsurface damage investigation.

The composite subsurface damage was investigated with NDI and optical microscopy of the laminate cross-sections. The pulse echo ultrasonic C-scan inspection performed at the completion of the fourth blast cycle revealed no subsurface defects. Examination of composite cross sections up to 1000x revealed no subsurface delaminations or cracking. An example of a repeat blasted cross-section is shown in figure 16. Note that this is the same sample whose surface is

shown in figure 14. The small resin cracks that were evident in the SEM surface assessment did not extend past the resin rich area at the surface.

6.0 CONCLUSIONS

The microstructure of unidirectional graphite/epoxy laminates was assessed after paint removal with plastic media blasting (PMB). Five independent process variables were investigated: media material, media size, nozzle pressure, angle of attack, and stand-off distance. The damage to the microstructure was evaluated using ultrasonics, optical microscopy, and scanning electron microscopy. From this study, the following conclusions were made:

1. One cycle of PMB paint removal can be performed on Gr/Ep with only minor surface abrasion to the resin. This was demonstrated with a variety of process conditions using both polyester (type I) and urea formaldehyde (type II) media materials.

2. Type I media caused less damage to Gr/Ep microstructure than the type II media. Increasing the dwell time to five times the coating removal duration caused severe damage with the type II media. Little change in the microstructure was seen after extended dwell exposure with the type I media. This indicates that the type I media is less sensitive to operator error than the type II media.

3. Minor surface damage was observed in the composite materials after four paint/blast cycles. One condition was found to cause only resin abrasion and no fiber damage after four paint/blast cycles. However, the use of both type I and type II media caused small surface cracks in the resin after four paint/blast cycles. These cracks did not extend past the resin rich surface of the composite.

4. Very little difference in damage was seen between AS4/3501-6 and IM6/3501-6 Gr/Ep composite materials.

7.0 RECOMMENDATIONS

The use of PMB as a cost effective method to remove coatings from composite aircraft structure appears to be promising; however, several issues require further investigation. The long term effects of repeat blasting on the mechanical performance of composites must be thoroughly assessed. The strength and stiffness properties should be measured under static loading. An investigation into other types of composite material configurations is also required to fully assess the applicability of PMB. Honeycomb construction and lightning strike protection schemes are some examples of composite structure that require evaluation. Although little difference was seen between AS4/3501-6 and IM6/3501-6, other matrices may be more susceptible to damage from PMB. For instance, bismaleimide resins used for higher temperature applications have lower fracture toughness properties than epoxies and may require less aggressive blast conditions or media materials. Furthermore, all of the PMB coating removal conditions evaluated in this study were performed with media that was not recycled. An evaluation of the effects of media contaminants on structural materials is required to implement PMB into the Naval aircraft rework process.

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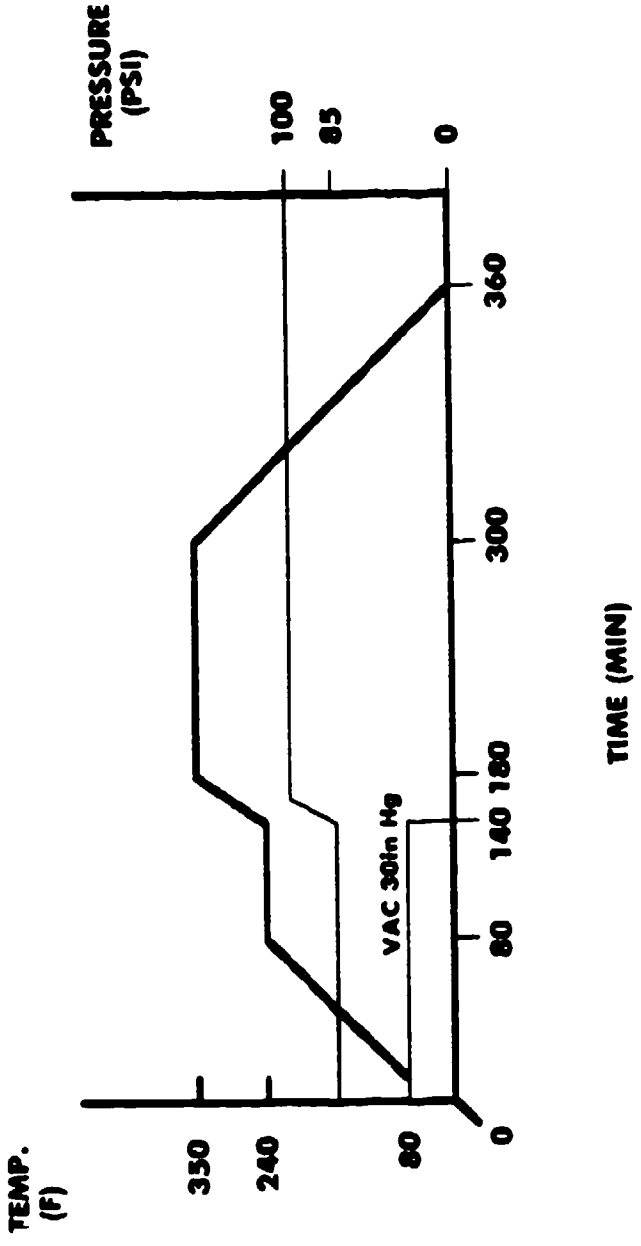


Figure 1. AS4/3501-6 Cure Cycle

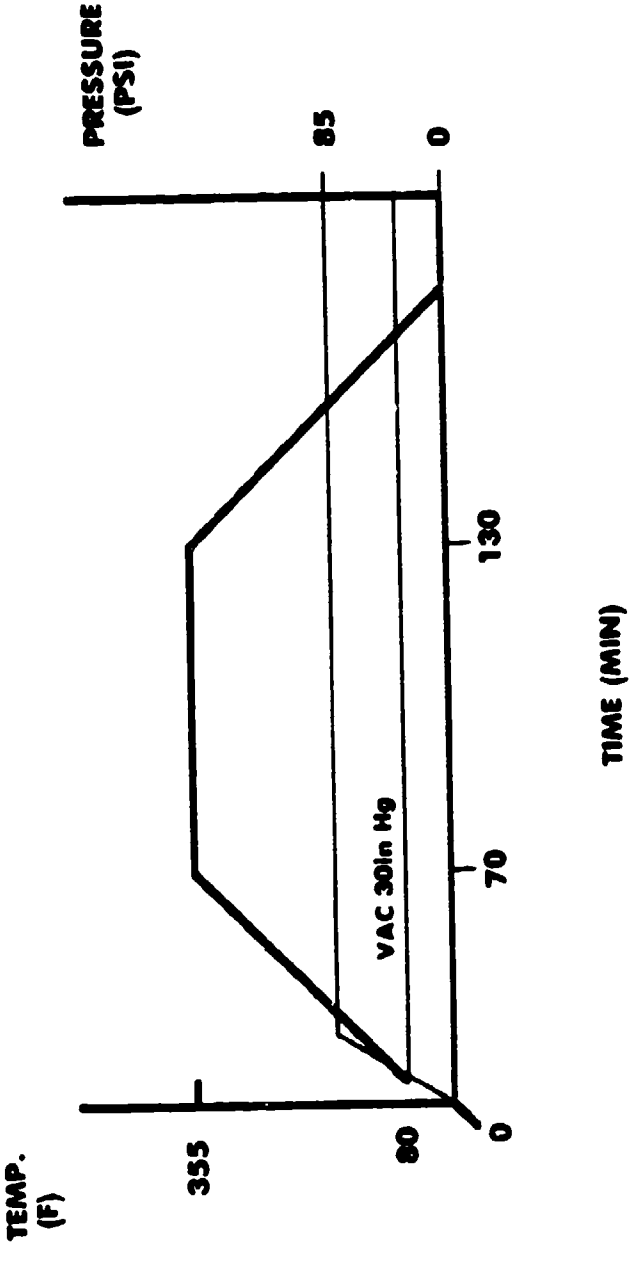


Figure 2. IM6/3501-6 Cure Cycle

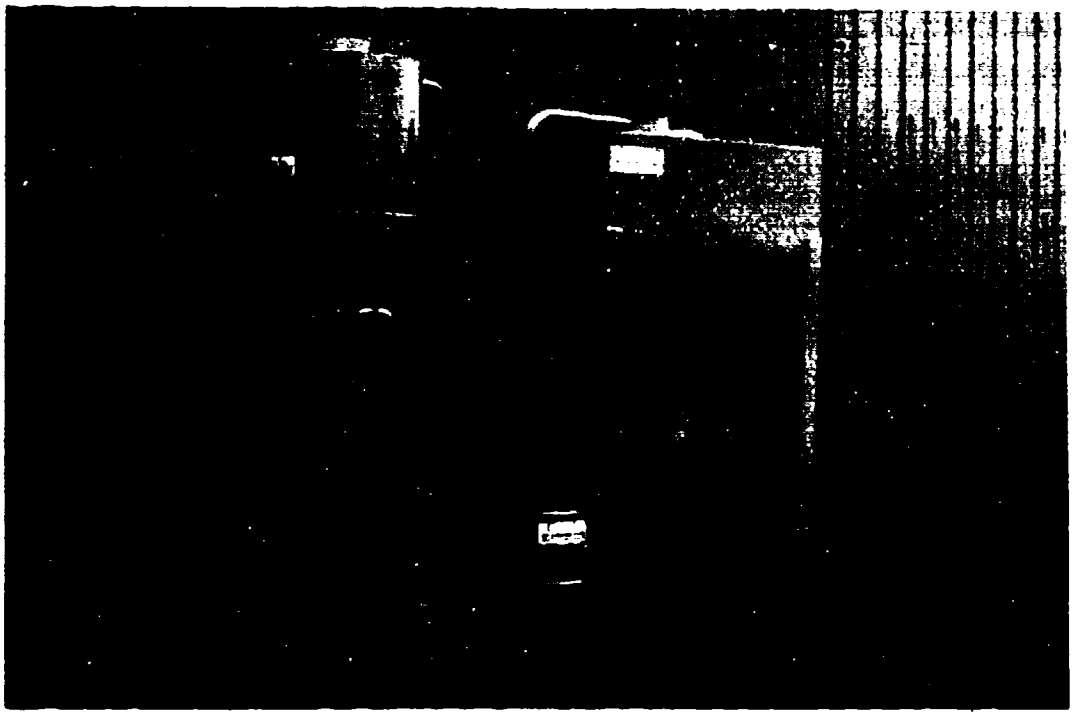
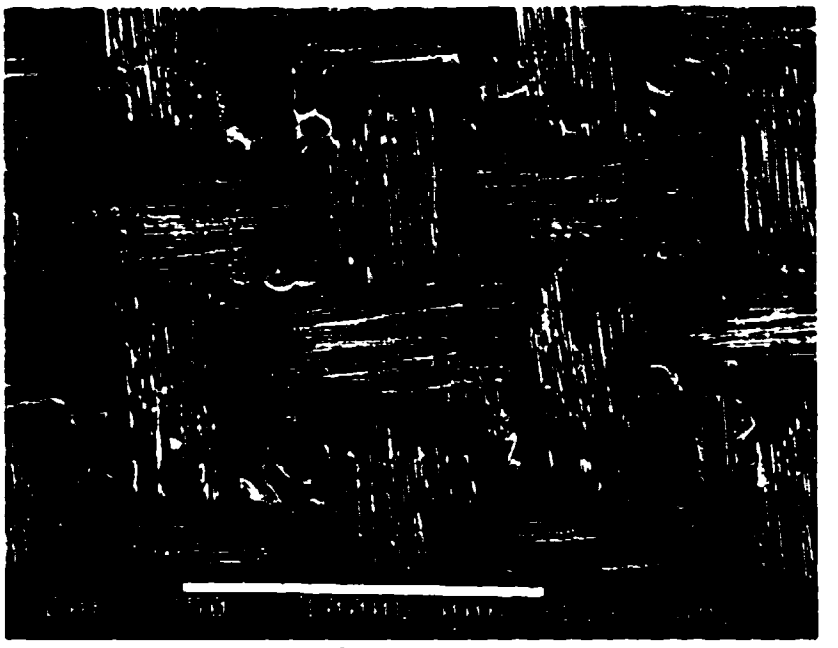


Figure 3. Plastic Media Blasting Equipment



(a)

SEM PHOTOMICROGRAPH (50X)

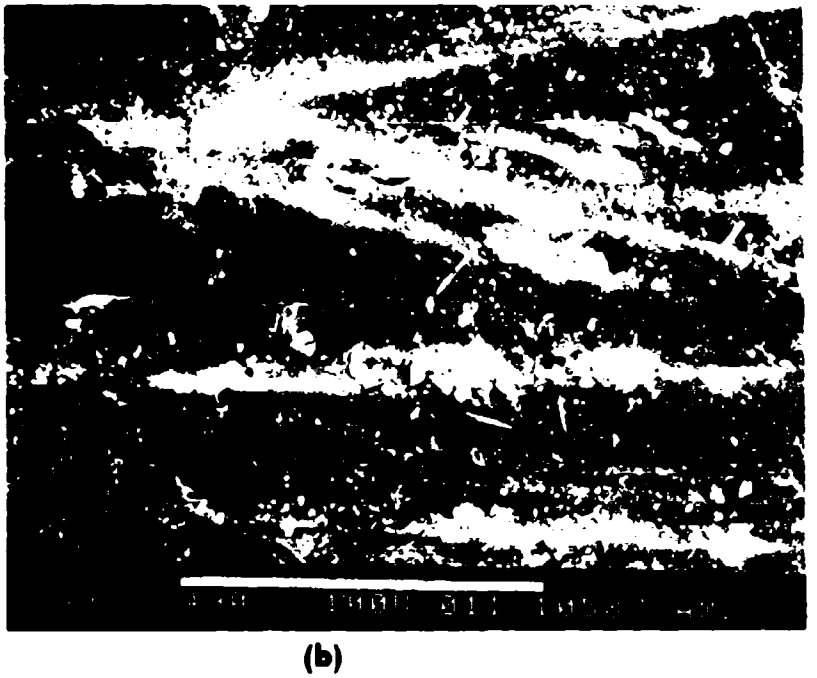
(b)

SEM PHOTOMICROGRAPH (500X)

Figure 4. Control Panel: No Damage (Unpainted, Unblasted Surface of AS4/3501-6 Graphite/Epoxy)

(a)

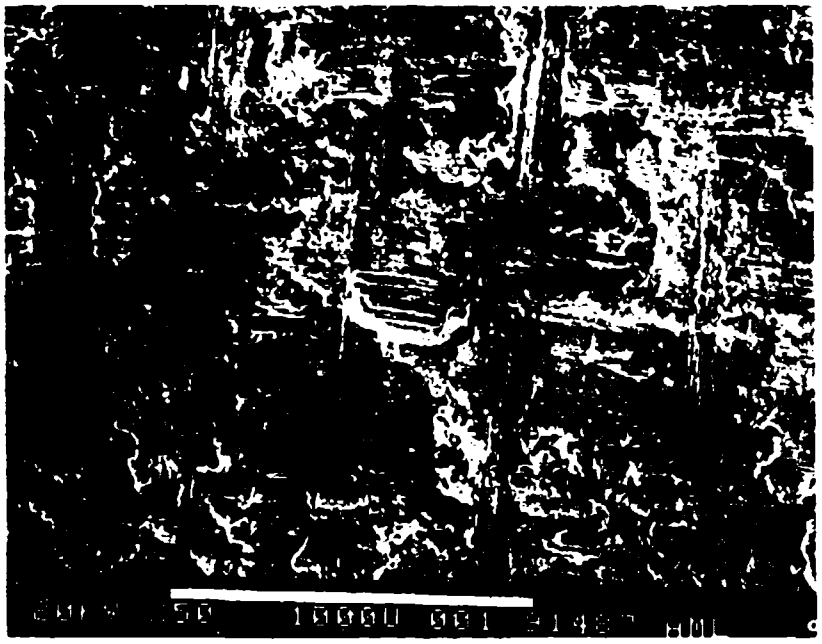
SEM PHOTOMICROGRAPH (50X)



(b)

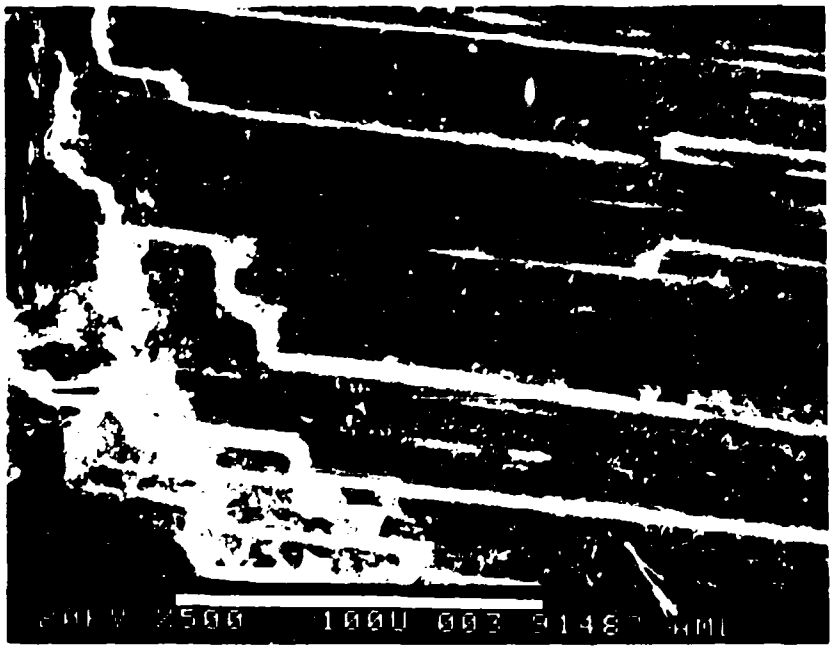
SEM PHOTOMICROGRAPH (500X)

Figure 5. Category 1: Minor Resin Abrasion (Type I Media, 90° Angle, 24" Distance, 35 psi, 20-30 Sieve Size)



(a)

SEM PHOTOMICROGRAPH (50X)



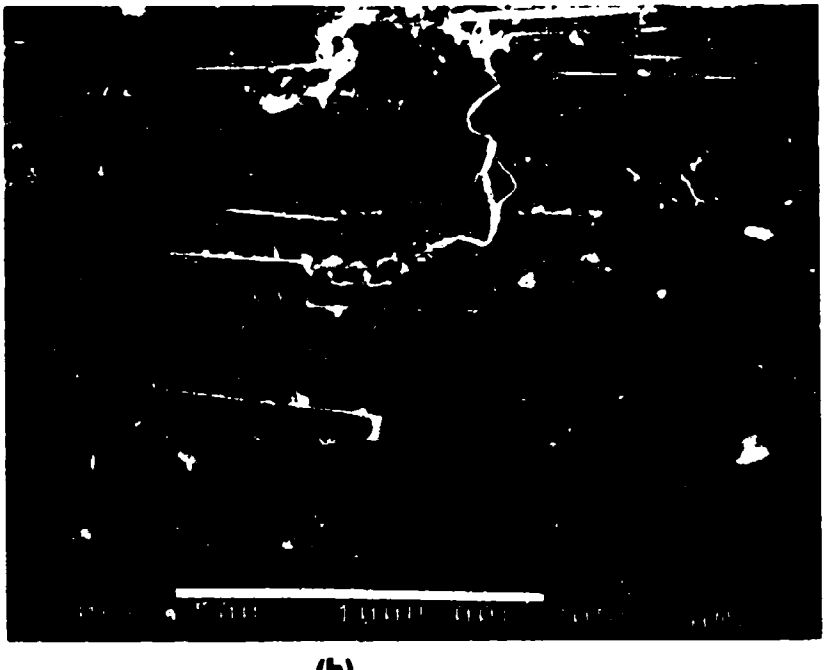
(b)

SEM PHOTOMICROGRAPH (500X)

Figure 6. Category 2: Minor Fiber Damage (Type II Media, 45° Angle, 12" Distance, 35 psi, 30-40 Sieve Size)

(a)

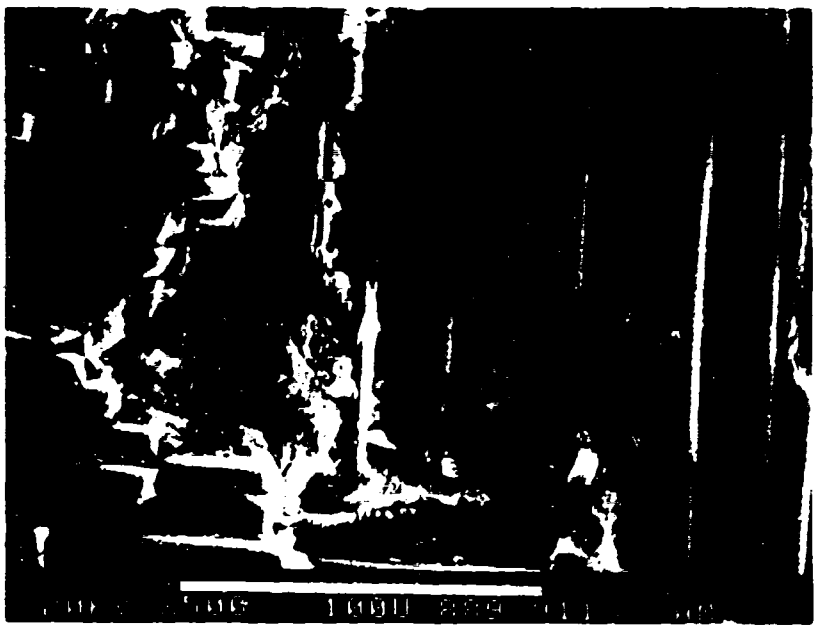
SEM PHOTOMICROGRAPH (50X)



(b)

SEM PHOTOMICROGRAPH (500X)

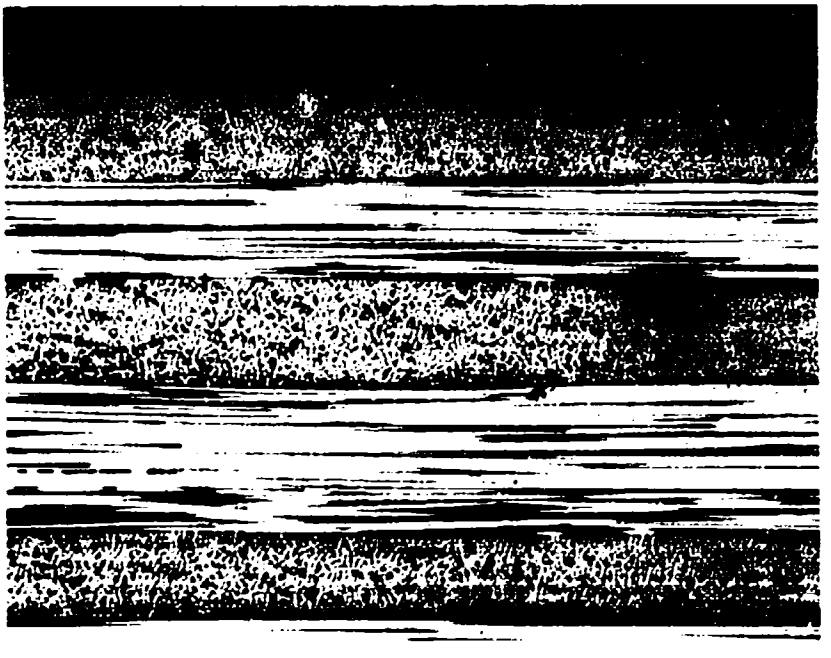
Figure 7. Category 3: Extensive Fiber Damage (Type II Media, 45° Angle, 24" Distance, 25 psi, 30-40 Sieve Size)



(a)

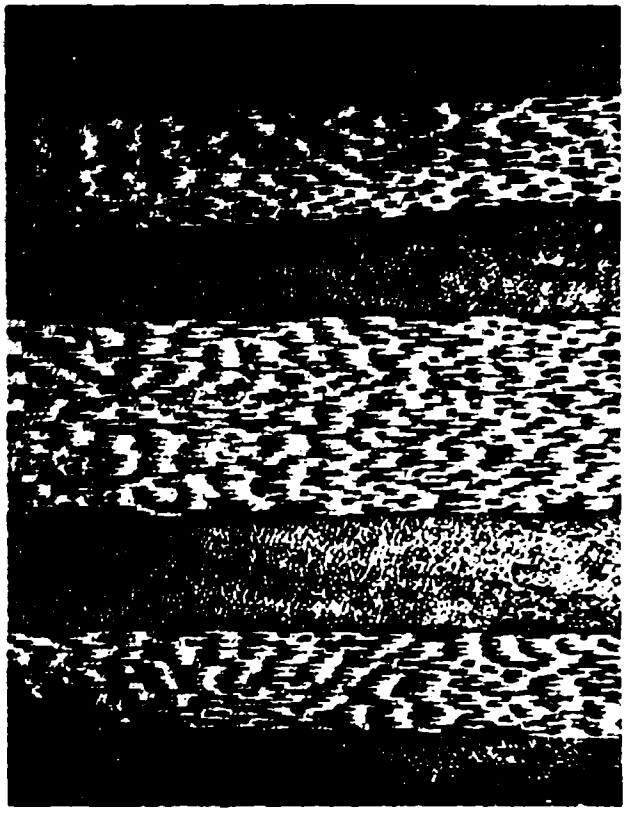
SEM PHOTOMICROGRAPH (500X)

Figure 8. Category 4: Damage Extends into the Second Ply (Type II Media, 90° Angle, 24" Distance, 35 psi, 30-40 Sieve Size, Extended Dwell Time of 30.5 Sec.)



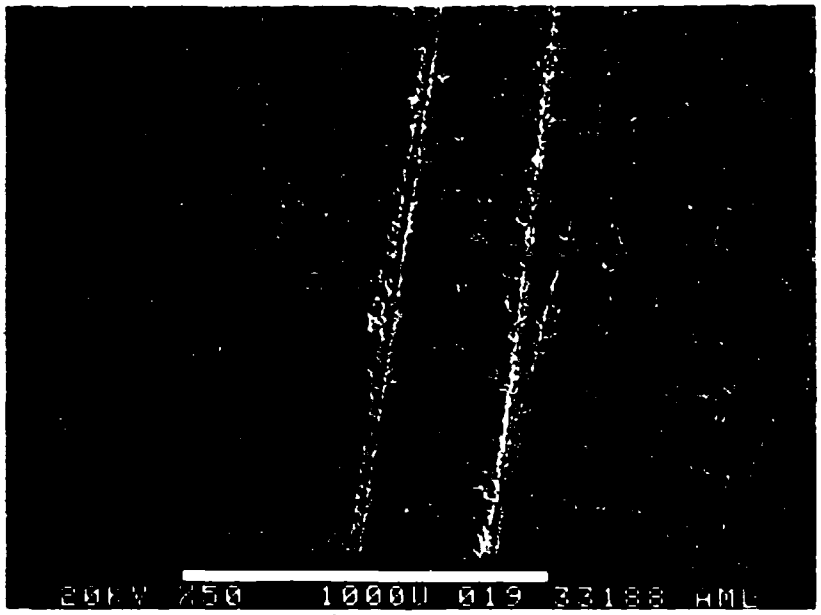
OPTICAL MICROSCOPY PHOTOMICROGRAPH (100X)

Figure 9. Control Laminate Cross-Section (Unpainted, Unblasted)



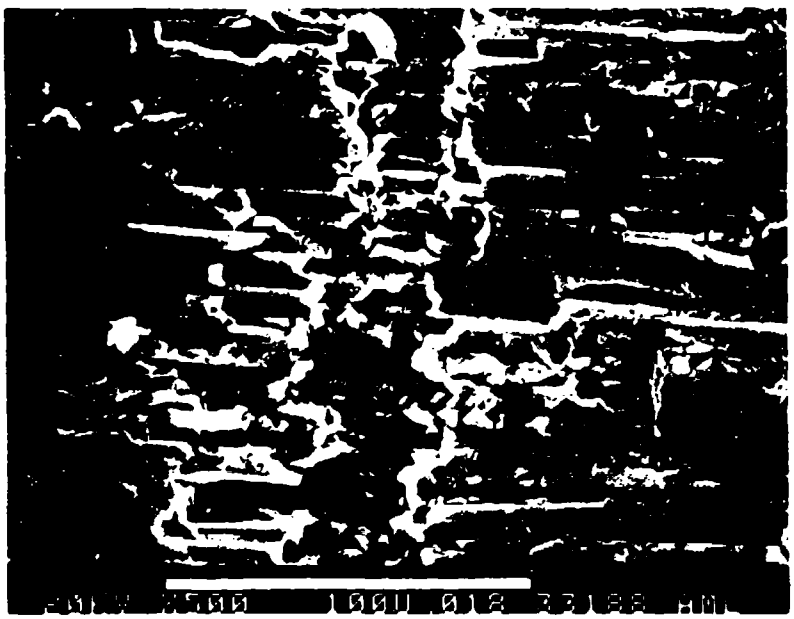
OPTICAL MICROSCOPY PHOTOMICROGRAPH (100X)

Figure 10. Sub-Surface Damage Investigation (Type II Media, 90° Angle, 24" Distance, 35 psi, 30-40 Sieve Size, Extended Dwell Time of 30.5 Sec.)



(a)

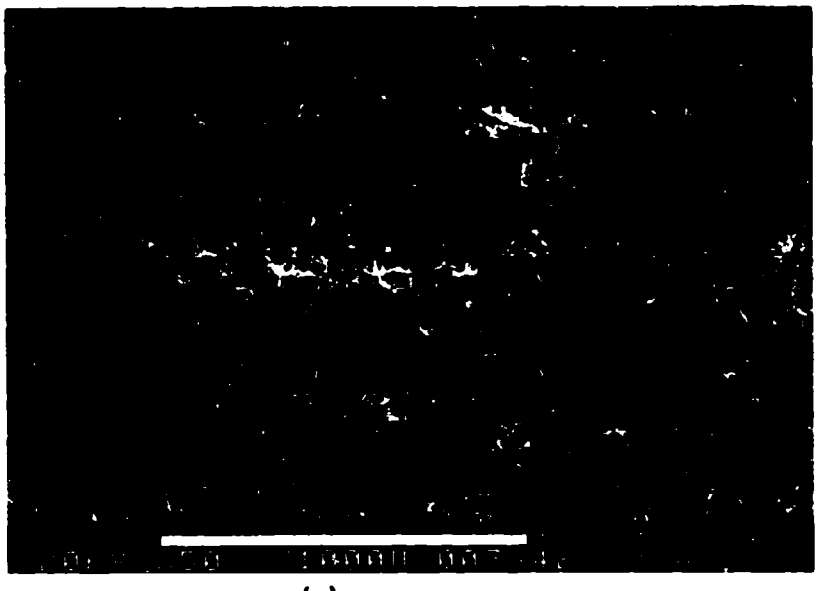
SEM PHOTOMICROGRAPH (50X)



(b)

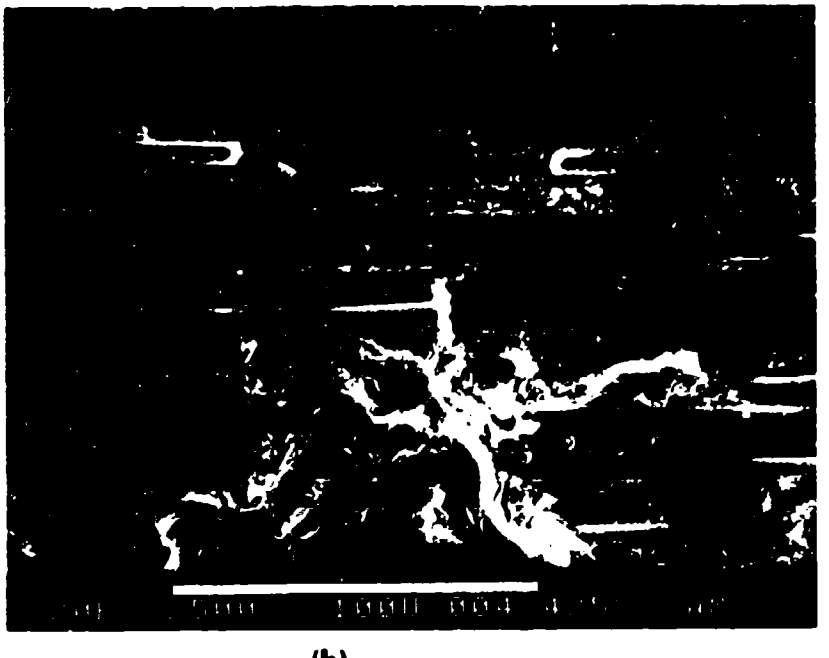
SEM PHOTOMICROGRAPH (500X)

Figure 11. Surface of GR/Ep After Coating Removal by Sanding (180 Grit)



(a)

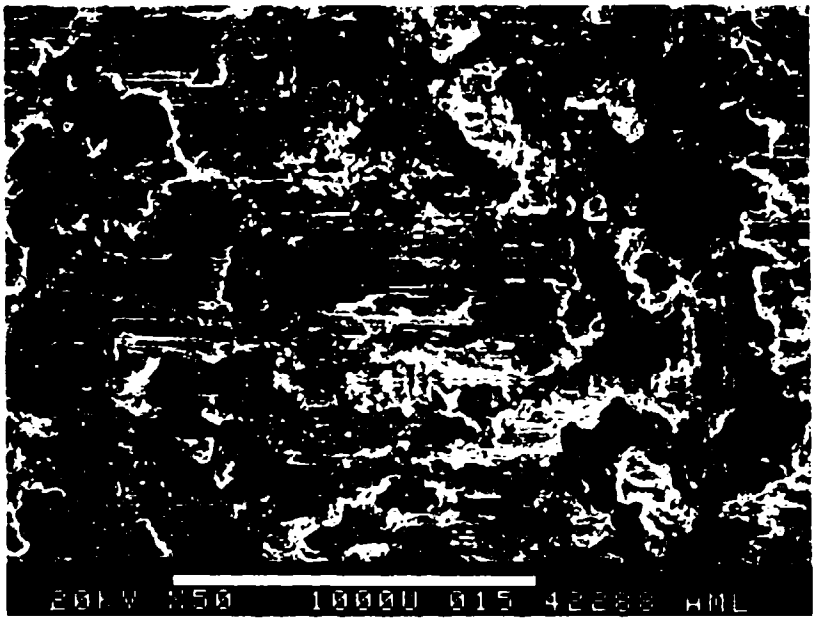
SEM PHOTOMICROGRAPH (50X)



(b)

SEM PHOTOMICROGRAPH (500X)

Figure 12. Surface of AS4/3501-6 after Four Paint/Blast Cycles (Type II Media, 90° Angle, 12″ Distance, 25 psi, 20-30 Sieve Size)



(a)

SEM PHOTOMICROGRAPH (50X)

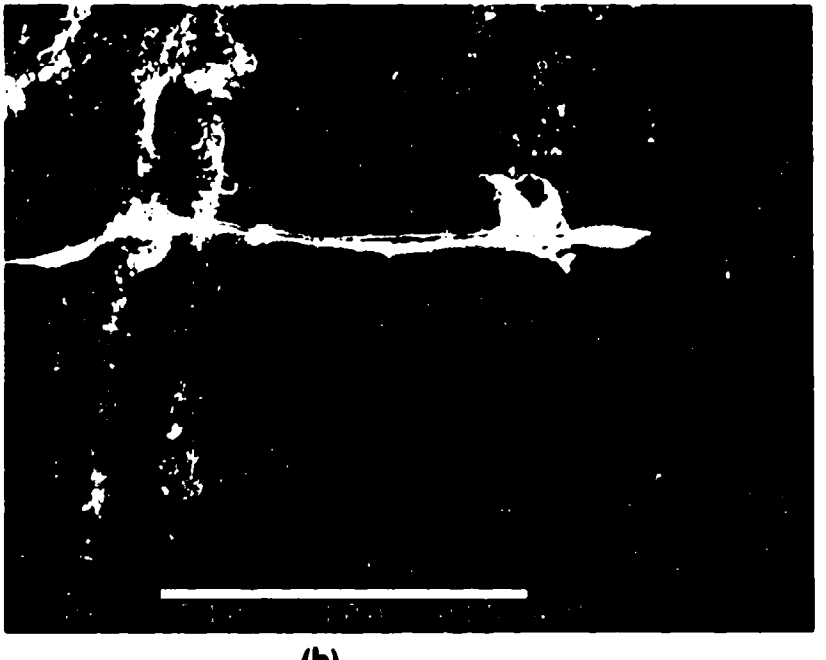
(b)

SEM PHOTOMICROGRAPH (500X)

Figure 13. Surface of IM6/3501-6 after Four Paint/Blast Cycles (Type II Media, 90° Angle, 24" Distance, 35 psi, 20-30 Sieve Size)

(a)

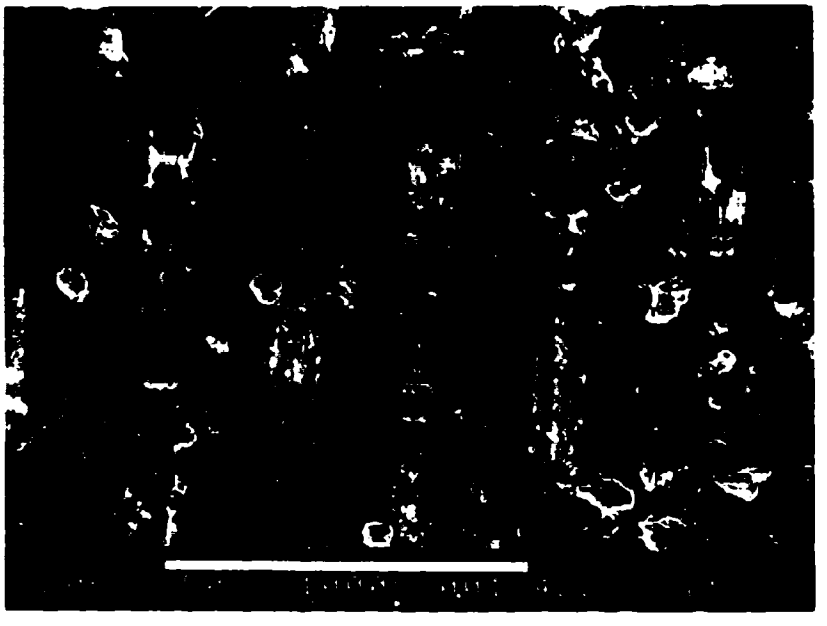
SEM PHOTOMICROGRAPH (50X)



(b)

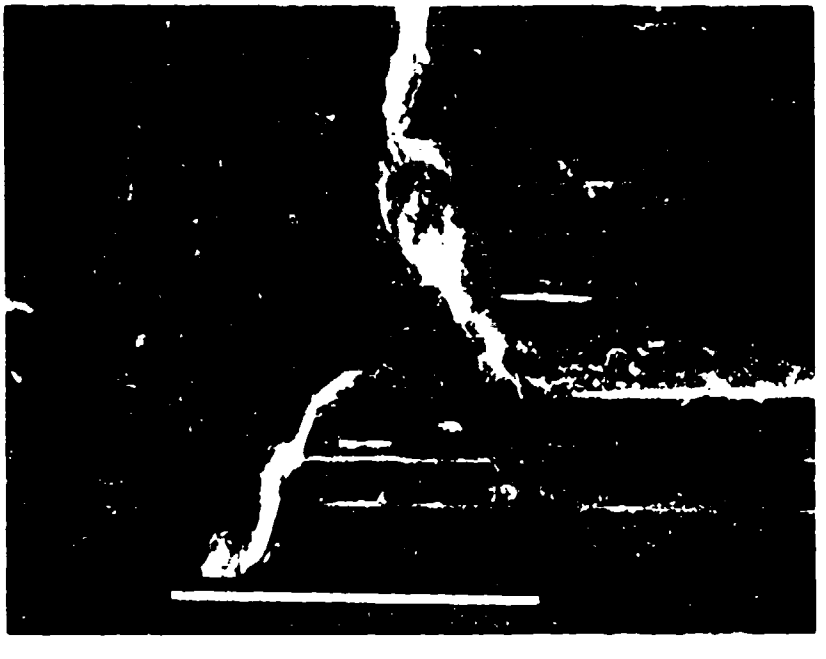
SEM PHOTOMICROGRAPH (510X)

Figure 14. Surface of AS4/3501-6 after Four Paint/Blast Cycles (Type I Media, 90° Angle, 12″ Distance, 35 psi, 20-30 Sieve Size)



(a)

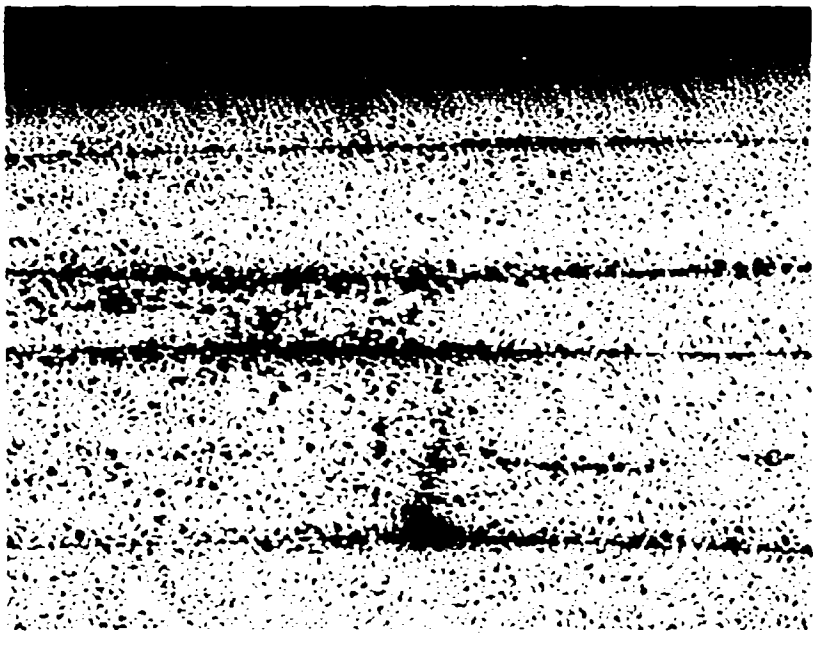
SEM PHOTOMICROGRAPH (50X)



(b)

SEM PHOTOMICROGRAPH (500X)

Figure 15. Surface of IM6/3501-6 after Four Paint/Blast Cycles (Type I Media, 90° Angle, 12" Distance, 35 psi, 20-30 Sieve Size)



OPTICAL MICROSCOPY PHOTOMICROGRAPH (100X)

Figure 16. Cross-Section of AS4/3501-6 after Four Paint/Blast Cycles (Type I Media, 90° Angle, 12" Distance, 35 psi, 20-30 Sieve Size)

TABLE 1 - Phase I Tests of 30-40 U.S. Sieve Size Media
(Two-level factorial design)

PMB PROCESS CONDITIONS				RESULTS	
MEDIA (Type)	NOZZLE PRESSURE (psi)	ANGLE (deg)	STAND OFF DISTANCE (inches)	COATING REMOVAL TIME (sec)	MICROSCOPY* RATING (0-4)
CONTROL	--	--	--	--	0
I	25	45	12	20.4	1
I	25	45	24	41.5	1
I	25	90	12	29.6	1
I	25	90	24	38.2	1
I	35	45	12	13.6	1
I	35	45	24	45.5	1
I	35	90	12	13.0	1
I	35	90	24	27.9	1
II	25	45	12	7.0	2
II	25	45	24	15.5	2-3
II	25	90	12	6.8	1
II	25	90	24	7.4	1
II	35	45	12	6.7	2
II	35	45	24	14.8	2-3
II	35	90	12	5.0	1-2
II	35	90	24	6.1	1

* Microscopy Rating Scale:
- 0 - no visible signs of damage.
- 1 - minor resin abrasion, release ply pattern clearly visible, no fiber damage.
- 2 - extensive resin abrasion, release ply pattern visible, local areas of fiber damage.
- 3 - release ply no longer visible, fiber damage over most of surface.
- 4 - damage extends into the second ply.

TABLE 2 - Phase I Tests of 20-30 U.S. Sieve Size Media

PMB PROCESS CONDITIONS				RESULTS	
MEDIA (Type)	NOZZLE PRESSURE (psi)	ANGLE (deg)	STAND OFF DISTANCE (inches)	COATING REMOVAL TIME (sec)	MICROSCOPY RATING (0-4)
CONTROL	--	--	--	--	0
I	25	90	12	15.1	1-2
I	35	45	12	9.0	1
I	35	90	12	7.3	1
I	35	90	24	11.9	1
II	25	90	12	5.3	1
II	25	90	24	6.7	1
II	35	45	12	3.4	1
II	35	90	12	2.0	1
II	35	90	24	2.7	1

* Microscopy Rating Scale:
- 0 - no visible signs of damage.
- 1 - minor resin abrasion, release ply pattern clearly visible, no fiber damage.
- 2 - extensive resin abrasion, release ply pattern visible, local areas of fiber damage.
- 3 - release ply no longer visible, fiber damage over most of surface.
- 4 - damage extends into the second ply.

TABLE 3 - Phase I Effects of Extended Dwell Time

PMB PROCESS CONDITIONS				RESULTS	
U.S. SIEVE SIZE	MEDIA (Type)	NOZZLE PRESSURE (psi)	ANGLE (deg)	STAND OFF DISTANCE (inches)	MICROSCOPY* RATING (0-4)
30-40	I	35	45	12	1
30-40	I	35	45	24	1
30-40	I	35	90	12	1
30-40	I	35	90	24	1
30-40	II	25	45	12	2
30-40	II	25	45	24	2-3
30-40	II	25	90	12	4
30-40	II	25	90	24	2-3
30-40	II	35	45	12	4
30-40	II	35	45	24	3
30-40	II	35	90	12	3
30-40	II	35	90	24	4

Extended dwell was five times the primer/topcoat removal time.

* Microscopy Rating Scale:

0 - no visible signs of damage.
1 - minor resin abrasion, release ply pattern clearly visible, no fiber damage.
2 - extensive resin abrasion, release ply pattern visible, local areas of fiber damage.
3 - release ply no longer visible, fiber damage over most of surface.
4 - damage extends into the second ply.

TABLE 4 - Effects of Repeat Blasting

PMB PROCESS CONDITIONS					RESULTS			
					AS4/3501-6		IM6/3501-6	
Media Size (US Sieve)	Media Type	Nozzle Pressure (psi)	Angle (deg)	Stand Off Distance (in.)	Mic. Rating	Avg. Paint Removal Rate(ft^2/min)	Mic. Rating	Avg. Paint Removal Rate(ft^2/min)
30-40	II	25	90	12	2-3	0.8	2-3	0.6
30-40	II	35	90	24	2-3	0.8	2-3	0.6
20-30	II	25	90	12	2	1.2	2	0.8
20-30	II	35	90	24	1-2	1.4	2	0.9
20-30	I	35	45	12	1-2	0.7	1-2	0.5
20-30	I	35	90	12	1	0.6	1-2	0.5

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