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296 769

February 15, 1963
REIC Accession List 60

MONTHLY ACCESSION LIST 60

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RADIATION EFFECTS INFORMATION CENTER

BATTELLE MEMORIAL INSTITUTE

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The Radiation Effects Information Center has been established at Battelle Memorial Institute by the United States Air Force to provide a means of placing radiation-effects data in the hands of designers and those conducting research and development. Access to the Center and to its reports is obtained through the Air Force. This report has been prepared pursuant to the provisions of Contract No. AF 33(657)-10085 [Continuation of AF 33(616)-7375], Task No. 738103, Project No. 7381 & 7634.

RADIATION EFFECTS INFORMATION CENTER
MONTHLY ACCESSIONS LIST RECIPIENTS

As indicated by the dates covered, new accessions over the past seven months period is covered by the abstracts in this Monthly Accession List. This is a result of a lapse in the Radiation Effects Information Center contract; which has been due to new contract award requirements, negotiations, and contract preparation. This lapse has resulted in a backlog of documents to be abstracted for the Monthly Accession List. Current documents will be merged with the backlog so that the delay between current receipt of a document by the REIC and announcement in the Monthly Accession List will not exceed six weeks. It is planned to have completed processing of the backlog by May 30, 1963.

To facilitate the use of the Monthly Accession List in retrospect searches, an index will be provided commencing with the March 15, 1963 issue.

The continued receipt of reports from organizations conducting radiation effects research and development programs is essential to the value which the Radiation Effects Information Center may have to all Government agencies, contractors, and universities. Your continued assistance in providing reports and report announcements will be of material benefit in providing the most complete and efficient information center.

LIST OF AVAILABLE REIC PUBLICATIONS

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Attention E. N. Wyler

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ASD (ASTEVC, Mr. Robert G. Merkle)
Wright-Patterson AFB, Ohio

Unclassified Reports

| <u>Report Number</u> | <u>Title</u> |
|----------------------|---|
| 1 | The Effect of Nuclear Radiation on Semiconductor Materials (December 20, 1957), AD 147399 |
| 1 (First Addendum) | The Effect of Nuclear Radiation on Semiconductor Materials (March 31, 1959), AD 210758 |
| 6* | A Survey of Current Research and Developments in the Field of Dosimetry (May 31, 1958), AD 157172 |
| 6 (First Addendum) | A Survey of Current Research and Developments in the Field of Dosimetry (March 31, 1959), AD 210766 |
| 10 | The Effect of Nuclear Radiation on Semiconductor Devices (April 30, 1960), AD 240433 (Supersedes Memo Nos. 4, 5, 6) |
| 10 (First Addendum) | The Effect of Nuclear Radiation on Semiconductor Devices (July 15, 1961), AD 262081 |
| 16 | Survey of Irradiation Facilities (February 28, 1961) AD 256953 |
| 17 | The Effect of Nuclear Radiation on Structural Adhesives (March 1, 1961) (Supersedes Report Nos. 7 and 11) |
| 18 | The Effect of Nuclear Radiation on Electronic Components (June 1, 1961) (Supersedes Report Nos. 2, 8, 12, 14, and 15 and Memo Nos. 2, 7, 12, 14, and 20) |
| 19 | The Effect of Nuclear Radiation on Lubricants and Hydraulic Fluids (May 31, 1961) AD 261278 (Supersedes Report No. 4) |
| 20 | The Effect of Nuclear Radiation on Structural Metals (September 15, 1961) (Supersedes Report No. 5) |
| 21 | The Effect of Nuclear Radiation on Elastomeric and Plastic Components and Materials (September 1, 1961) (Supersedes Report Nos. 3, 9, and 13 and Memo Nos. 1, 3, 8, 13, and 17) |
| 23 | Proton and Electron Damage to Solar Cells (April 1, 1962) |
| 24 | Radiation Effects State of the Art 1961-1962 (June 30, 1962) |

* Out of Print in REIC; Available only from ASTIA, Armed Services Technical Information Agency, Document Service Center, Arlington Hall Station, Arlington, Virginia.

Classified Reports

| <u>Report Number</u> | <u>Title</u> |
|-----------------------|--|
| 1-C | The Effect of Nuclear Radiation on Hydraulic, Pneumatic, and Mechanical Systems for Subsonic, Transonic, and Low-Supersonic Speed Aircraft (Title Unclassified) (Secret, Restricted Data) (May 31, 1958) |
| 1-C (First Addendum) | The Effect of Nuclear Radiation on Hydraulic, Pneumatic, and Mechanical Systems for Subsonic, Transonic, and Low-Supersonic Speed Aircraft (Title Unclassified) (Secret, Restricted Data) (March 31, 1959) |
| 1-C (Second Addendum) | The Effect of Nuclear Radiation on Hydraulic, Pneumatic, and Mechanical Systems (Title Unclassified) (Secret, Restricted Data) (September 15, 1960) |
| 2-C | The Effect of Nuclear Radiation on Ceramic Materials (Title Unclassified) (Secret) (June 30, 1959), AD 157173 |
| 2-C (First Addendum) | The Effect of Nuclear Radiation on Ceramic Materials (Title Unclassified) (Secret, Restricted Data) (June 15, 1961) |
| 4-C | The Effect of Nuclear Radiation on Electrical and Electronic Systems (Title Unclassified) (Secret, Restricted Data) (March 15, 1960) |
| 6-C | The Effects of Nuclear Weapon Bursts and Simulated Bursts on Electronic Components (Title Unclassified) (Secret, Restricted Data) (May 31, 1961) |

Unclassified Memoranda

| <u>Memorandum Number</u> | <u>Title</u> |
|--------------------------|---|
| *9 | The Effect of Nuclear Radiation on Glass (November 30, 1958) AD 207701 |
| 10 | Format for Reporting Radiation Effects Data (May 15, 1959) AD 218251 |
| *11 | The Effect of Nuclear Radiation on Hydrocarbon Fuels (November 30, 1958) AD 207702 |
| *15 | The Effect of Nuclear Radiation on Hoses and Couplings (March 31, 1959) AD 225504 |
| *16 | The Effect of Nuclear Radiation on Refrigerants (June 30, 1959) AD 219510 |
| *18 | The Effect of Nuclear Radiation on the Performance of a Hydraulic Flight Control System (June 15, 1959) AD 219512 |
| 21 | Space Radiation and Its Effects on Materials (June 30, 1961) |
| 23 | Radiation Dosimetry: An Annotated Bibliography (September 15, 1961) |

Classified Memoranda

| <u>Memorandum Number</u> | <u>Title</u> |
|--------------------------|---|
| 1-C | The Effects of Nuclear Radiation on Fluorolubes and Other Gyroscope Fluids (Title Unclassified) (Secret) (September 5, 1958), AD 302126 |
| 2-C | The Effect of Nuclear Radiation on Explosives and Solid Propellants (Title Unclassified) (Secret, Restricted Data) (June 15, 1959) |

* Out of Print in REIC; Available only from ASTIA, Armed Services Technical Information Agency, Document Service Center, Arlington Hall Station, Arlington, Virginia.

Memorandum Number

Title

3-C

Dose-Rate Effects on Materials, Components, and Systems (Title Unclassified) (Secret, Restricted Data) (July 31, 1959)

10-C

Nuclear Radiation Effects Projects (Title Unclassified) (Confidential) (March 31, 1962)

MONTHLY ACCESSION LIST

By: Radiation Effects Information Center

Dates Covered: July 1, 1962 to January 31, 1963

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Note: (1) The articles noted here represent those accessioned and some extracted and placed in the files of the Radiation Effects Information Center during the period covered. The number at the top of each article is for the purpose of internal identification. Any questions or comments should be addressed to: Radiation Effects Information Center, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio, Attn: E. N. Wyler; or to Mr. Robert G. Merkle, ASTEVC, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

(2) Document Availability - Reports listed in the Monthly Accession List are not available from Battelle. Whenever known, their availability has been indicated under the title (Avail: ASTIA, AD 130775) to enable the recipient of this list to order the document from its available source.

(3) ASTIA - Reports available to Government Contractors with correct Field-of-Interest Register on file from the Armed Services Technical Information Agency, Document Service Center, Arlington Hall Station, Arlington, Virginia.

(4) AEC - Reports available to Government Contractors via channels described in Nuclear Science Abstracts. DOD Contractors' requests should not go to the AEC Technical Information Service, Oak Ridge, Tennessee.

(5) ASAPRD-NS - Reports available to Air Force Contractors via the project officer through channels from ASD, ASAPRD-NS, Wright-Patterson Air Force Base, Ohio.

(6) Unless otherwise noted, all references are unclassified.

(7) Reproduction of this document is authorized.

MISCELLANEOUS

17296

C. Marotta and W. Guber

A DESCRIPTION OF AN IBM-7090 MONTE CARLO PROGRAM (UNC-90-6) FOR THE SOLUTION OF THE TIME DEPENDENT NEUTRON TRANSPORT PROBLEM IN AN ATMOSPHERE WITH DENSITY DEPENDENT ON HEIGHT

United Nuclear Corporation, Development Division - NDA,
White Plains, N. Y., UNC-5006, April 15, 1962,
DA-49-186-ORD-1012, 58 pp

This report describes an IBM-7090 Monte Carlo program for the transport of neutrons from a point monoenergetic source in an atmosphere with density dependent on height, extending up to 700 kilometers above ground zero. The earth is treated as an absorbing surface. The neutron flux is calculated at specified detector regions as a function of time and energy. A simple but effective importance sampling technique is incorporated in the program to improve statistics at detectors many mean free paths from the source. A Final Edit Program is described in this report which can be used to superpose, with specified weighting, the results of various monoenergetic sources.

17307

R. L. Chaplin and P. E. Shearin, Dept. of Physics,
University of North Carolina, Chapel Hill, N. C.

SOME EXPERIMENTAL TECHNIQUES OF LOW-TEMPERATURE RADIATION DAMAGE STUDIES

The Review of Scientific Instruments, 33, (4), April, 1962,
pp 459-462

Radiation damage studies of metal specimens have been achieved by using a Van de Graff accelerator to supply energetic electrons. The irradiating electrons are magnetically deflected so that the electron beam bombards a well-defined rectangular area. A method is described which is used to determine the location of the beam with respect to the position of the specimen. A low temperature thermal switch is discussed in terms of its theoretical and experimental behavior. A practical method for improving the thermal contact between the specimen and its holder by using the helium exchange gas technique is described. Estimates of the degree of thermal contact between specimen and specimen holder are possible because of the particular electrical circuit in the experimental chamber.

17326

Samuel Glasstone

THE EFFECTS OF NUCLEAR WEAPONS

United States Department of Defense, April, 1962,
730 pp

This volume includes the following sections: general principles of nuclear explosions, descriptions of nuclear explosions, air blast phenomena, air blast loading and target response, structural damage from air blast, effects of surface and subsurface bursts, thermal radiation and its effects, initial nuclear radiation, residual nuclear radiation and fallout, radio and radar effects, effects on personnel, and principles of protection.

17526

C. M. Crain and H. G. Booker

THE EFFECTS OF NUCLEAR BURSTS IN SPACE ON THE
PROPAGATION OF HIGH-FREQUENCY RADIO WAVES
BETWEEN SEPARATED EARTH TERMINALS

The Rand Corporation, Santa Monica, Calif., Feb., 1962,

15 pp

Avail: ASTIA, AD 272846

This report discusses a possible method for detecting nuclear bursts in space. The method is based on the effects that the bursts should have on the phase and amplitude of high-frequency radio transmission between separated terminals on the earth's surface. Relations are derived that show how these effects should vary with time after the nuclear detonation and how they are related to bomb temperature, yield, and distance from the earth. The phase shift is independent of bomb temperature over a wide range of temperatures, whereas attenuation decreases about 10 db for each 50 per cent decrease in bomb temperature. Thus, absorption-measuring techniques become decreasingly attractive for detecting cooler bombs. It is concluded that measurements of high-frequency phase and amplitude change, in conjunction with very-low-frequency phase measurements, may provide a very sensitive means for detecting nuclear bursts in space by ground-based radio equipment, even for quite cool bombs. The possibility of determining bomb temperature is also shown.

17618

A. G. Emslie

RADIATIVE HEAT TRANSFER THROUGH SEAMS AND PENETRATIONS IN
PANELS OF MULTILAYER METAL-FOIL INSULATION

Arthur D. Little, Inc., Report No. 63270-04-04, April, 1962,

NAS5-664, 20 pp

The report is a theoretical analysis of some aspects of the feasibility of insulating a storage tank containing cryogenic fuel by means of prefabricated panels of multilayer metal-foil insulation, in view of the extra heat leakage into the tank at seams and penetrations. The difficulty arises because the very high thermal conductivity in the plane of the panels prevents overlapping or caulking of the joints. Thus, gaps must be left between adjacent panels and around penetrating pipes and struts. The extra heat input due to the gaps is calculated. In order that this heat input be no larger than 10 per cent of the total input to a 10 ft x 10 ft cylindrical tank, the gap at the seam would have to be less than 0.02 inch. Since this is impractically small, we conclude that multilayer metal foils cannot be applied to a tank in the form of prefabricated panels. Other methods, such as filament-winding or layer-by-layer application of the foil, must be used instead.

17623

J. W. Cox and P. M. Uthe

TORY II-A MECHANICAL AND AERO-THERMODYNAMIC DESIGN

University of California, Lawrence Radiation Lab.,

Livermore, Calif., UCRL-6305, Feb. 2, 1962,

W-7405-eng-48, 47 pp

The first nuclear reactor in the Pluto program, Tory II-A, is described from the standpoint of mechanical and aero-thermodynamic design. Experimental objectives and predicted aereo-thermodynamic performance are presented. A discussion of mechanical design includes principal structural features, material selection, and a review of component design and testing. Digital computing machine codes used to study transient and steady-state aero-thermodynamic performance are described, together with the correlation functions employed. Both experimental and analytical methods are outlined for evaluating thermal stress in fuel elements and structural members.

17638

John W. Cox and P. Michael Uthe, Jr., Lawrence
Radiation Lab., University of California
MECHANICAL AND AEROTHERMODYNAMIC DESIGN OF TORY IIA
Aerospace Engineering, 21, (6), June, 1962, pp 8-20

An excellent review article on the nuclear-powered ram-jet engine. The essential features of such an engine are shown.

17641

MICROFILM'S TOLERANCE TO RADIATION STUDIES
Reproductions Review, 12, (6), June, 1962, pp 95-96

Research by experts at Minnesota Mining and Manufacturing Co. microfilm products group indicate that if the microfilm products are stored in an area beyond the radius of thermal or shock destruction, radiation will not permanently affect their usefulness. Aperture cards containing exposed and developed images on both silver halide and diazo film were exposed to radiation and no measurable effect was noted on either film image. When raw diazo film was given a dose of 1400 roentgens, there was no significant effect on the capability of the film to copy a microfilm image.

17659

R. D. Ingram
REACTOR IRRADIATION OF A MAGNETIC FLUX VALVE
Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 17 pp
Avail: AIEE as CP-62-1259

Pre-irradiation analysis, modification, irradiation and post-irradiation analysis of a magnetic flux valve are presented. Pre-irradiation analysis consisted of studying the materials contained in the flux valve to determine their susceptibility to radiation damage. Modification consisted of replacing radiation-damage-susceptible materials with materials that can perform the same functions but are more radiation resistant. The irradiation test consisted of a description of the test, including radiation time, dose and power levels, and the operation of the flux valve with respect to integrated dose received. Post-irradiation analysis consisted of inspecting the materials contained in the valve to determine the extent of radiation damage they incurred. The analysis revealed that Dow Corning F-60 damping fluid had gelled causing the flux valve to become inoperative.

17696
NUCLEAR BLASTS TESTING R-F BLACKOUT
Electronics, 35, (19), May 11, 1962, p 27

Dominic, the U. S. nuclear test series now underway in the Pacific, includes among its goals evaluating the disruptive effects of nuclear explosions on communications and radar and the ability of electronic equipment to withstand blasts and fallout, as well as tests of weapons. The blackout is expected to provide information on techniques for preventing a breakdown of communications caused by enemy (or even our own) nuclear blasts during war.

ORGANIC AND INORGANIC COMPOUNDS

17267
F. R. Callihan, R. A. Falk, T. P. Martins, C. L. Quatela,
and A. S. Koch
NUCLEAR RADIATION RESISTANT GYROSCOPE BEARING LUBRICANTS
AND FLOTATION MEDIA
Sperry Rand Corp., Sperry Gyroscope Co., Great Neck, N. Y.,
WADD-TR-60-753, Feb., 1962, Tech. Documentary Rpt. Part
II, Nov. 16, 1959 - Sept. 30, 1961, AF 33(616)-6817,
28 pp
Avail: ASTIA

Fluids for use as base stocks for the formulation of radiation-resistant lubricants were investigated; one of them, tert-butyl-1,9-diphenylnonane, appears particularly promising and is recommended for further evaluation. Towards the objective of developing perfluoroaromatic materials as highly stable fluids, methods for the preparation of hexafluorobenzene were investigated. A successful procedure involving the pyrolysis of dichlorofluoromethane was developed and is reported herein.

17272
R. T. Keen, R. A. Baxter, R.H.J. Gercke, and W. L. Orr
RADIOLYSIS PRODUCTS OF POLYPHENYL COOLANTS PART 1 IN-
PILE LOOP IRRADIATIONS
North American Aviation, Inc., Atomics International,
Canoga Park, Calif., NAA-SR-4355, March 30, 1962,
AT(11-1)-GEN-8, 70 pp
Avail: OTS

Commercially available polyphenyl materials, of interest as potential coolant-moderators for organic moderated reactors, were irradiated in an in-pile loop in the Materials Testing Reactor. The materials studied were biphenyl, two isomeric terphenyl mixtures, and an isomeric mixture of isopropyl biphenyls. This paper discusses the changes in chemical composition of the coolant materials during irradiation, and the characterization of the radiolysis products. Decomposition products were classified into four groups of different volatility ranges: (1) gases, (2) low boilers, (3) intermediate boilers, and (4) high boilers. The high boilers accounted for 85 to 90 per cent of the total decomposition products; therefore this fraction was studied in detail.

17280

John D. McCollum and W. A. Wilson
TRIPLET EXCITATION INDUCED BY ELECTRON IRRADIATION
PART II - EXAMINATION OF AROMATIC SYSTEMS
American Oil Co., Whiting, Ind., ASD-TDR-62-32,
Feb., 1962, Tech. Documentary Rpt., May - Nov., 1961,
AF 33(616)-8247, 19 pp
Avail: ASTIA, OTS

Flash spectroscopy has been used to search for transient triplet absorption from eleven compounds irradiated by single electron pulses. Transients ascribed to triplets were found from 1,2-benzanthracene and p-terphenyl. Quenching of triplets in viscous paraffin oil appears sensitive to triplet structure; relative quenching rates of 8:3:1 were observed for p-terphenyl: 1,2-benzanthracene:anthracene triplets. Phenyl ether gives a transient probably assignable to phenyl radical.

17299

Melvin W. Hanna and Larry J. Altman, California Institute
of Technology, Gates and Crellin Labs. of Chemistry,
Pasadena, Calif.
HYPERFINE INTERACTIONS IN X-IRRADIATED MAGNESIUM PHOSPHITE
HEXAHYDRATE
The Journal of Chemical Physics, 36, (7), April 1, 1962,
pp 1788-1792

An analysis of the electron spin resonance spectra of X-irradiated single crystals of $MgHPO_3 \cdot 6H_2O$ has shown that the principal long-lived paramagnetic species produced by irradiation is a PO_3 fragment. This fragment retains the same orientation within the unit cell as the undamaged molecule.

17311

Robert M. Brugger, Phillips Petroleum Co., Idaho Falls,
Idaho
SCATTERING OF SLOW NEUTRONS BY SOLID AND LIQUID TERPHENYLS
Physical Review, 126, (1), April 1, 1962, pp 29-39

These data show that the difference between the scattering from the liquid and the solid is principally of magnitude and not shape. No effects due to the ortho-, meta-, or para-chemical binding is evident.

17345

R. L. Adamczak, R. J. Benzing, and H. Schwenker
LUBRICATION IN SPACE ENVIRONMENTS
Wright-Patterson AFB, Aeronautical Systems Division,
O., Paper presented at the National Symposium
on The Effects of Space Environment On Materials,
St. Louis, Mo., May 7-9, 1962, 12 pp

Solid, semi-solid and liquid lubricants, hydraulic fluids, heat transfer fluids and novel lubrication techniques are discussed with respect to the current "State of the Art" and the future capabilities of these various materials and/or their application.

17359

Ferd E. Williams, General Electric Research Lab.,
Schenectady, N. Y.
THEORY OF DEFECT FORMATION IN ALKALI HALIDES BY
IONIZING RADIATION
Physical Review, 126, (1), April 1, 1962, pp 70-72

Assuming the creation at low temperatures by ionizing radiation (X-rays and β -rays) of two halogen atoms at adjacent halide ion sites, we have estimated in a tight-binding approximation the time constants for the electronic and atomic relaxation processes. It is concluded that an appreciable fraction of the atoms may move before the positive holes further separate. The atomic motion is most probably to form two negative halogen molecule ions rather than a neutral halogen molecule. Each halogen molecule ion acquires momentum in the [110] direction from interaction with the asymmetric crystalline field; and by "billiard ball" collisions concurrent with tunnelling of the positive hole, separation of the halide vacancy and the molecule ion may be achieved. A related mechanism of defect formation, but requiring only a single ionization, is considered.

17360

Masayasu Ueta and Hiroshi Sugimoto, Tohoku University,
Japan
THERMAL GLOW IN A DEFORMED KCl CRYSTAL IRRADIATED
BY THE ULTRA VIOLET LIGHT
Journal of Physical Society of Japan, 17, (3), March,
1962, pp 571-2

A KCl crystal grown from the purified powder was plastically deformed by 5.7 per cent and cut into two pieces of equal size. One piece was illuminated with the light of a hydrogen discharge lamp through a ultra violet grade fused quartz window supplied from Corning Glass Works. Another piece was irradiated by X-rays obtained from the X-ray tube with W-target operated at 35 KV, 10 ma through a thin aluminum foil. Thermal glow curves of these two crystals are shown. In the case of ultra violet light, four peaks were obtained at 80, 158, 200, and 250 C. The three peaks of 80, 158, and 200 C are ascribed to the combined effects of plastic deformation and ultra violet light. The peak of 250 C does not appear if the crystal is illuminated by light through a filter of KCl crystal. When the window of hydrogen lamp was replaced by a LiF crystal-plate, which transmitted shorter wavelength-light than quartz plate, this peak was greatly enhanced. The peak of 250 C is considered to be due to the effect of light absorbed in the second fundamental absorption band arising from band to band transition and considered to generate an electron hole pair. Glow peaks are characteristic of plastic deformation.

17528

J. P. Stone, C. T. Ewing, Ch. H. Blachly, E. W.
Steinkuller, J. R. Spann, B. E. Walker, and R. R.
Miller
HEAT-TRANSFER STUDIES ON SOME STABLE ORGANIC FLUIDS IN
A FORCED CONVECTION LOOP
U. S. Naval Research Laboratory, Washington, D. C.,
NRL-RPT-5675, Oct. 26, 1961, Final Rpt., AT-(45-1)-1070,
21 pp
Avail: ASTIA, AD 268341

Heat-transfer coefficients were measured for irradiated monoisopropylbiphenyl, tertiary eutectic (biphenyl with two terphenyls), irradiated tertiary eutectic, n-hexadecane, di(2-ethylhexyl) adipate, biphenyl, and monoisopropylbiphenyl heated in a long horizontal tube for the following conditions; bulk-fluid temperatures, 217 to 629 F; heat-transfer surface temperatures, 248 to 853 F; heat fluxes, 33,300 to 486,000 Btu/hr-ft²; fluid velocities, 4.6 to 51.7 ft/sec; Reynolds numbers, 11,800 to 402,000; and Prandtl numbers, 4.1 to 24.9. These coefficients were correlated by an equation of the Dittus-Boelter type with an average deviation of ± 5.5 percent. The physical properties of the fluids used for the correlation are included in the report. No fouling of heat-transfer surfaces from decomposition of the polyphenyl fluids was observed in fouling runs up to 76 hours duration. In fouling experiments the most severe conditions normally were: heat-transfer surface temperature, 850 F; bulk-fluid temperature, 600 F; and fluid velocity, 5 ft/sec. Component parts of the loop, consisting mainly of commercial "hot-oil" equipment, remained in good condition with a minimum of maintenance after four years of service.

17624

S. R. Matos and E. J. Johnson
PERFORMANCE OF IRRADIATED AND CHEMICALLY TREATED JP-5
FUEL WITH INHIBITED RED FUMING NITRIC ACID
Picatinny Arsenal, Dover, N. J., PA-TR-1-61, NP-11219,
DL-TR-1-61, 1961
Avail: ASTIA, AD 268931

Gamma radiated and NALCO 305 treated JP-5 were evaluated as rocket fuels with inhibited red fuming nitric acid in a 300-lb-thrust uncooled rocket engine operated at 330 psia chamber pressure. No significant difference in performance was noted between the two treated fuels and the untreated JP-5 when tested under similar conditions using specific impulse as the criterion of comparison. The irradiated JP-5 was treated at the Brookhaven National Laboratory, Long Island, N. Y., by immersion in a Cobalt-60 gamma pool to a total radiation level of 1500 roentgens obtained at a rate of 500 roentgens per hour. Testing was performed within the half-life period of the irradiated fuel. The chemical treatment consisted of adding 0.38 ml of NALCO 305 per gallon of JP-5. Prior to testing, the mixture was agitated and allowed to stand for eight hours to be certain that the additive had dispersed all the unstable fuel particles. Irradiation and chemical additives as a treatment for jet fuels was for the purpose of reducing the particle size of unstable constituents, determined to be present in the fuel by the electron microscope, to improve combustion and burning rate properties of the fuel.

17639

N. A. Tyapunina, M. P. Shaskol'skaya, Chao-chien,
and Yu. Kh. Vekilov, Mosco Steel Institute
THE EFFECT OF PLASTIC DEFORMATION AND IRRADIATION ON
THE INTERNAL FRICTION OF LiF SINGLE CRYSTALS
Soviet Physics - Solid State, 3, (12), June, 1962,
pp 2643-2647

Changes in internal friction (at a frequency of ~ 100 kc) and dislocation density have been measured in relation to the previous loading of LiF single crystals, both unirradiated and irradiated with X-rays. Increasing the X-ray dose (and, consequently, the concentration of point defects) leads to a reduction in the internal friction. With a suitable radiation dose the internal friction can remain constant throughout the plastic range. Irradiation with X-rays also causes strengthening.

17695

R. A. Back, T. W. Woodward, and K. A. McLauchlan,
National Research Council of Canada, Div. of Pure
Chemistry, Ottawa, Canada

ABSOLUTE YIELDS IN THE GAMMA-RADIOLYSIS OF GASES
Canadian Journal of Chemistry, 40, (7), July, 1962,
pp 1380-1384

Despite the very considerable amount of work done in recent years on the radiolysis of gases, the dosimetry of these systems, especially the absolute dosimetry, is very far from satisfactory. Absolute yields of Hydrogen from the γ -radiolysis of hydrocarbon gases were therefore obtained by relating the hydrogen produced to saturation ion currents measured in the radiolysis vessel. Values for G_{H_2} of 1.28, 1.20, 6.25, 5.40, and 5.00 have been estimated for ethylene, propylene, propane, n-butane, and isobutane respectively. These values are consistently lower than those obtained previously with α -rays, and this is discussed as an effect of radiation quality. Arguments are advanced for the use of M/N, the yield per ion pair, rather than G, as a measure of yields in the radiolysis of gases.

17697

E. V. Peshikov and S. V. Starodubtsev, Nuclear Physics
Institute, Academy of Sciences, Uzbekh SSR, Tashkent
RADIATION-INDUCED CHANGES IN THE PROPERTIES OF ROCHELLE
SALT CRYSTALS (IN WEAK ELECTRIC FIELDS)
Soviet Physics-Solid State, 4, (1), July, 1962, pp 170-174

The effect of gamma radiation on the dielectric losses, permeability, and electromechanical (f_p , Q , k) properties of Rochelle salt crystals as measured in weak electric fields was investigated. The results obtained are in qualitative agreement with the notion of diminishing domain effects as a contribution to the indicated parameters. In all the tests Cobalt-60 gamma radiation was used with a dose rate of 0.5×10^6 r/hr and at a temperature of 10-20 C, with water shielding.

17698

E. Piantanida and M. Piazzì
BEHAVIOR OF EXPLOSIVES UNDER GAMMA IRRADIATION NOTE III
(IN ITALIAN)
Chimica Industria 44, (3), March, 1962, pp 247-250

Some experimental results relative to the effects of the gamma rays on the explosives studied in the two preceding notes are here given. The results of other experiments on smokeless powders made with the purpose of studying the relations between the effect of the gamma irradiations on the contents in centralite are referred.

17703

J. R. Morton, National Physical Lab., Teddington, Middlesex,
Great Britain

THE E.S.R. SPECTRUM OF IRRADIATED AMMONIUM HYPOPHOSPHITE
Molecular Physics, 5, (3), May, 1962, pp 217-223

Electron spin resonance spectra of ordinary and deuterated ammonium hypophosphite crystals irradiated with gamma rays of mean energy 1.0 Mev indicate that the ionic radical HPO_2 is initially formed. There is evidence that the radical HPO_2 reacts with an adjacent H_2PO_2 ion forming the species $\text{O}_2\text{P-PO}_2$. The spectra of irradiated deuterated crystals confirmed this analysis.

17704

D. A. Armstrong, University of Alberta, Calgary, Alberta,
Canada

HYDROGEN FORMATION IN GAMMA-IRRADIATED HYDROGEN CHLORIDE
Canadian Journal of Chemistry, 40, (7), July, 1962,
pp 1385-1393

Hydrogen yields from pure liquid and solid hydrogen chloride irradiated in vacuum with Cobalt-60 γ -rays to a total dose of 5×10^{19} ev/g were GH_2 (liquid) = $6.5_0 \pm 0.1_0$ and GH_2 (solid) = $3.3_0 \pm 0.1_0$ at -79 C and -196 C respectively. The yield from solid hydrogen chloride was only slightly reduced by the addition of chlorine; but the yield from liquid samples was reduced sharply by low concentrations of chlorine to a value of about 4.5, and then much more gradually by larger concentrations. Sources of the thermal and hot hydrogen atoms were examined and it was suggested that the decomposition of electronically excited molecules might be an important mode of decomposition.

ELECTRONICS

17284

Virgil D. Hocraffer

PERMANENT EFFECTS OF GAMMA RADIATION ON VARIOUS SWITCHES

Minneapolis-Honeywell Regulator Co., Micro Switch

Engineering Test Lab., Freeport, Ill., LTR 15027-1,

Dec. 30, 1960, 15 pp

Avail: Micro Switch, Freeport, Ill., File ref. 6335

The following switches were irradiated: 1SM1, 1SE1-3, V3-1, V3-1301, BZ-2R, BA-2R, 1EN1-6, 2EP2-E, 1LS1, and 1HS1. Two different reactors were used in these tests. One reactor is located at the University of Minnesota and is a 1000 curie, Cobalt-60 source with a 10 feet x 13 feet x 10 feet test cell. The second test

reactor used was the Argonne National Laboratories reactor located in Chicago, Illinois, which is a Cobalt-60, high level gamma facility, with an attenuated flux of about $.795 \times 10^6$ r per hr. The switches to be tested were checked initially for operating characteristics and insulation resistance and sent away to be irradiated. Upon their return they were checked for operating characteristics, insulation resistance, dielectric strength, and mechanical and electrical life where applicable. The insulation resistances were measured at 500 volts DC on a 1 to 100,000 megohm test unit. Dielectric strength was measured on test equipment having a maximum voltage output of 6,000 volts AC and current limited to about .250 amperes.

17287

Lyndon Taylor
SEMICONDUCTOR DEVICE IRRADIATION
Texas Instruments, Dallas, Tex., March 16, 1962, Tech.
Rpt., 26 pp

This experiment investigated amplification, leakage currents, and breakdown voltages of several units, each of types 2N705; 2N726; 2N743; 2N797; 2N1406; and TI-X691, to a total reactor radiation dose of about 10^{15} neutrons ($E > 100$ kev)/ cm^2 and 2×10^8 ergs/gm (C) from gamma rays. Bipolar silicon devices can be used to neutron doses of 10^{13} to $10^{14}/\text{cm}^2$. Germanium bipolar transistors are satisfactory to about 10^{14} to $10^{15}/\text{cm}^2$. The Field Effect Transistor shows very good resistance to radiation effects and can be used to about 10^{15} neutrons ($E > 100$ kev)/ cm^2 .

17291

S. Kaye
FEASIBILITY STUDY TOWARD DEVELOPMENT OF RADIATION RESISTANT
SOLAR CELL
Electro-Optical Systems, Inc., Pasadena, Calif., EOS-2080-
ML-6, May 15, 1962, Monthly Rpt., April 1-30, 1962,
NAS7-92, 10 pp

Four cells were irradiated with 1 Mev electrons using the Van der Graff accelerator at Space Technology Laboratory. The short circuit current of the cells as a function of the integrated electron flux, the initial efficiencies of the cells, the resistivity of the starting base material, the ratio of the cell short circuit current to its initial current, and the effective diffusion length as a function of the integrated bombardment flux are shown.

17292

STUDY OF EFFECT OF HIGH-INTENSITY PULSED NUCLEAR
RADIATION ON ELECTRONIC PARTS AND MATERIALS
International Business Machines Corporation, FSD Space
Guidance Center, Owego, N. Y., IBM-62-521-6,
Qtly. Prog. Rpt. No. 7, Jan. 1 - March 31, 1962,
DA 36-039-SC-85395, 20 pp
Avail: ASTIA

This report describes the magnetic core pulse radiation tests conducted at the Sandia Pulsed Reactor Facility (SPRF) in March, 1962. No test results are included since test analysis has not been completed. The test data and analysis will be presented in the next (8th) quarterly progress report.

17294

Fred J. Schmidt

RESEARCH AND INVESTIGATION ON RADIATION RESISTANT,
HIGH TEMPERATURE THERMIONIC CIRCUITRY

General Electric, Receiving Tube Dept., Owensboro, Ky.,
Interim Engineering Rpt. No. 4, Jan. 1 - March 31, 1962,
AF 33(616)-8096, 110 pp

The present report covers the experimental work directed toward the development of high temperature, nuclear radiation resistant, integrated thermionic circuitry of high efficiency and long life. TIMM tube research and development efforts were concentrated primarily on the design of a more satisfactory grid for computer switch tube use and improvement of grid tensioning methods and techniques. The investigation of resistor processing procedures is included. An investigation program has been initiated to determine whether a Ti-TiO₂ concentration cell exists at the titanium-ceramic interface of TIMM capacitors. No radiation effects studies have been conducted to date.

17295

J. J. Wysocki, J. A. Scott-Monck, B. Goldstein, and
R. Novak

SEMICONDUCTOR PHOTOVOLTAIC CONVERSION

Radio Corporation of America, RCA Labs., Princeton,
N. J., Nov. 30, 1961, Final Triannual Rpt.,
Nov. 1, 1960 - Oct. 31, 1961, DA 36-039-sc-87417, 58 pp
Avail: ASTIA, AD 271629

The radiation resistance to 800 kev electrons of np Si cells from floating-zone and quartz-crucible material is comparable for flux levels below 5×10^{16} cm⁻². The FZ cells appear to be more radiation-resistant above this flux level. No major difference in radiation resistance was observed in quartz-crucible cells with different base doping and resistivity. Floating-zone pn Si cells are better than quartz-crucible pn cells by a factor of three or more. Since the fractional change in short-circuit current calculated for outer space conditions is comparable to that observed on earth, the radiation properties of these cells are expected to be comparable in free-space. Changes in I_0 and λ were observed in the dark i-v characteristics of these cells upon irradiation. Annealing effects at room temperature were not observed. An attempt is made to correlate the above findings with other published work. The major difficulty in such a comparison is lack of information on the location and properties of the recombination centers introduced by irradiation. The lowest electron energy at which bulk conductivity changes were observed is 167 kev in n-type and approximately 220 kev in p-type Si. The defect level in n-type material is located at $E_c - 0.199$ ev at 240 K. If there is not a threshold difference for damage, then the defects are produced in p-type Si with a probability of less than 1/100 of that in n-type Si for energies below 200 kev, and approximately 10 times less at higher electron energies.

17304

L. K. Vodop'yanov and E. A. Konorova, P. N. Lebedev
Physics Institute, Academy of Sciences, USSR, Moscow
ELECTRICAL PROPERTIES OF SrTiO_3 MONOCRYSTALS SUBJECTED
TO NEUTRON IRRADIATION
Soviet Physics - Solid State, 3, (11), May, 1962,
pp 2486-2488

Measurements were made of the dielectric constant ϵ , dielectric losses, conductivity, and optical absorption in the visible and infrared regions of the spectrum on SrTiO_3 monocrystals after irradiation with a high integral flux of 10^{18} cm^{-2} thermal neutrons.

17305

A. F. Plotnikov, V. S. Vavilov, and L. S. Smirnov,
P. N. Lebedev Physics Institute, Academy of Sciences,
USSR
KINETICS OF PHOTOCONDUCTIVITY IN NEUTRON IRRADIATED
p-TYPE SILICON
Soviet Physics - Solid State, 3, (11), May, 1962,
pp 2363-2367

This paper presents data relating to the concentration of defects introduced into p-type silicon by a fast neutron flux of $\sim 10^{13}$ n cm^{-2} at an average energy of 1 Mev. The hole-capture cross sections of these defects are evaluated; this permits one to arrive at certain conclusions concerning the charge of the defects. A calculation based on the Khichin-Pease "cascade" theory indicated that as a result of irradiation there were about 10^{14} cm^{-3} displaced atoms which should produce energy levels in the forbidden energy gap of the material. Measurements of the Hall effect showed that the change in hole concentration as a result of irradiation was also about 10^{14} cm^{-3} .

17306

T. Ya. Sera, V. V. Serdyuk, and I. M. Shevchenko,
I. I. Mechnikov State University, Odessa, USSR
EFFECTS OF GAMMA-IRRADIATION ON THE SPECTRAL DISTRIBUTION
OF PHOTOSENSITIVITY OF CdS MONOCRYSTALS
Soviet Physics - Solid State, 3, (11), May, 1962,
pp 2568-2569

The effects of γ -radiation on the photoconductivity spectrum of CdS have been studied. It was shown before that the long wavelength photosensitivity of cadmium sulfide monocrystals can be considerably increased by means of a thermal processing of the quenching type. This processing promotes the appearance of a large number of microfissures and dislocations in the bulk of the crystal. The crystals were exposed to radiation from a cobalt gun of 60 mr intensity. In this case also, just as after X-ray irradiations, the photoconductivity of CdS monocrystals is considerably decreased. The primary effect of the ionizing radiation consists of ionization of the metalloid ion (the sulfur ion) until it becomes charged positively; and then, under the influence of the field produced by the surrounding lattice ions, it moves out into an interstitial position.

17309

A. R. Driesner, C. P. Kempter, C. E. Landahl, C. A. Linder, and T. E. Springer, Los Alamos Scientific Laboratory, University of California, Los Alamos, N. M.
HIGH TEMPERATURE W/W-25 Re THERMOCOUPLES
Instruments & Control Systems, 35, (5), May, 1962,
pp 105-108

Tungsten/tungsten-rhenium thermocouples have been used successfully for measuring hydrogen gas temperature in the Kiwi-A reactors of the Rover nuclear propulsion program. The most useful combination for these thermocouples has been tungsten coupled with a tungsten 25 weight per cent rhenium alloy. This alloy exhibits a solidus temperature slightly over 3100 C, has considerably more room temperature ductility than tungsten, and yields an electromotive force of about 40 millivolts against tungsten at 2300 C. In one design, 60 mil W and W-Re wires are pressed and swaged into a tungsten block. The wires are passed through an insulated pressure seal. The time response of the thermocouple is in the 1-second range.

17328

L. W. Aukerman
ELECTRON AND PROTON DAMAGE TO SEMICONDUCTORS AND DEVICES
Battelle Memorial Institute, Columbus, O., Paper presented at the AIEE Summer General Meeting, Denver, Col., June 18-22, 1962, 14 pp
Avail: AIEE as paper No. CP 62-1222

A review of recent radiation-damage research, especially concerning solar cells, is presented. Although there are large variations in the radiation tolerance of individual silicon solar cells, the experiments indicate that the effects of damaged regions induced by spallation reactions can be neglected up to energies of at least 200 Mev. Commercial p on n silicon solar cells are less resistant to radiation damage than n on p cells fabricated from "pulled" silicon. On the other hand, p on n cells fabricated from "floating-zone" silicon appear to be superior to the n on p cells in the case of proton irradiation. Comparisons of radiation effects in GaAs and silicon suggest that GaAs solar cells of comparable efficiency to present day silicon cells may have a greater tolerance to radiation damage when and if they become available.

17329

Leonard B. Gardner and Alvin B. Kaufman
THE FEASIBILITY OF NUCLEAR RESISTANT INERTIAL PLATFORM AND CONTROL SYSTEMS
Litton Systems, Inc., Guidance and Control Systems Division, Woodland Hills, Calif., 6 pp

The information contained in this report is a review of irradiations performed with the GTR (General Dynamics), CP-5 (Argonne National Laboratories), SPRF (Sandia), ASD Cobalt-60, 20 Mev Cyclotron (UCLA), and 20 Mev Linear Accelerator (USC).

17342

L. W. Aukerman and R. D. Graft
SOME RADIATION EFFECTS IN GaAs
Battelle Memorial Insitute, Columbus, O., March 26, 1962,
Paper presented at the National Symposium on The Effects
of Space Environment On Materials, St. Louis, Mo.,
May 7-9, 1962, 25 pp

The annealing behavior of n-type GaAs irradiated at room temperature with 1-Mev electrons suggests that the defects produced do not form complexes with impurity atoms. This is contrary to the behavior of radiation-produced defects in germanium and silicon, which are known to form complexes with certain impurities. The rate of annealing in n-type GaAs is dependent on the carrier density, but this can be explained in terms of the effect of Fermi level on the mobility of defects. The 1-Mev electron damage can be completely annealed at about 220 C in n-type GaAs and at about 350 C in p-type material. In the case of neutron irradiation of GaAs, where the probability of creating clusters, or damaged regions, is greater than in the case of charged particles, the damage could not be completely removed by annealing although annealing temperatures as high as 600 C were tried. These results are discussed in terms of a radiation-damage model.

17343

Donald J. Hamman
THE EFFECTS OF SPACE RADIATION ON ELECTRONIC COMPONENTS
Battelle Memorial Institute, Columbus, O., March 22, 1962,
Paper presented at the National Symposium on The
Effects of Space Environment On Materials, St. Louis,
Mo., May 7-9, 1962, 11 pp

It is concluded that space radiations do not present design problems in the case of engineering materials unless these materials undergo sustained exposures on the order of several years. However, for radiation-sensitive materials, damages from space radiations will be a very serious problem even for short exposures when changes in characteristics can affect performance. Thus, radiation damage may be a serious problem in using semiconductor devices, such as solar cells, infrared detectors, and transistors, in space applications. However, no space system has yet given evidence of failure that could be attributed to radiation effects. A proper determination of the shielding required for a given mission is, of course, of extreme importance.

17344

William C. Hulten
RADIATION EFFECTS OF 40 and 440 MEV PROTONS ON TRANSISTORS
NASA Langley Research Center, Paper presented at the
National Symposium on The Effects of Space Environment
On Materials, St. Louis, Mo., May 7-9, 1962, 41 pp

Experimental results are presented covering the data collected before, during, and after the bombardment of several types of transistors with 40 and 440 Mev protons. The data indicate a proton energy as well as a transistor frequency dependence on degradation of the various parameters measured. A number of figures are presented showing the degradation of the gain of the transistors as a function of integrated proton flux.

17351

Raymond C. O'Rourke, William A. Steffy, Jeffries
Wyman, and Sylvia Vacca
ANALYSIS OF EXPERIMENTAL RADIATION EFFECTS DATA
Edgerton, Germeshausen & Grier, Inc., Boston, Mass.,
EGG-B-2366, March 31, 1962, Qtly. Prog. Rpt.
No. 3, Dec. 1, 1961 - Feb. 28, 1962, DA 36-039-sc-87306,
70 pp
Avail: ASTIA

During the reporting period, all of the Godiva II, Triga and KEWB magnetic tape records were transferred to Visicorder strip-chart paper records. The recorded transients from the reactor pulses in the Godiva II records were subsequently measured and plots of I_{CO} and H_{FE} during the times of interest were made in all cases where the tape records yielded good readable records. (In some cases the transistor devices saturated and no peak value is measurable; in some few cases no pulse data was recorded). In addition to measuring the Godiva II I_{CO} and H_{FE} excursions as evidenced by the tape data, a number of different phenomenological expressions for analyzing $I_{CO}(t)$ were examined and one KEWB record was analyzed with some success with one of these approximation methods.

17352

Edward E. Conrad and Stuart M. Marcus
GAMMA INDUCED PHOTOCONDUCTIVITY IN A POLYETHYLENE
TEREPHTHALATE CAPACITOR
Diamond Ordnance Fuze Laboratories, Washington, D. C.,
DOFL-TR-1037, May 4, 1962, 23 pp
Avail: ASTIA

Gamma-induced photoconductivity was measured in a Mylar (polyethylene terephthalate) capacitor over a range of flux from 10^2 R/sec to 4×10^6 R/sec.

17353

Alvin B. Kaufman and Leonard B. Gardner
NGL PLATFORM NUCLEAR RADIATION PROGRAM VOLUME I -
RESEARCH AND ANALYTICAL DATA SECTION
Litton Systems, Inc., Flight Control Lab., Woodland
Hills, Calif., ASD-TR-61-511, Jan., 1962,
Final Rpt., AF 33(600)-41452, 312 pp
Avail: ASTIA

This program specified the modification and test of the gyro, accelerometer, DC amplifier, and other components of the system. Testing of materials used therein was made where data was not available to determine the most suitable modification materials. The goal of this research was the attainment of modification and redesign information which would allow production of a system capable of operating in a combined steady state or pulse nuclear and MIL-E-005272B environment. Four different nuclear facilities were utilized for the radiation tests. Convair's GTR, Argonne's CP-5, ASD's gamma facility, and the Sandia Pulse Reactor Facility (SPRF) were used. The test program indicated that, within certain limitations, the components could be modified or redesigned to achieve the specified goal. Volume I presents an analysis of the modified component performance relative to its effect on system navigational accuracy and on the cause of nuclear induced degradation. Recommended redesign, dosimetry, nuclear spectrum considerations, and other associated subjects are discussed.

17354

D.M.J. Compton, S. W. Kurnick, V.A.J. van Lint, and
E. G. Wikner

RADIATION EFFECTS ON SILICON SOLAR CELLS

General Dynamics Corp., General Atomic Div., John
Jay Hopkins Lab., San Diego, Calif., GACD-3001,
March 7, 1962, Qtly. Prog. Rpt. No. 1, Dec. 1, 1961 -
Feb. 28, 1962, NAS7-91, 7 pp

Irradiations have been performed using 5-Mev and 45-Mev electrons at 77 K at the electron linear accelerator. In preliminary experiments on "floating-zone" 10 ohm-cm phosphorus-doped silicon the conductivity, Hall effect and magnetoresistance were monitored as a function of electron flux at 5-Mev and 45-Mev. The carrier removal rate for 5-Mev electrons was 0.4/cm; for 45-Mev electrons it was 0.9/cm. The ratio of these removal rates, which are assumed to be a measure of the ratio of the number of defects formed, agrees well with the ratio of the number predicted by the Seitz-Koehler theory for 5-Mev and 45-Mev electrons. For a 5-Mev electron irradiation of "floating-zone" 10 ohm-cm boron-doped silicon, a removal rate of 0.16/cm was obtained. Post-irradiation anneals were also carried out. The annealing was found to depend on the amount of irradiation the sample has received. The influence of electron irradiation on the lifetime of minority carriers in "pulled" 10 ohm-cm phosphorus doped silicon has also been measured at room temperature. Using 42-Mev electrons the lifetime was measured as a function of temperature (between 300 K and 77 K) before irradiation, during irradiation and after the irradiation.

17355

B. T. Lowrey and J. C. Mitchell

IRRADIATION OF A TELEMETERING SYSTEM AND RELATED
RECONNAISSANCE SENSORS

Chance Vought Corp., Dallas, Tex., ASD-TDR-62-420,
May, 1962, Tech. Documentary Rpt., AF 33(657)-7229,
125 pp

This report documents the work performed in modifying, instrumenting, and irradiating a minimum telemetering system; and in evaluating the possible use of xerographic storage plates and photomultipliers in a nuclear radiation environment. A partially hardened 230 Mc telemetering subsystem consisting of ten sensors, two SCO's, mixer amplifier, FM/FM transmitter, and PM/FM transmitter was dynamically irradiated at the 3 Mw Ground Test Reactor (GTR) for 100 continuous hours during September, 1961. The average integrated nuclear radiation exposure for the subsystem was 3.0×10^{16} n_f/cm^2 ($nE > 1.0$ Mev) and 8.0×10^{10} ergs/gm-(C). Failure of the low pass filters in the two SCO's occurred after an exposure of 4.0×10^{14} n_f/cm^2 ($nE > 1.0$), 1.3×10^9 ergs/gm-(C). Transmitter output power of the FM/FM and PM/FM transmitters failed after an exposure of 6.0×10^{15} n_f/cm^2 ($nE > 1.0$ Mev), 2.0×10^{10} ergs/gm(C) and 3.0×10^{14} n_f/cm^2 ($nE > 1.0$ Mev), 8.0×10^8 ergs/gm-(C), respectively. There was no gross change in dark resistivity of a photosensitive amorphous selenium (xerographic) detector after exposure in the GTR's 2 7/8 inch square pneumatic tube to 1.1×10^8 n_f/cm^2 -sec ($nE > 1.0$ Mev) 2.1×10^7 ergs/gm-hr (C) for ten minutes. Two RCA No. 5819, 10 stage, S11 spectrum and two DuMont No. 6292, 10 stage, S11 spectrum photomultiplier tubes were dynamically irradiated in General Dynamics' 3000 curie Cobalt-60 gamma source on October 1, 1961, to investigate the degree of gamma photon induced dark current saturation. Both types of phototubes exhibited stable response to high light stimuli in a nuclear environment of 2.0×10^7 ergs/gm-hr(C).

17356

J. F. Weller, F. J. Campbell, and J. W. Kallander,
U. S. Naval Research Lab., Washington, D. C.
SPACE-RADIATION EFFECTS ON ELECTRICAL INSULATION
AND SEMICONDUCTORS
Electro-Technology, Feb., 1962, 10 pp (Reprint)

A review of Van Allen belt radiation, cosmic rays, and solar flares on insulation and semiconductors is given. Thirty references are cited.

17357

L. K. Vodop'yanov and G. I. Skanavi
EFFECT OF SLOW-NEUTRON IRRADIATION ON THE DIELECTRIC
PROPERTIES OF POLYCRYSTALLINE TITANATES
ARS Journal 32, (5), May, 1962, Translated from Bulletin
of the Academy of Sciences USSR, Physical Series,
24, (2), 1960, pp 842-843

By irradiation of ionic polycrystalline materials with a heavy flux of slow neutrons, one can produce a high concentration of Frenkel defects, particularly if the material comprises elements with a large cross section for slow neutron capture. The formation of defects leads to the appearance of relaxation polarization which is responsible for increase of the dielectric loss and also of the dielectric constant in cases when the dielectric constant before irradiation is not excessively high (specifically, in the cases of magnesium and zinc titanates).

17366

J. N. Hobstetter and C. A. Renton, Bell Telephone
Labs., Inc., Murray Hill, N. J.
POINT DEFECTS IN p-TYPE GERMANIUM AS INTRODUCED BY
DEFORMATION, QUENCHING, AND ELECTRON BOMBARDMENT
Journal of Applied Physics, 33, (2), Feb., 1962,
pp 600-605

In order to compare point defect formation in germanium through different modes of production, Hall measurements have been made on germanium after different treatments. The same starting material was used in all experiments, namely, 5-ohm-cm p-type germanium. Markedly different behavior was observed. For the electron bombarded material, the number of carriers is reduced at all temperatures below room temperature, while the quenched material shows an increase at all temperatures. The deformed material exhibits intermediate behavior, with the carrier concentration increased at high temperatures and decreased at low temperatures. This is accounted for by an energy level scheme similar to that of James and Lark-Horovitz.

17522

K. Ikrath
NUCLEAR PULSE EFFECTS IN CABLES. A THEORETICAL MODEL
FOR TRANSIENT RADIATION EFFECTS IN WIRES AND CABLES
U.S. Army Signal Research & Development Lab., Fort
Monmouth, N. J., 50 pp

An equivalent circuit for a piece of cable is developed and the differential equations of this circuit are solved under the conditions of a transient burst of nuclear radiation and under various ranges of cable bias voltage. Graphs of representative cases are presented and compared to experimental results. A method of solving for the transient change in cable parameters is given and sample calculations are shown.

17525

R. W. Runnels

AN INVESTIGATION OF SOLAR CELL CAPABILITIES FOR
SATELLITE APPLICATIONS

Wright-Patterson AFB, ASD, Electronic Technology Lab.,

O., ASD-TR-61-334, Nov., 1961, 37 pp

Avail: ASTIA, AD 270455

This report covers an investigation of the physical and electrical characteristics of solar cells constructed of several different materials and by different manufacturers. The solar spectrum as found outside the atmosphere at the earth's mean orbit is presented. Energy levels in the vicinity of Earth, Mars, and Venus are given, as well as the thermal and pressure conditions expected. The radiation of the Van Allen belts and the effects upon the various types of cells are discussed. Several techniques for solar simulation are given and the approach to solar simulation by the Electronic Technology Laboratory is identified.

17532

B. Gerstein, A. Schlueter, and A. Fueyo

EFFECTS OF NUCLEAR RADIATION ON QUARTZ CRYSTAL UNITS

Admiral Corp., Chicago, Ill., March 30, 1962, Second

Qtly. Prog. Rpt., No. 3, DA 36-039-SC-85322, 150 pp

Avail: ASTIA

Crystal units were irradiated in a linear accelerator to a one-minute integrated gamma dose of 10^8 R and in a 60" cyclotron to a one-minute integrated proton flux of 3.6×10^{12} p/cm². Tabulations and graphs of the transient changes experienced by the samples are presented. Details of the transient nuclear effects are discussed for each type of crystal unit together with a presentation of graphs plotted from data obtained during the one-minute irradiation and post-irradiation period of observation. In addition, a discussion of the permanent effects indicates that gamma radiation appears to be the most damaging. The information that has been obtained thus far indicates that the integrated 10^8 R gamma irradiation produced the largest transient and permanent frequency changes. A preliminary examination of the photographs reveals that the phase angle change was the greatest in the electron irradiation. The proton irradiations produced a negligible change in the frequency during the irradiation. The fact that the changes were small was due to the high energy absorption in the metal case of the crystal unit, thus permitting only the relatively small energy penetration to the crystal itself.

17616

D.M.J. Compton

TRANSIENT RADIATION EFFECTS

General Dynamics Corp., San Diego, Calif., GACD-3178,

May 15, 1962, Tech. Summary Rpt., April 15, 1961 -

April 14, 1962, DA-49-186-502-ORD-939, 200 pp

The progress reported includes (1) Carrier generation has been studied in both germanium and silicon, the excess carrier concentration introduced having been varied from $\sim 10^{13}$ to 3×10^{17} carriers/cm³. (2) The carrier generation in germanium has been studied using high energy electrons and using gamma rays. The efficiency of generation by these two different types of radiation has been shown to be proportional to their rate of energy deposition as measured by their heating effect. (3) Since both holes and electrons are introduced, the conductivity differs from that shown when a semiconductor is heavily doped to introduce only one sign of carrier. (4) The energy required to form an electron-hole pair by high energy radiation has been measured for germanium and silicon as 7.8 ev and 6.6 ev, respectively. (5) Effects in insulators due to secondary emission, electron insertion and conductivity have been examined both experimentally and theoretically in an attempt to establish a simple phenomenological theory. (6) Radiation-induced conductivity in nitrogen gas and in air over a range of pressures has been studied using a pulse technique that enables a voltage pulse to be applied with a variable delay after the radiation pulse, and also using a double voltage pulse technique. (7) Secondary emission has been studied as a function of sample thickness and surface treatment. An apparatus using spherical geometry has also been used. (8) Consideration has been given to the problem of equilibration of high energy radiation beams, i.e., the build-up of gamma rays in an electron beam and of electrons in a gamma beam.

17619

R. M. Magee

STUDY TO DETERMINE EFFECTS OF FISSION PRODUCT GAMMA

RADIATION ON ELECTRONIC PARTS AND EQUIPMENT

The Bendix Corp., Bendix Systems Div., Ann Arbor, Mich.,

BSC-31975, June, 1962, Prog. Rpt. No. 1, March 1, -

May 31, 1962, NObsr-87267, 30 pp

Circuit cards from the Naval Tactical Data System computer and associated equipment will be tested under gamma radiation to determine their performance in a fission product radiation environment. The circuit cards being studied and the test methods to be used are described.

17626

E. P. Plankis

RADIATION EFFECTS ON MICROWAVE DEVICES

General Electric Co., Power Tube Dept., Schenectady,

N. Y., Qtly. Prog. Rpt. No. 3, Jan. 1 - March 31,

1962, DA-36-039-SC-87253, 85 pp

Monitoring and calibration procedures for radiation testing of voltage-tunable magnetrons at the Sandia Pulse Reactor Facility are described. Magnetic tape data and appearance of tape background signals are discussed. The effects of pulsed nuclear radiation on four parameters of the Z-5312 VTM and the Z-5428 VTM are discussed, and photographs of parameter variations during and after the nuclear burst are analyzed. Threshold radiation levels for normal VTM operation are established. Radiation effects in cables with voltages applied but with VTM heater voltage off are discussed and photographs included. Dosimetry used in recording peak gamma dose rates of 2×10^7 rads/second and peak neutron fluxes of 1×10^7 neutrons/cm²/second is described.

17627

J. C. Corelli and D. M. Amorosi
CHARACTERISTICS AND ANNEALING OF NEUTRON-IRRADIATED
PbTe
General Electric Co., Knolls Atomic Power Lab.,
Schenectady, N. Y., KAPL-2169, Sept. 25, 1961,
W-31-109-Eng-52, 40 pp

Electrical conductivity and Hall and Seebeck coefficient changes of n-type PbTe have been extended to reactor irradiations of 10×10^{19} cm⁻² neutrons with energy greater than 1 Mev and thermal neutron doses of 10^{21} cm⁻². Similar properties have been measured for extruded p-type PbTe after reactor irradiations of 10^{19} cm⁻² for fast neutrons and 3×10^{20} cm⁻² for thermal neutrons. Sample temperatures during irradiation were 60 ± 20 C. Isothermal annealing experiments indicate the simultaneous recovery of conductivity and Hall and Seebeck coefficients from 100 to 170 C and from 140 to 180 C for p- and n-type materials, respectively.

17630

PREDICTION OF TRANSIENT NUCLEAR RADIATION EFFECTS
IN ELECTRONIC CIRCUITS
The Boeing Company, Aero-Space Div., Seattle, Wash.,
D2-9878, Jan., 1962, AF 33(616)-7804, 90 pp

A method of prediction of transient radiation effects in electronic circuits for a combined neutron and gamma radiation environment is presented. Electronic and radiation transfer functions of resistors, capacitors, and transistors have been developed empirically and are represented by analog circuitry. Single and two-transistor circuits have been simulated in the same manner, and actual circuit tests have been performed to check the predicted analog results. The two results are in reasonable agreement except for one unresolved characteristic of a newly discovered effect in transistors. The method shows promise of being a valuable tool in the design of radiation-resistant circuits and systems.

17636

S. Kaye
FEASIBILITY STUDY TOWARD DEVELOPMENT OF RADIATION
RESISTANT SOLAR CELL
Electro-Optical Systems, Inc., Pasadena, Calif.,
EOS-Rpt-2080-ML-7, June 15, 1962, Monthly Rpt.,
May 1, - May 31, 1962, NAS7-92, 10 pp

Solar cells have been subjected to irradiation by both 1 Mev electrons and 95.5 Mev protons. In both cases the Electro-Optical Systems' solar cells appeared to be more radiation resistant than typical n on p cells made without a graded base structure. These cells differed from those irradiated previously in that the p-n junction was situated at the edge of the graded base region, whereas earlier cells had approximately 25 microns of ungraded material between the junction and the beginning of the gradient in the base region.

17644

Lembit Kosenkranus, The Boeing Co., Seattle, Wash.
ANALOG COMPUTER TECHNIQUES FOR THE PREDICTION OF
TRANSIENT NUCLEAR RADIATION EFFECTS ON TRANSISTOR
CIRCUITS

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 20 pp
Avail: AIEE as CP-62-1082

The representation of transistor circuits with an analog computer was developed for predicting transient responses of these circuits during nuclear radiation bursts. Transistors were simulated from the measured or manufacturer-specified characteristic curves. Radiation effects in the transistors were added in the form of transient increase in emitter to base potential, and by the reduction of current gain (beta) of the transistor with a radiation controlled negative feedback. Linear networks between transistors were simulated from the transfer functions of these networks. A comparison is made between the responses of real and simulated single stage common emitter amplifiers and the real and simulated radiation bursts, respectively.

17645

R. S. Caldwell, The Boeing Co., Seattle, Wash., D. S.
Gage, Northwestern Univ., Evanston, Ill., and G. H.
Hanson, Univ. of Washington, Seattle, Wash.
THE TRANSIENT BEHAVIOR OF TRANSISTORS DUE TO IONIZING
RADIATION PULSES

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 20 pp
Avail: AIEE as CP-62-1081

The detailed mechanism of secondary photocurrent generation in transistors due to short pulses of ionizing radiation is discussed quantitatively and the results of 0.2 μ sec flash X-ray experiments are explained. The dependences of the transient current pulse on transistor types, radiation dose, initial bias level, and external circuit impedance are presented. A possible equivalent circuit controlled by stored base charges is developed which makes it possible to predict more accurately the transient responses of many transistor circuits.

17646

P. A. Trimmer, Diamond Ordnance Fuze Labs., Washington,
D. C.

RADIATION EFFECTS ON TRANSISTORIZED POWER CONVERTERS

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 10 pp

Avail: AIEE as CP-62-1192

Two types of transistorized power converters, common emitter and common base, were exposed to pulsed neutron radiation at the Diamond Ordnance Radiation Facility, a TRIGA Mark F reactor. Permanent damage data were obtained for time integrated fast neutron fluxes from 2.2×10^{12} to 2.6×10^{14} neutrons/cm². It was found that proper operation could be maintained by adjustment of the bias and feedback currents with an accompanying loss in efficiency. Both design types performed equally well. The results of these tests are discussed along with the selection of transistors for use in power converters that must survive in a radiation environment. A brief description of the radiation facility is also given.

17647

L. G. Wright, C. A. Rosen, and S. I. Taimuty, Stanford
Research Institute, Menlo Park, Calif.

RADIATION EFFECTS IN FERROELECTRIC MATERIALS

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 10 pp

Avail: AIEE as CP-62-1077

The effects of reactor radiation (10^{15} - 10^{18} neutrons/cm²) on the dielectric properties of BaTiO₃, 96 per cent BaTiO₃ + 4 per cent PbTiO₃, 95 per cent BaTiO₃ + 5 per cent CaTiO₃, and lead zirconate were studied. Complex permittivity and large-signal hysteresis properties were measured before and after irradiation, after room temperature aging, and after 500 C heat treatment. Effects on the hysteresis properties and the small-signal permittivity were small except for exposures of 10^{18} n/cm². All of the measured properties were affected in some degree by aging and heat treatment.

17648

V.A.J. van Lint, General Dynamics Corp., San Diego,
Calif.

MECHANISMS OF TRANSIENT RADIATION EFFECTS IN ELECTRONIC
PARTS

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 5 pp

Avail: AIEE as CP-62-1078

The mechanism whereby intense ionizing radiation produces transient radiation effects in electronic parts has been analyzed. Important manifestations include: (1) generation of excess carriers in semiconductors, causing enhanced reverse leakage currents in junctions; (2) emission of secondary electrons from surfaces; (3) enhanced conductivity in gases and insulators; and (4) optical effects, such as absorption and fluorescence. Some of these effects can be estimated by order of magnitude calculations, and the results used to interpret transient effects in electronic circuits.

17649

Lyndon Taylor, Texas Instruments, Inc., Dallas, Tex.
REACTOR IRRADIATION OF SEMICONDUCTOR DEVICES
Paper presented at the AIEE Summer General Meeting, Denver,
Colo., June 17-22, 1962, 13 pp
Avail: AIEE as CP-62-1080

This experiment investigated amplification, reverse junction currents, and breakdown voltages of several units each of types 2N705, 2N726, 2N743, 2N797, 2N1406, and TIX691 to a total reactor radiation dose of about 10^{15} neutrons ($E > 100$ kev)/ cm^2 and 2×10^8 ergs/gm (C) from gamma rays. Bipolar silicon devices perform properly after exposure to neutron doses of 10^{13} to 10^{14} / cm^2 . Germanium bipolar transistors are tolerant of about 10^{14} to 10^{15} / cm^2 . The field-effect transistor shows very good resistance to radiation effects and can be used to about 10^{15} neutrons ($E > 100$ kev)/ cm^2 .

17650

H. W. Wicklein, The Boeing Co., Seattle, Wash.
TRANSIENT RADIATION EFFECTS IN COAXIAL CABLES DUE TO
GAMMA-NEUTRON RADIATION PULSES
Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 22 pp
Avail: AIEE as CP-62-1079

Definitive good-geometry tests have been performed on RG-59B/U and RG-174/U coaxial cables at the Kukla pulsed reactor. It has been observed that the radiation-induced current from center conductor to grounded shield is described by $i = \delta \cdot l \sum A_i I_0^{c_i} \delta + A_0 \delta^{0.87}$ where A_0 is voltage-dependent and the A_i depend on voltage and radiation pulse amplitude and shape. The responsible mechanisms are Compton scattering, ion pair generation, and secondary emission.

17651

S. I. Taimuty and J. S. Mills, Stanford Research
Institute, Menlo Park, Calif.
THE EFFECTS OF RADIATION ON FERRITES
Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 9 pp
Avail: AIEE as CP-62-1076

The effects of reactor exposures in the range 10^{16} - 10^{18} fast neutrons/ cm^2 on the magnetic properties of 16 polycrystalline ferrites and garnets are presented. Measured properties included coercive force, remanence, saturation induction, complex permeability, and ferromagnetic resonance (FMR) linewidth. It was found that the hysteresis properties and FMR linewidth were slightly affected by exposures of 10^{18} neutrons/ cm^2 . Complex permeability was affected by exposures as small as 10^{16} neutrons/ cm^2 . All of the observed changes were small.

17656

J. Rogers and C. L. Craig, Sperry Gyroscope Co.,
Div. of Sperry Rand Corp., Great Neck, N. Y.
DEGRADATION OF ELECTRICAL INSULATION FROM REACTOR
IRRADIATION

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 12 pp
Avail: AIEE as CP-62-1297

Commonly used electrical insulating materials in sheet, tubing and magnet wire forms were exposed to reactor radiation environments. The results indicated that silicone treated reconstituted mica, silicone resin coated fiberglass tubing and polyurethane coated magnet wire were the most radiation tolerant of the materials tested. Radiation stability of insulation has been found to depend on the basic molecular structure, the compounding ingredients, and the non-radiation as well as the radiation environment. Many unusual testing problems are encountered in reactor exposures. A critical factor is a uniform technique for determination of the radiation dosage. Use of exposure dosage and a total dosage concept simplifies this determination when testing heterogeneous complex insulating materials, and allows comparison of results from different reactors or reactor locations.

17658

R. Bobone and B. W. Merchant, General Electric Co.,
General Engineering Lab., Schenectady, N. Y.
PREDICTING DAMAGE TO SILICON SOLAR CELLS SUBJECT TO
COMPLEX RADIATION SPECTRA

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 18-22, 1962, 20 pp
Avail: AIEE as CP-62-1279

A semi-empirical method is presented for predicting the damage to silicon cells subjected to various spectra of electron radiation. Voltage-current characteristics were obtained over a damage temperature range of -150 to +150 F and for electron energies from 300 to 800 kev.

17661

K. D. Alexopoulos and R. B. Oswald Jr., University
of Athens, Athens, Greece
RECOVERY OF GAMMA-RADIATION DAMAGE IN P-TYPE INDIUM
ANTIMONIDE

Paper presented at the International Atomic Energy
Agency Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, IAEA-SM-25/77,
May 7-11, 1962, 7 pp

In the present experiments p-InSb was irradiated at 78 K with a strong Cobalt γ -source which allowed a dose rate of 5.8×10^5 Rep/h. After the irradiation the material underwent isochronal annealing. After each step the Hall coefficient and the resistivity were measured at 78 K. Initially the material had an excess of acceptors of 4.9×10^{14} per cm^3 and a Hall-mobility of $7130 \text{ cm}^2 \text{ volt}^{-1} \text{ sec}^{-1}$. Upon irradiating with progressively larger doses,

the number of acceptors increased. The displacement rate was initially 3.7×10^{-3} $\frac{\text{acceptors/cm}^3}{\text{photons/cm}^2}$ and fell slightly at higher doses. After being irradiated with interruptions up to a total dose of 654×10^5 Rep the material was left to anneal at 78 K for 180 hours, after which about 86 per cent of the damage was found to have annealed. The sample was then submitted to isochronal annealing of one hour duration for each temperature. It is shown that no further annealing occurs at the proximity of these low temperatures.

17662

M. Balkanski and W. Nazarewicz, Laboratoire de Physique
de l'Ecole Normale Supérieure, Paris
SINGLE PHONON ABSORPTION BANDS IN FAST NEUTRON IRRADIATED
SILICON

Paper presented at the International Atomic Energy Agency
Symposium on Radiation Damage in Solids and Reactor
Materials, Venice, Italy, IAEA-SM-25/59, May 7-11, 1962,
3 pp

In the present paper, the position of the remaining two absorption bands in neutron irradiated silicon are established (417 and 322 cm^{-1}) and arguments are presented that the bands at 488 , 417 , 322 cm^{-1} represent single phonon absorption bands due to defect activated normal vibration modes. In this way, it is shown that by means of activation of optical and acoustical modes by lattice defects, it is possible to measure the phonon frequencies in silicon crystals. The silicon single crystals of $800 \Omega\text{-cm}$ initial resistivity used in this study were irradiated at liquid nitrogen temperature with fast neutrons (dose 10^{19} n/cm^2) in the reactor at the "Centre d'Etudes Nucleaires", Grenoble.

17666

J. W. MacKay and E. E. Klontz, Purdue University,
Dept. of Physics, Lafayette, Ind.
ROLE OF CARRIERS IN THE DISPLACEMENT PROCESS IN GERMANIUM
Paper presented at the International Atomic Energy
Agency Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, IAEA-SM-25/35,
May 7-11, 1962, 3 pp

It is the purpose of this paper to examine the consequences of this model of the displacement process in germanium, and, in particular, the role the carriers may play in determining the efficiency of defect production.

17693

J. C. King and D. B. Fraser, Bell Telephone Labs., Inc.,
Whippany, N. J.
EFFECT OF REACTOR IRRADIATION ON QUARTZ CRYSTAL RESONATORS
1962 Conference Radiation Effects on Glass, Rochester, N. Y.,
Summary Paper No. 7, 2 pp

Quartz crystal resonators have been subjected to an integrated fast flux ($> .1$ Mev) of 1.2×10^{18} nvt. Except for an initial "leveling-off" of resonant frequency as a function of reactor exposure for the natural crystal, both resonators showed a linear increase in frequency with total flux. The acoustic loss also increases linearly with total flux.

POLYMERS

17269

D. E. Field, J. E. Cowling, and F. M. Noonan
THE PROPERTIES OF PAINTS AS AFFECTED BY ULTRAVIOLET
RADIATION IN A VACUUM - PART 2
U. S. Naval Research Laboratory, Chemistry Division,
Washington, D. C., NRL-5737, March 8, 1962, Interim
Rpt., 28 pp
Avail: OTS

The optical properties of most organic coatings are changed on exposure to intense ultraviolet radiation in high vacuum. Of the reflective pigments studied, those containing zinc sulfide and leafing aluminum are shown to be most stable to this radiation.

17337

Norman E. Wahl and John V. Robinson
THE EFFECTS OF HIGH VACUUM AND RADIATION ON POLYMERIC
MATERIALS
Bell Aerosystems Co., Research Department, Buffalo, N. Y.,
Paper presented at the National Symposium on The Effects
of Space Environment On Materials, St. Louis, Mo.,
May 7-9, 1962, 28 pp

This paper describes experimental studies that were conducted to determine the effects of heat, low pressure, and radiation on plastics and elastomeric materials.

17339

Robert P. Bringer
FLUOROCARBON PLASTICS UNDER THE INFLUENCE OF UNUSUAL
ENVIRONMENTAL CONDITIONS
Minnesota Mining and Manufacturing Company, March 30,
1962, Paper presented at the National Symposium on
The Effects of Space Environment On Materials, St.
Louis, Mo., May 7-9, 1962, 22 pp

The effects of high and low (cryogenic) temperatures, exposure to liquid oxygen, γ - and X-irradiation in air and in vacuum, ultraviolet radiation, and vacuum exposure are explored.

17340

Leo E. Gatzek, Aerospace Corp. and Lionel Isenberg,
Aerojet-General Corp.
THE EFFECT OF SPACE ENVIRONMENT ON REINFORCED PLASTICS
Paper presented at the National Symposium on The Effects
of Space Environment On Materials, St. Louis, Mo.,
May 7-9, 1962, 46 pp

Examples of unique plastic molding, filament-winding, and laminating techniques as applied to aerospace structures are presented. Effects of the aerospace environment on reinforced plastics and probable ways of improving these materials commensurate with future requirements are discussed.

17341

R. M. McCurdy and G. M. Rambosek
THE EFFECT OF GAMMA RADIATION ON STRUCTURAL ADHESIVE
JOINTS
Minnesota Mining & Manufacturing Co., Adhesives, Coatings
& Sealers Division, March 20, 1962, Paper presented at
the National Symposium on The Effects of Space Environment
On Materials, St. Louis, Mo., May 7-9, 1962, 12 pp

It was concluded that: (1) nitrila-phenolic adhesives are more resistant to radiation damage than epoxy-based adhesives; (2) the peel strength of adhesives deteriorates more rapidly than other properties; (3) thick adhesive layers retain useful strength better than thin glue lines.

17358

R. C. Giberson
GAMMA-RADIATION EFFECTS ON POLYCARBONATE RESIN
Modern Plastics, 39, (8), April, 1962, pp 146-228

Other than increasing coloration, oxidation appears to have little effect on polycarbonates up to exposures of 1×10^8 r. They lose all of their strength after an exposure of 3.3×10^8 r in air. The gases evolved from exposure to ionizing radiation are CO, CO₂, H₂, and small amounts of CH₄ and O₂. The ratio of CO/CO₂ groups evolved decreases in the range of exposure from 1×10^8 r. It is concluded from these observations that degradation of polycarbonates in an irradiation field occurs by a chain-scission mechanism.

17361

Hiroshi Sasakura, Nozomu Takeuchi, and Toshiaki Mizuno,
Industrial Research Institute, Osaka, Japan
ELECTRON SPIN RESONANCE OF IRRADIATED POLYOXYMETHYLENE
Journal of Physical Society of Japan, 17, (3), March,
1962, p 572

Samples were irradiated to the total dose of 10^7 rep. The irradiations were carried out with electron beam (Van de Graaff accelerator) in vacuum at dry ice temperature, and with Cobalt-60 gamma ray in air at room temperature. Electron

energy of 2.5 Mev and electron current of 50 μ A were used to ensure the uniform irradiation and the minimum temperature rise in samples. A quite simple doublet was observed in the measurement of ESR of gamma-irradiated polyoxymethylene. The ESR curve of electron irradiated polyoxymethylene was composed of one doublet, one singlet, and others.

17362

Seizo Nakashio, Sumitomo Chemical Co., Ltd. Osaka,
Masatsune Kondo, Sumitomo Atomic Energy Industries,
Hyogo, Hiro Tsuchita, Befu Chemical Industries Ltd.,
Kako, and Masasuke Yamada, Koei Chemical Co., Ltd.,
Osaka, Japan

SOLID STATE POLYMERIZATION OF OXETANES BY IONIZING
IRRADIATION

Makromolekulare Chemie, 52, April 18, 1962, pp 79-97

It was observed [at a dose rate of 2×10^4 rads/hr at zero C] that the reaction rate depended on the crystal size and was more rapid with larger crystals. The degree of orientation of the crystal is also an important factor in the solid state polymerization. Preferred orientation of the crystal affected that of its polymer. The rate of polymerization is proportional with the dose rate, whereas the degree of polymerization is less dependent. These solid state polymerizations may be assumed to proceed by an ionic mechanism. In the polymerization of derivatives of 3,3-bis (halogenomethyl) oxacyclobutanes, the reaction proceeds with rates in the following order; Cl- > Br- \gg I-.

17363

Atsushi Komaki, Syukuro Yano, Hiroshi Yoshida, and
Seizo Okamura, Kyoto University, Kyoto, Japan

EFFECT OF FREE RADICALS ON THE PROTON RESONANCE OF
IRRADIATED POLYMERS

Journal of Physical Society of Japan, 17, (3),
March, 1962, p 581

The changes in resonance line shape and also in spin-lattice relaxation time (T_1) were examined in the case of polyethylene. The materials were irradiated by Cobalt-60 gamma rays in vacuum at room temperature and measured also at same temperature. Up to the dose of 1×10^8 roentgens, the change in NMR line shape was not observed, and it seems that polyethylene retains its original structure. The relation between T_1 and concentration of trapped radicals was examined. The concentration was controlled by varying the irradiation dose. The change in T_1 of the broad component is due to the effect of free radicals trapped in polyethylene. As to the narrow component, no change could be observed in this experiment.

17364

R. Barker, M.R.H. Hill, Atomic Energy Research
Establishment, Harwell, Eng.

POLYMER PRODUCTION IN THE RADIOLYSIS OF LIQUID
CYCLOHEXANE

Nature, 194, (4825), April 21, 1962, pp 277-278

Liquid cyclohexane was irradiated at ambient temperature (about 20 C) with Cobalt-60 γ at a dose-rate of 1.2×10^{17} ev/min/gm to total doses of 5.27×10^{21} ev/gm. The G values of cyclohexene and bicyclohexyl decrease with dose up to an equilibrium dose beyond which the net $G(C_6H_{10}) = 0$ and $G(C_{12}H_{22})$ maintains a constant value. G (polymer) increases from zero at zero dose to a constant value. Irradiations with a pulsed X-ray beam of instantaneous dose-rate 4.2×10^{20} ev/min/gm gave $G(C_6H_{10})$ and $G(C_{12}H_{22})$ both independent of dose over the limited range studied (up to 5×10^{20} ev/gm.) and no polymer formation. There is a decrease of about a half in the total decomposition of cyclohexane on going from zero dose to about 1.5×10^{21} ev/gm. It seems likely that cyclohexene is the product responsible for this decrease. It could be explained as a quenching of excited cyclohexane molecules by cyclohexene, with very little chemical decomposition of the resulting cyclohexene molecule.

17524

E. E. Kerlin and E. T. Smith
INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND
VACUUM ON ENGINEERING MATERIALS
General Dynamics/Fort Worth, Nuclear Aerospace
Research Facility, Fort Worth, Tex., FZK-142,
March 20, 1962, Qtly. Prog. Rpt. No. 1, Nov. 9,
1961 - Feb. 8, 1962, NAS8-2450, 52 pp
Avail: NASA

Efforts were directed toward writing the specifications and selecting a vendor for the high-vacuum test chambers, conducting a literature survey and performing analyses on potential test materials, and designing special test equipment required in the experiments. As a result of the survey and analysis, certain materials have been selected which are recommended for testing. These materials fall into four separate categories: thermal insulation materials, potting compounds, structural adhesives, and plastic laminates. Experimental test apparatus for measuring the weight loss of fifteen samples continuously and remotely during irradiation has been designed, and shop drawings have been completed during this period. A preliminary design has also been made for an apparatus to measure degradation of bearing lubricants during irradiation. Fabrication was initiated on special localized neutron and gamma shield which are necessary to protect the critical components of the vacuum systems.

17531

S. E. Harrison, Sandia Corp., Albuquerque, N. M.
MEASURED BEHAVIOR OF GAMMA-RAY PHOTOCONDUCTIVITY IN
ORGANIC DIELECTRICS
Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 18-22, 1962, 20 pp
Avail: AIEE as CP-62-1251

Photoconductivity measurements are reported for polyethylene, polystyrene, a mica-filled epoxy formulation, polypropylene, nylon, Teflon, diallylphthalate, and H-film. The measurements were made at gamma-ray intensities within the interval from 1.0×10^{-3} rads (H_2O)/sec to 1.0×10^4 rads (H_2O)/sec and at temperatures

which ranged from 38 C to 71 C. Conductivity was found to have distinct features in three time intervals denoted as A, B, and C. In interval A conductivity is responding to a step increase in gamma-ray intensity. This response is exponential in nature with the time constant decreasing with increased gamma-ray intensity. The change in time constant (τ_0) as a function of gamma-ray intensity ($\dot{\gamma}$) at a fixed temperature is approximated by $\tau_0 = B \dot{\gamma}^{-\alpha}$ where B and α are empirical constants. In interval B the photoconductivity ($\sigma - \sigma_0$) has reached an equilibrium value whose magnitude as a function of gamma-ray intensity at a fixed temperature is characterized to good approximation by $(\sigma - \sigma_0) = A \dot{\gamma}^\delta$ where A and δ are empirical constants. In interval C the conductivity is recovering upon sample removal from the gamma-ray environment. The measured photoconductivity decay can be characterized by $\sigma = \sigma_{eq} \sum_{i=1}^n A_i e^{-t/\tau_i}$ where σ_{eq} is the equilibrium conductivity

of interval B defined by $\sigma_{eq} = \sigma_0 + A \dot{\gamma}^\delta$, the τ_i 's are discrete decay time constants of the recovery, the coefficients, A_i , are the weighting factors associated with the i^{th} decay time constant, and n is the number of discrete decay time constants in the recovery process.

17612

Malcolm Dole

RADIATION EFFECTS IN ORDERED POLYMERS

Northwestern University, Evanston, Ill., ARL-62-311,

March, 1962, Final Tech. Rpt., AF 33(616)-5826,

55 pp

Avail: ASTIA

To determine the effect of isotacticity on radiation effects, isotactic and atactic polypropylene were irradiated in vacuum with Cobalt-60 γ -rays to a total dose of 9.09 mrad and the chemical effects produced by the irradiation studied. The gases liberated were mostly hydrogen (96 per cent) and methane (2.5-3.8 per cent), with the methane yield greater for the atactic sample. The atactic crosslinking and degradation G-values were nearly equal, and also equal to the chain scission G-value for isotactic polypropylene. However, the crosslinking G-value for the latter was only 0.6 that of atactic polypropylene. The intrinsic viscosity of both types of polypropylene initially decreased rapidly with dose until the gel-point was approached when a minimum was reached. A difference in the electron spin resonance (ESR) spectra was observed subsequent to the irradiation. The isotactic spectrum changed irreversibly from a six to a nine line spectrum on annealing, but the latter exhibited a reversible change to a 17-line spectrum on heating to 165 K. The atactic spectrum did not undergo these changes.

17614

George Odian and Bruce S. Bernstein

A STUDY OF THE MECHANISM OF RADIATION-INDUCED GELATION

IN MONOMER-POLYMER MIXTURES

Radiation Applications Inc., Long Island City, N. Y.,

RAI-306, June 13, 1962, Summary Rpt., May 1, 1961 -

April 30, 1962, AT(30-1)-2816, 49 pp

The effect of polyfunctional monomers on the efficiency of the radiation crosslinking of polyethylene, polypropylene, polyisobutylene, and polystyrene has been studied. Various monomers were screened as to their efficiency in

the crosslinking of polyethylene via the polyfunctional monomer crosslinking technique. The efficiency of any particular monomer was found to be dependent on the extent to which it swells the polymer and to its chemical structure. Allyl methacrylate and allyl acrylate were found to be two of the most efficient monomers. The dose required to produce a 50 per cent gel content in polyethylene was found to be approximately 1.5 Mrads for the monomer crosslinking technique using allyl methacrylate as compared to 11 Mrads for the straight radiation technique. Seventy per cent gel is obtained in polypropylene with allyl methacrylate after approximately 2 Mrads of radiation, whereas monomer-free polypropylene will not give a gel at this dosage. The use of 14 per cent allyl acrylate with polyisobutylene yields a gel content of approximately 55 per cent after 1 Mrad of radiation. Monomer-free polyisobutylene, not only does not give a gel at this dosage, but in addition actually is degraded to lower molecular weight material. The monomer crosslinking technique is also useful in increasing the efficiency of the radiation crosslinking of polystyrene.

17615

F. N. Coppage

TRANSIENT PHOTOCONDUCTIVITY OF POLYSTYRENE AND POLY-
ISOBUTYLENE EXPOSED TO PULSES OF NEUTRON AND GAMMA
RADIATION

Sandia Corp., Albuquerque, N. M., SCR-525, June, 1962,
Presented at AIEE Summer General Meeting and Aero-
Space Transportation Conference, Denver, Col.,
CP-62-1238, 18 pp

Photoconductivity in polystyrene and polyisobutylene-impregnated Kraft paper dielectrics has been measured during and following exposures to short-duration, high-intensity pulses of nuclear radiation. Absorbed dose rates were $\leq 1 \times 10^7$ rads/sec. Temperatures of the dielectric samples were controlled in the range from 118 C to 80 C. The observed magnitude of conductivity, for a given absorbed dose rate differed with the different radiation sources. The effectiveness of neutrons in producing photoconductivity as compared to gamma rays is negligible.

17635

S. E. Harrison and P. F. Proulx

MEASURED BEHAVIOR OF GAMMA-RAY PHOTOCONDUCTIVITY IN ORGANIC
DIELECTRICS

Sandia Corp., Albuquerque, N. M., June, 1962, 20 pp

Photoconductivity measurements are reported for polyethylene, polystyrene, a mica-filled epoxy formulation, polypropylene, nylon, Teflon, diallylphthalate, and H-film. The measurements were made at gamma-ray intensities within the interval from 1.0×10^{-3} rads (H_2O)/sec to 1.0×10^4 rads (H_2O)/sec and at temperatures which ranged from 38 C to 71 C.

17640

Wesley E. Loos, Research Triangle Institute, Durham,
N. C.

EFFECT OF GAMMA RADIATION ON THE TOUGHNESS OF WOOD

Forest Products Journal, 12, (6), June, 1962, pp 261-264

Radiation levels of 10^7 rad or greater definitely degrade wood and decrease its toughness. Dose levels below 10^6 rad show indications of a slight increase in some strength properties. Also, to use radiation dose levels of 10^7 rad or greater to induce co- or graft-polymerization of monomers in wood must cause a large gain in the desired property of the wood to offset its loss in strength.

17643

A. S. Kuzminskii, T. Ya. Abramova and M. V. Zueva
RADIATION VULCANIZATION OF NITRILE RUBBERS
Soviet Rubber Technology, 20, (9), Sept., 1961, pp 10-13

Radiation vulcanization enables mechanical goods to be used within a wider temperature range (-60 to $+120$ C) than does sulphur vulcanization from -40 to $+100$ C). The optimum mix for radiation vulcanizates of nitrile rubbers consists of just two ingredients, rubber and carbon black. The optimum dosage of radiation is $15 - 20 \times 10^6$ r. The best fillers are carbon blacks of the channel type.

17654

J. F. Dexter and E. G. Curtindale, Dow Corning Corp.,
Midland, Mich.
THE EFFECTS OF GAMMA RADIATION AT ELEVATED TEMPERATURES
ON SILICONE DIELECTRICS
Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 18-22, 1962, 25 pp
Avail: AIEE as CP-62-1241

Tests are being made to determine the effects of gamma radiation superimposed on the aging effects of high temperatures on the electrical and physical properties of liquid, semi-solid, elastomeric and resinous silicones. These tests show that many silicone dielectrics exhibit appreciable resistance to changes in properties induced by exposure to radiation at temperatures ranging from 150 C to 200 C.

17699

J. A. Sauer, L. J. Merrill, and A. E. Woodward, Pennsylvania
State University, University Park, Pa.
DYNAMIC MECHANICAL STUDIES OF IRRADIATED POLYPROPYLENE
Journal of Polymer Science, 58, (166), Part 1, April,
1962, pp 19-28

The internal friction and the dynamic modulus of isotactic polypropylene samples subject to varying degrees of pile irradiation have been studied at low audio frequencies and over the temperature range from 100 K to over 400 K. The radiation dosages used varied from 5.4×10^{17} to 14×10^{18} nvt. For irradiation doses up to about 3×10^{18} nvt, one observed change is a decrease in the temperature at which the final upswing in damping and drop in modulus occurs, presumably as a result of defects produced in the crystallites by the irradiation. As the irradiation dose increases above 3×10^{18} nvt, all evidence of crystallinity is lost, and the internal friction peak which occurs in the neighborhood of 300 K and which is associated with the glass transition of the amorphous regions moves

to higher temperatures as a result of the increasing chain-stiffening effect due to crosslinking. The secondary loss peak at 250 K attributed to the motion of a small number of segments in the amorphous regions is found to increase in magnitude with increasing dose. The results of density determinations made before and after irradiation and also after subsequent exposure of the irradiated samples to melting temperatures and of solvent extraction studies of the irradiated samples confirm the simultaneous occurrence of crosslinking and of crystalline degradation upon pile irradiation of polypropylene samples.

17700

S. M. Miller, R. Roberts, and R. L. Vale, A.E.R.E.,
Wantage, Eng.
USE OF DIMALEIMIDES AS ACCELERATORS FOR THE RADIATION-
INDUCED VULCANIZATION OF HYDROCARBON POLYMERS
Journal of Polymer Science, 58, (166), Part 2, April,
1962, pp 737-754

The effect of alkyl and aryl dimaleimides on the rate of crosslinking of natural rubber is described by means of experiments with ionizing radiation. The dose for vulcanization can be reduced from 5×10^7 to 2.0×10^6 rad by use of purified rubber and 5 per cent of additive, and the reaction is dose-rate dependent with an intensity exponent of 0.57. The reaction is further accelerated by the addition of small quantities of solvents. By use of C^{14} -labeled dimaleimides it is shown that there is approximately one dimaleimide unit to each crosslink. Possible chain mechanisms for the reaction are discussed.

17701

N. A. Slovokhotova, G. K. Sadovskaya, and V. A. Kargin,
Academy of Sciences of the U.S.S.R., Moscow
EFFECTS OF HIGH SPEED ELECTRONS ON THE STRUCTURE OF
POLYETHYLENE TEREPHTHALATE
Journal of Polymer Science, 58, (166), Part 2, April,
1962, pp 1293-1299

Polyethylene terephthalate (PET) films were irradiated at room temperature with high speed electrons in vacuo. Their infrared spectra, solubility, and degree of swelling in o-chlorophenol were measured as a function of the irradiation dose. The investigation has shown that irradiation causes both crosslinking and degradation. In the absence of air, crosslinking predominates over chain scission. Irradiation of PET is accompanied by the formation of polyphenyl systems. The initial partly crystalline PET becomes completely amorphous on irradiation.

17702

Yoshizo Tsuda, Toyo Rayon Co., Ltd., Otsu, Japan
COPOLYMERIZATION STUDIES OF RADIATION-INDUCED POLYMERIZATION
AT LOW TEMPERATURE
Journal of Polymer Science, 58, (166), Part 1, April,
1962, pp 289-297

Copolymerization of acrylonitrile with styrene or methyl methacrylate was performed by gamma-irradiation in vacuum at -78.5 C at a dose rate of 4×10^4 r/hr in

various solvents. Both an anionic copolymerization and a free-radical reaction were observed to proceed simultaneously. However, when water, alcohol, or ester is present, the anionic polymerization is inhibited. On the other hand, when the content of styrene increases, the free-radical polymerization is retarded. From results of the fractionation of styrene-acrylonitrile copolymer obtained it was concluded that an anion-radical of acrylonitrile formed by irradiation at low temperatures initiates both an anionic and a free-radical copolymerization.

METALS AND CERAMICS

17270

P. Harteck, S. Dondes, Rensselaer Polytechnic Institute
Troy, N. Y., and P. Lockwood, Owens-Corning Fiberglas
Corp., Granville, O.

GLASS FIBERS CONTAINING FISSIONABLE AND FERTILE MATERIALS

U. S. Atomic Energy Commission, NYO-9968, Sept. 30, 1961,

Summary Rpt., AT(30-3)-321, 102 pp

Avail: OTS

Experimental results show that enriched uranium bearing glass fibers do not fragment under neutron irradiation although the fission fragments are released (a self-healing property) and the tensile strength drops sharply at about levels of 60,000 psi. To date only the volatile fission products (iodine, bromine, xenon and krypton) have been found in a gas cycled over enriched uranium bearing glass fibers of 214 microns in diameter within a nuclear reactor (possibly a self-cleaning property). Plutonium bearing glass fibers "wipe" clean, the usual test for removable activity.

17327

A. L. Lowe, Jr. and L. R. Weissert, Babcock and Wilcox
Co., Lynchburg, Va.

THE EFFECT OF HIGH-TEMPERATURE IRRADIATION ON THE
TENSILE PROPERTIES OF A LOW-ALLOY STEEL

Reprinted from Special Report No. 69, 1961, The
Iron and Steel Institute, 4 Grosvenor Gardens
London SW1, pp 410-415

Tensile specimens of 1 1/4 per cent Cr-1/2 per cent Mo steel were irradiated to about 2.5×10^{19} nvt (> 1 Mev) over a temperature range of 725-1700 F. Preliminary results from postirradiation tests conducted at room temperature indicate that above 800 F the effect of radiation damage is reduced but full recovery of unirradiated properties does not occur until the irradiation temperature equals the annealing temperature.

17336

M. R. Achter and P. Shahinian

EFFECT OF ENVIRONMENT ON THE STRENGTH OF METALS

U. S. Naval Research Laboratory, Metallurgy Division,
Washington, D. C., March 15, 1962, Paper presented

at the National Symposium on The Effects of Space
Environment On Materials, St. Louis, Mo., May 7-9, 1962,
23 pp

Metals at low temperature and high stress are stronger in vacuum or inert gas than in a reactive environment; at high temperature and low stress there is a reversal and they are stronger in the reactive environment. A mechanism is proposed to explain this reversal in the environmental effect in terms of two competing processes. Surface adsorption lowers the work required to initiate and propagate a crack while oxide and nitride formation harden and strengthen the metal. To demonstrate the operation of these effects the results of tensile, creep-rupture, and fatigue investigations from room temperature to 1900 F are described and explained by the proposed mechanism.

17349

J. Martin Tobin

SOME EFFECTS OF NEUTRON IRRADIATION ON SELECTED

BERYLLIA MATERIALS

General Dynamics Corp., General Atomic Div., John Jay

Hopkins Lab., San Diego, Calif., GA-2648, April 30,

1962, AT(04-3)-187, 83 pp

Avail: OTS

The effect of 1.7×10^{21} to 2×10^{21} nvt (> 1 Mev) integrated fast-neutron flux at elevated temperatures (800 to 980 C) upon the size and shape, density, crack structure, crushing strength, and thermal conductivity is reported for a wide selection of beryllia ceramic materials. The measurements and observations made have indicated that the use of some fluxing additives results in improved irradiation stability of the properties measured. For the majority of the 45 beryllia pellets which were irradiated, a dimensional increase of less than 1 per cent, a density decrease of less than 3 per cent, a decrease in axial crushing strength of 60 per cent to 80 per cent, and a decrease in estimated thermal conductivity of 15 per cent to 40 per cent were found.

17365

G. V. Byurganovskaya and N. F. Orlov

FORMATION OF COLOR CENTERS IN SODIUM SILICATE AND QUARTZ

GLASSES UNDER THE ACTION OF GAMMA RADIATION

Optics & Spectroscopy, 12, (2), February, 1962,

Translated from Optika i Spektroskopiya, pp 151-154

The dependence of the intensity of the induced absorption bands in fused quartz and sodium silicate glasses on the gamma-radiation dose, as well as the influence of cerium, antimony, arsenic, manganese, iron, and lead additives on the properties of the absorption bands of sodium silicate glasses was investigated. The glasses were irradiated at room temperature, with steadily increasing integral doses of Cobalt-60 gamma-rays up to 10^8 roentgens. The dose rate was 9000 roentgens/hr. Anomalies are noted in the dependence of the optical absorption curves on the radiation dose in the case of fused quartz and sodium silicate glass treated with Fe_2O_3 at doses of approximately 10^5 and 10^6 roentgens. It is suggested that these anomalies are due to the presence of impurities or to specific melting conditions.

17368

E. Ruedl, P. Delavignette, and S. Amelinckx, Solid
State Physics Dept., Studiecentrum voor Kernenergie,
MOL, Belgium

ELECTRON-MICROSCOPE STUDY OF IRRADIATED PLATINUM
International Atomic Energy Agency, Symposium on
Radiation Damage in Solids and Reactor Materials,
Venice, Italy, May 7-11, 1962, 17 pp

As-annealed and, also, annealed and fission-fragment and α -particle irradiated foils were examined. Preferential loop formation is noticed at certain boundaries, in particular along coherent twin boundaries. It is noted that, for small doses, dislocation loops are not distributed at random in the interior of the grains but show a tendency to align. After quenching, specimens contain both cavities and loops. The damage rate of quenched specimens seems to be larger than that of annealed ones; the loop concentration is less along a denuded zone parallel to boundaries and subboundaries.

17369

A. A. Johnson, N. Milasin, and F. N. Zein
THE EMBRITTEMENT OF BODY-CENTERED CUBIC TRANSITION
METALS BY NEUTRON IRRADIATION
International Atomic Energy Agency, Symposium on
Radiation Damage, Venice, Italy, May 7-11, 1962,
24 pp

The hardening and embrittlement of pure body-centered cubic transition metals by neutron irradiation is discussed. For relatively low doses ($<$ about 10^{19} nvt) the hardening is characterized by an increase in yield stress without a corresponding increase in ultimate tensile strength. This probably means that the hardening is caused almost entirely by the pinning of dislocations by point defects. When certain b.c.c. metals such as niobium, molybdenum, and tungsten are irradiated near room temperature, a species of point defect, believed to be the lattice vacancy, is retained in the lattice.

17370

H. Bridge, B. S. Gray, B. T. Kelly, U.K.A.E.A. Reactor
Materials Lab., Culcheth, and H. Sorensen, D.A.E.C.
Research Establishment, Riso, Denmark
AN EFFECT OF FLUX LEVEL AND FLUX SPECTRUM ON THE
ACCUMULATION OF DAMAGE IN REACTOR IRRADIATED GRAPHITE
International Atomic Energy Agency Symposium on
Radiation Damage in Solids and Reactor Materials,
Venice, Italy, I.A.E.A.-SM-25/50, May 7-11, 1962,
22 pp

The results of an experiment to measure the effect of flux level on the damage accumulated in reactor quality graphite when it is irradiated to fast neutron doses of 4×10^{19} n/cm² are presented. An effect is clearly demonstrated from measurements of electrical and thermal resistivity, Young's modulus and dimensional changes, which

can be interpreted in terms of a dominant process in the damaging mechanism with an activation energy for thermal annealing of 1.2 ev. In addition, data are given comparing the changes in electrical resistivity occurring at low doses in an irradiation facility in a graphite moderated reactor with those in a hollow fuel element facility in a heavy water moderated reactor. The variation with dose is shown to be of the same form in both cases. The irradiation temperatures used during the main experiment were in the range 150 to 225 C.

17371

J.G.Y. Chow, S. B. McRickard, and D. H. Gurinsky
EFFECT OF FAST NEUTRON IRRADIATION ON THE MECHANICAL
PROPERTIES OF PURE IRON
Brookhaven National Laboratory, Upton, N. Y., BNL-6069,
26 pp

After an exposure of 2×10^{18} nvt or greater the yield strength increases at a greater rate and a marked ductile to brittle transition is observed at much higher temperatures. The yield strength is independent of grain size after irradiation. The yield strength after 2×10^{18} nvt is a function of the exposure and testing temperature only.

17372

J. Nihoul, Studiecentrum voor Kernenergie, Mol-Donk,
Belgium
THE RECOVERY OF RADIATION DAMAGE IN MOLYBDENUM
International Atomic Energy Agency, IAEA-SM-25/47,
Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, May 7-11, 1962,
8 pp

Specimens of 0.1 mm diameter molybdenum wire were prepared. The molybdenum was 99.9 per cent pure. The main impurities being iron and carbon. After annealing at 1700 C the specimens were irradiated in the liquid nitrogen facility of BRL to a dose of about $2 \cdot 10^{17}$ fast neutrons/cm² after which they were withdrawn and stored at this temperature until the recovery measurements.

17373

A. Ascoli
NEUTRON BOMBARDMENT ENHANCED SEGREGATION IN Cu-Ni
ALLOYS
Laboratori C.I.S.E., Milano, Italy, 10 pp

Electrical resistivity of neutron irradiated Cu-Ni wires was measured vs integrated flux. Relative decrease of resistivity as much as 4.3 per cent were detected for a total integrated flux of about 1.7×10^{18} fast n cm⁻² and no saturation limit was reached.

17375

N. Balai and R.J.K. Bloch
MAGNETIC PROPERTIES OF IRRADIATED SA-212B PRESSURE
VESSEL STEEL
Argonne National Laboratory, 18 pp

Magnetic properties of irradiation-hardened SA-212B pressure vessel steel were measured and compared with unirradiated, hardened, and tempered material from the same heat of steel. The measurements revealed that the magnetic properties of the irradiated steel were not affected by the fast neutron irradiation (> 1 Mev) dosage ranging between 1×10^{20} and 1.3×10^{21} nvt although mechanical hardening has taken place.

17376

J. N. Lomer, E.W.J. Mitchell, and D. H. Niblett,
University of Reading, Reading, UK
SOME EFFECTS OF ELECTRON IRRADIATION ON THE INTERNAL
FRICTION OF COPPER
International Atomic Energy Agency, IAEA-SM-25,
Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, May 7-11, 1962,
21 pp

Polycrystalline copper specimens of 99.999 per cent purity were annealed in vacuo in sealed silica tubes at 1000 C for 40 hours and allowed to cool in the furnace. Electron irradiations were carried out using a Van de Graaff accelerator providing a vertical beam of electrons at energies up to 2 Mev.

17377

B. A. Loomis, Argonne National Laboratory, Argonne,
Ill.
SWELLING OF URANIUM
Symposium on Radiation Damage in Solids and Reactor
Materials, IAEA, Venice, Italy, May 7-11, 1962,
13 pp

Uranium irradiated to about 0.30 At. per cent burnup swelled or decreased in density on postirradiation annealing. The amount of swelling did not increase proportionally with an increase in the annealing temperature. A pronounced increase in the amount of swelling commenced to occur at about 600 C.

17378

R. G. Bellamy, Atomic Energy Research Establishment,
Harwell, UK
THE CRACKING OF IRRADIATED URANIUM
International Atomic Energy Agency, IAEA-SM-25/53,
Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, May 7-11, 1962,
13 pp

Alpha uranium cracks during irradiation only when thermal cycling with a maximum temperature above 450 C occurs. The stresses producing cracking are due to anisotropic expansion of the uranium during thermal cycling; brittle cracking occurs when irradiation embrittlement prevents these stresses being accommodated by plastic flow.

17379

C. G. Collins, General Electric Co., Cincinnati, O.
RADIATION EFFECTS IN SINTERED BeO BODIES OF SEVERAL
COMPOSITIONS

International Atomic Energy Agency, Symposium on
Radiation Damage in Solids and Reactor Materials,
Venice, Italy, May 7-11, 1962, 26 pp

Results of dimensional and strength changes in several compositions of BeO following irradiation at 100 C are described. Volume expansion in the dosage range from 1 to 8×10^{20} n/cm² (≥ 1 Mev) exhibited two different rates of expansion with dosage, the second and higher rate occurring above 1.5 to 2×10^{20} n/cm². Disintegration or powdering occurred at $\sim 6 \times 10^{20}$ n/cm² and corresponded to 6 to 8 per cent volume increase. The modulus of rupture at the knee of the volume expansion curve was of the order of 15 to 40 per cent of the pre-irradiation value. The expansion results are consistent with the behavior predicted on the basis of anisotropic lattice expansion.

17380

Rudolf Sizmann and Ulrich Daunert
RADIATION INDUCED DIFFUSION IN METALS
Laboratorium fur Technische Physik der Technischen
Hochschule, Munchen, Germany

The originally rough cu metal surface (roughness about 1000 A) appeared to be smoothed completely after a dose of 5.10^{15} α /cm². The α -particles came from a 100 mc Polonium 210 source; they had an initial energy of 5.2 Mev. The flux density on the copper surface was 2.5×10^9 α /cm²sec. The irradiation was done at room temperature.

17613

H. H. Yoshikawa, E. M. Woodruff, J. M. Davidson, J.
W. Helm, and R. E. Nightingale
RADIATION EFFECTS IN CARBONS AND GRAPHITES
General Electric Co., Hanford Atomic Products Operation,
Richland, Wash., HW-SA-2368, March 19, 1962, Presented
at the International Atomic Energy Agency Symposium
on Radiation Damage in Solids and Reactor Materials, Venice,
May 7-11, 1962, AT-(45-1)-1350, 12 pp

Radiation effects on a variety of carbons and graphites up to a maximum exposure of 8.6×10^{21} nvt ($E > 0.18$ Mev), and up to a maximum temperature of 1200 C are presented. The high temperature radiation-induced contraction in graphite and the cracking of graphite in regions with appreciable flux gradients are discussed.

17642

William H. Cropper, Sandia Corp., Albuquerque, N. M.
GAMMA-RAY-INDUCED COLORATION IN SOLIDS APPLICATION TO
GLASS SYSTEMS

Journal of the American Ceramic Society, 45, (6), June,
1962, pp 293-297 Presented at the Fall Meeting of the
Glass Div., The American Ceramic Society, Wernersville,
Pa., Oct. 15, 1959, (Symposium on Glass Radiation)

It is considered that the most significant initial effect of the radiation is to produce free electrons and trapped holes in a track. A method of calculation is described which gives the concentration of color centers formed at various doses. The treatment of silver phosphate and other more complex glasses is discussed.

17660

A. H. Willis and R. Pennickx
THE EFFECT OF HEAVY PARTICLE BOMBARDMENT ON WIGNER
ENERGY STORAGE IN GRAPHITE

Centre D'etude De L'energie Nucleaire C.E.N., presented
at International Atomic Energy Agency Symposium on
Radiation Damage in Solids and Reactor Materials,
Venice, Italy, May 7-11, 1962, 5 pp

Bombardment of graphite by the reaction products of uranium and boron cause an acceleration in the rate of storing Wigner energy. The magnitude of the increased energy storage appears to be related to the energy dissipated to the graphite rather than the mass or charge of the reaction products. This probably indicates that the secondary particles produced, i.e. carbon atoms, are responsible for the energy storage.

17663

B. G. Childs, A. Ogilvie, J. C. Ruckman and J. L.
Whitton, Dounreay Experimental Reactor Establishment,
Caithness, Eng.
THE LOW TEMPERATURE IRRADIATION BEHAVIOUR OF CAST
URANIUM CARBIDE

Paper presented at the International Atomic Energy
Agency Symposium on Radiation Damage in Solids and
Reactor Materials, Venice, Italy, IAEA-SM-25/52,
May 7-11, 1962, 45 pp

Increases of up to 160 per cent in electrical resistivity, occur for UC specimens irradiated at low temperatures to exposures up to 1.6×10^{19} n/cm². The lattice parameters of the specimens also increased, a rising to 1.5×10^{-3} at 4.9×10^{17} n/cm². The changes for a UC₂ containing specimen was greater than that for one containing free U. The effect of tungsten impurity is to suppress the additional changes in the UC₂ containing specimens.

17664

R. Gain, Institut fur Reaktorwerkstoffe der Kernforschungsanlage Julich, Julich, Ger.
COMPARISON OF IRRADIATION DAMAGE IN ARTIFICIAL AND NATURAL GRAPHITE AT DIFFERENT IRRADIATION TEMPERATURES
Paper presented at the International Atomic Energy Agency Symposium on Radiation Damage in Solids and Reactor Materials, Venice, Italy, IAEA-SM-25/3, May 7-11, 1962, 17 pp

At ambient irradiation temperatures, due to the strong anisotropy of the graphite moulded blocks and because of their high density, dimensional changes are already so considerable that even a relatively low neutron dose of about 10^{19} nvt > 0.18 mev is not tolerable. These high damage rates disappear more and more with increasing irradiation temperature. By about 500 C all property changes investigated are of the same magnitude as those of CSF graphite. There is also very little difference in the strength factors.

17665

G. W. Keilholtz, J. E. Lee, Jr., R. P. Shields, and W. E. Browning, Jr., Oak Ridge National Lab., Oak Ridge, Tenn.
RADIATION DAMAGE IN BeO
Paper presented at the International Atomic Energy Agency Symposium on Radiation Damage in Solids and Reactor Materials, Venice, Italy, IAEA-SM-25/32, May 7-11, 1962, 13 pp

BeO specimens were irradiated with integrated doses from 1×10^{20} to 2.6×10^{21} nvt (> 1 Mev) over the range 100-1025 C. The greatest damage occurred to specimens irradiated to high fast-neutron doses at low temperatures. Increases in linear dimensions of irradiated samples from 0.5 to 4 per cent were observed. This effect increased with neutron dose and decreased with temperature. Petrographic examinations of the irradiated specimens showed a decrease in the refractive index corresponding to the decrease in density. Also the thermal conductivity of the samples decreased substantially as exposure progressed.

17667

C. Motoc and I. Teodorescu, Institutul de Fizica Atomica al Academiei, Bucharest, Romania
RADIATION EFFECTS IN THIN FILMS
Paper presented at the International Atomic Energy Agency Symposium on Radiation Damage in Solids and Reactor Materials, Venice, Italy, IAEA-SM-25/7, May 7-11, 1962, 4 pp

The aim of this article is to review some of the effects already observed and to give the results obtained by irradiating thin Ni, Ag and Au films under special conditions. Thin films were irradiated in the V.V.R.S. reactor at a total neutron flux ranging from 10^{15} to 10^{18} nvt at different temperatures. By irradiating under the described conditions, thin films of Au, Ni, Ag, the following effects have been observed: (a) Radiation induced oxidation in thin films; (b) Phase transition due to fast neutron irradiation; (c) Alloy formations.

17689

Joseph A. Aboaf, J. Raymond Hensler, Norbert J. Kreidl,
Eberhardt Lell, and Joseph L. Rood
IRRADIATION DAMAGE TO GLASS
Bausch and Lomb Inc., Rochester, N. Y., TID-14482,
Nov., 1961, AT (30-1)-1312, 23 pp

Discharge experiments on electron-irradiated lead silicate glasses were performed. Electrical discharge in glass following gamma irradiation was found to occur only when the gamma beam strikes the glass from one direction only. Dielectric constants were measured for irradiated glass. Studies are also being made of irradiation of highly compressed glass.

17694

R. S. Barker and D. A. Richardson, Pilkington Brothers
Limited, Eng.
EFFECTS OF GAMMA IRRADIATION ON THE OPTICAL ABSORPTION
OF LEAD SILICATE GLASS
1962 Conference Radiation Effect on Glass, Rochester,
N. Y., Summary Paper No. 15, 2 pp

A description is given of the effect of doses of gamma radiation from 10^4 to 10^8 rads. The absorption spectra of all the irradiated samples may be divided into two Gaussian shaped absorption bands centered at 2.54 ev and 3.36 ev. The positions of the peaks of these bands do not change with radiation dose nor with time after the irradiation ceases. The widths of the bands at half the maximum absorption value also remain constant.

DOSIMETRY

17289

W. E. Dungan and J. H. Lewis
NUCLEAR MEASUREMENT TECHNIQUES FOR RADIATION-EFFECTS
ENVIRONMENTAL TESTING
General Dynamics, Forth Worth, Tex., NARF-62-4T, FZK-9-175,
March 31, 1962, AF 33(657)-7201, 123 pp

The methods and techniques employed at General Dynamics/Fort Worth for characterizing radiation-effects environments are discussed. Procedures for dosimetry planning and execution, together with detailed examples for specific application, are included. Included also are reaction data, calibration factors, and flux calculations for thermal-, resonance-, and fast-neutron foil-type detectors. Several figures illustrate typical neutron spectra and integrals, gamma spectra, decay schemes, statistical analysis of data, pulse shapes, and nonnuclear (temperature) parametric effects on gamma systems. Thirty-three references pertinent to the documented information are cited. Information contained in two appendices includes decay schemes of some useful neutron detectors and detailed procedures for IBM reduction of foil data.

17315

Harold L. Overton, University of Houston, Houston, Tex.
LITHIUM-IODIDE SCINTILLATORS FOR FAST-NEUTRON DETECTION
Nucleonics, 20, (6), June, 1962, pp 78-80

In experiments to test the efficiency of these crystals the authors used an environment similar to what one would expect in oil-well logging. At a threshold setting of 1.4 Mev the crystal indicates approximately a one-to-one correspondence between counting rate and fast neutron population. Moreover it performs even better when encased in a polystyrene cover--giving a better detection efficiency for the flux range in logging work and for detecting neutrons with energies 1 Mev. The counting rate of pulses detected by the crystal for energies > 6 Mev is approximately linear with the fast-neutron flux in the graphite medium that we used for our experiments.

17316

Aron Bierman, Israel Atomic Energy Commission,
Rehovoth, Israel
SIMPLIFIED EVALUATION OF FILM DOSIMETRY RESULTS
Nucleonics, 20, (6), June, 1962, pp 82-85

Although the film badge has long been the principal tool of personnel dosimetry programs, most film interpretation is done laboriously from calibration curves. (At 1,200 badges per fortnight our program, like most others, does not justify the purchase of an automatic film reader.) By replacing the curves with a set of fixed tables the author found he could speed the work and reduce fatigue that causes human errors. By processing calibration films with each batch it was determined which table must be used with the batch. In combination with densities obtained under three badge filters, the tables provide a simple way to account for the energy-evaluation factors that are required because film sensitivity varies with radiation energy.

17318

Geoffrey Dearnaley and Archibald T. G. Ferguson,
Atomic Energy Research Establishment, Harwell, Eng.
TWO NEW SEMICONDUCTOR DETECTORS FOR FAST NEUTRONS
Nucleonics, 20, (4), April, 1962, pp 84-88

Two new neutron detectors, a proton-recoil counter and a He^3 counter that are so compact that they can easily be mounted close to a target or sample without modifying neutron flux have been developed. Moreover the gamma sensitivity of these counters is small and the excellent linearity of response allows one to calibrate and analyze the output spectrum with ease.

17319

D. Allan Bromley, Yale University, New Haven, Conn.
NUCLEAR EXPERIMENTATION WITH SEMICONDUCTOR DETECTORS
Nucleonics, 20, (5), May, 1962, pp 55-59

Representative fields where major advances have been recorded are those of electron and high-energy heavier charged-particle detection using lithium-drifted and other thick-depletion-layer devices, neutron-detection studies, nuclear astrophysical research where low mass, size, and power requirements are of paramount importance, focal-plane studies with magnetic spectrographs involving multichannel semiconductor systems, nuclear-reaction-product isotope identification with both hybrid gas-filled and semiconductor detectors and with all-semiconductor systems, high-efficiency particle detection with large-area mosaic detectors and fission, and other studies in high ambient neutron radiation fields where the junctions have unique advantages.

17523

William T.K. Johnson
EXTENDED APPLICATION OF A COBALT GLASS DOSIMETER
Diamond Ordnance Fuze Labs., Washington, D. C.,
DOFL-TR-1050, DOFL-Proj-23720, June 5, 1962,
25 pp
Avail: ASTIA

Cobalt glass dosimeters, normally used to measure gamma ray and electron fields, have been used to measure gamma ray and coexistent thermal neutron fields in the presence of a fast neutron field. The dosimeter is darkened in proportion to the energy deposited and this darkening is calibrated in known gamma ray and thermal neutron fields. A three-glass sandwich was used to distinguish the effects of gamma rays and thermal neutrons. The sensitivity of the glass to various energy gamma and X-rays is presented. A simple spectrophotometer is used to measure the transmission of light through the glass dosimeter. The cobalt glass dosimeter method of measuring gamma and thermal neutron fields is cheap, reliable, and easy. All the items used are off-the-shelf and a complete system can be set up for less than \$400. The operator need have some skill and patience to obtain results reproducible to ± 1 per cent, but no elaborate training is required.

17527

Nathan Klein
A BROAD RANGE CHEMICAL DOSIMETER FOR GAMMA RADIATION
Army Chemical Center, Nuclear Defense Lab., Md.,
NDL-TR-7, July, 1961, 30 pp
Avail: ASTIA, AD 268750

The use of air-saturated, aqueous solutions of benzene as a broad range chemical dosimeter for gamma radiation is described. This rather simple system is capable of measuring dose in the range 20r to 35,000r.

17617

W. R. Van Antwerp
AN INITIAL GAMMA-RAY SPECTROGRAPH
U.S. Army Chemical Center, Nuclear Defense Lab., Md.,
NDL-TR-20, Feb., 1962, Project 4-12-10-007-02, 110 pp
Avail: ASTIA

The feasibility of an initial gamma-ray spectrograph has been investigated. An instrument based on the magnetic analysis of Compton electrons is presented as having suitable attributes for use in the laboratory or in the field and for the measurement of gamma spectra from weapons or pulsed reactors. The instrument is designed for an energy range from 1 to 12 Mev and may be useable over the range from 0.25 to 25 Mev. Use of the natural focal properties of uncollimated Compton electrons in a semicircular beta-ray spectrograph is proposed, and theoretical and experimental results are presented on the performance of such an instrument. The resolution that can be obtained is approximately 40 kev, the instrument can be used at arbitrarily high rates, and the sensitivity is very low. In a typical situation 10^{15} gamma rays might be just detectable.

17621

A. Muller, F. Rizzo, and L. Galanter
SOLAR CELL DOSIMETER
Brookhaven National Laboratory, Upton, N. Y., BNL-721-
(T-255), Feb., 1962, Rpt. No. 1,
Avail: OTS

The experimental work of the radiation source development program at Brookhaven National Laboratory will require the use of rugged radiation dose rate devices capable of measuring doses ranging from 10,000 rads/hr to 1 or 2 x 10^7 rads/hr. A dose rate meter developed at BNL has done yeoman service in this area. The ionization chamber is not a simple instrument, and it is subject to radiation damage. This radiation damage causes a change in response and therefore requires periodic recalibration of the instrument.

17625

George R. Hopkins and John R. Shoptaugh, Jr.
A CERENKOV MONITOR FOR REACTOR LEVELS PULSE AND STEADY
STATE
General Dynamics Corp., San Diego, Calif.,
GA-3250, June 14, 1962, 11 pp

Several instrumentation approaches have been considered for solving the problem of recording the reactor power at all times during the pulse of the Triga Mark F reactor. One which is consistently appealing is to use the intensity of Cerenkov light from the reactor coolant and shielding water as a measure of reactor power. During the pulse this is sufficiently bright to be easily visible with all pool and room lights on.

17629

G. L. Miller
THE PHYSICS OF SEMICONDUCTOR RADIATION DETECTORS
Brookhaven National Laboratory, Upton, Long Island,
N. Y., BNL-699(T-241), Sept. 27, 1961, Lecture Ser.
No. 9, 16 pp
Avail: OTS

Solid state devices have played an important role in the detection of ionizing radiation for a number of years. One of the best known of these is the scintillation counter, the operation of which is based on the fact that, if ionizing radiation is incident on certain classes of materials, called phosphors, a quantity of light is given out. The modern form of the scintillation counter is shown. An incident particle causes light to be emitted from the phosphor. Some of this light falls on the photocathode of the photomultiplier and causes photoelectrons to be emitted. These electrons are accelerated and multiplied in number down the electron multiplier structure. The output signal from the last stage of the photomultiplier comprises a large number of electrons, the number being proportional to the amount of light emitted from the phosphor, and the light in turn being, one hopes, proportional to the incident particle energy, thus allowing this energy to be measured.

17631

C. S. Warren

NUCLEAR EMULSION TECHNIQUES FOR THE MEASUREMENT OF
FAST-NEUTRON ENERGY SPECTRA

General Dynamics/Fort Worth, Nuclear Aerospace Research
Facility, Fort Worth, Tex., NARF-61-36T FZK-9-159,
May 15, 1962, AF 33(657)-7201, 71 pp

The techniques employed by General Dynamics/Fort Worth to determine fast-neutron spectra with nuclear emulsions are described in detail. The report is divided into two parts. The general theory involved in the exposure of nuclear emulsions is developed in the first part, along with descriptions of procedures and equipment used. The second part is a presentation and discussion of some of the data obtained at GD/FW with nuclear emulsions.

17632

Edgar G. Bush

A TUNNEL-DIODE COUNTER FOR SATELLITE APPLICATIONS
NASA-Goddard Space Flight Center, Greenbelt, Md.,
NASA-TN-D-1337, June, 1962, 15 pp

Binary counters employing tunnel diodes as the bistable device have been developed for operation at much higher counting rates (up to 5 Mc) than other counters with comparable power dissipation and number of components. They operate reliably within wide supply-voltage tolerances and over a temperature range of -50 to +100 C which makes them suitable for satellite operations. They are also simple in construction, and standard 10 per cent tolerance components may be used in the circuits.

17653

R. F. Callaway and W. E. Austin, Lockheed-Georgia Co.,
Georgia Nuclear Labs., Dawsonville, Ga.

A FISSION CHAMBER AND CALORIMETER FOR NEUTRON AND
GAMMA DOSIMETRY

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 7 pp
Avail: AIEE as CP-62-1074

Lockheed Nuclear Products, under contract NASw-114 with the National Aeronautics and Space Administration is testing the combined effects of nuclear radiation, cryogenic temperature and stress on more than twenty-five space-related alloys in the NASA Plum Brook Reactor Facility. This paper describes in particular, the development of nuclear instrumentation of the measurement of the radiation field in the test loop to include $1.6 (10)^7$ R hr⁻¹ gammas, 10^{11} N thermal cm⁻² sec⁻¹ and 10^{13} N fast cm⁻² sec⁻¹. No radiation effects data is reported in this paper only instrument development.

17655

Leonard B. Gardner, Litton Systems, Inc.

NEUTRON MICRO-DOSIMETRY

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 2 pp

The customary method of measuring epithermal neutron flux from a single foil is adequate only if the flux is approximately constant over all resonances of the foil used. A more accurate method is based upon measuring the difference of specific activity between an infinitely thin foil and a shielded foil. This paper describes a variation of this method wherein both foils are of the same material, which should have a 1/E response without interfering resonances, but the material of the shield is chosen for its resonance energy and fabrication properties. The shield is made just thick enough so that at the resonance of interest $\Sigma X \geq 1$, where ΣX is the macroscopic absorption cross section at the resonance energy and X is the thickness of the shield measured in cm⁻¹.

17657

G. H. Bochard, Sandia Corp., Albuquerque, N. M.

MEASUREMENT OF BREMSSTRAHLUNG DOSE AND SPECTRUM FROM
A 600 KVP PULSED X-RAY GENERATOR USING PHOTOGRAPHIC
FILM

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 20 pp
Avail: AIEE as CP-62-1229

The properties of the interaction of bremsstrahlung radiation from a 600 kvp X-ray unit with various materials are presented. The physical features of the 600 kvp Fexitron flash X-ray system as a radiation source show that it has a beam of radiation along the axis of the X-ray tube. The beam behaves as though it emanates from a point source; its intensity decreases in proportion to the square of the distance from the source. The energy spectrum is estimated by calculating the response of photographic films under various filters to a postulated energy spectrum and comparing these results to those actually measured with filtered film. The procedure is continued until the results are in agreement.

17690

J. D. Hall and J. B. Ashe

NEUTRON-GAMMA RAY SPECTROMETER

Wright-Patterson AFB, Aeronautical Systems Div., O.,
ASD-TDR-62-52, April, 1962, Tech. Documentary Rpt.,
Jan. 1 - Dec. 15, 1961, AF 33(616)-7787, 25 pp

Avail: ASTIA, OTS

A neutron-gamma ray spectrometer developed at Texas Nuclear Corporation is described. The spectrometer employs pulse shape discrimination in an organic scintillator detector to selectively detect neutrons or gamma rays in a mixed field by a method not utilizing space charge limiting. Selective detection may be obtained for neutrons of energy higher than 0.7 Mev and for gamma rays above 0.25 Mev. Spectral information is usable to 15 Mev for neutrons and to 4 Mev for gamma rays. Detection efficiencies range from about 6 per cent to 30 per cent. Typical spectra, data analysis procedure, and operating characteristics of the spectrometer are presented.

FACILITIES

17285

K. C. Humpherys

NEUTRON FLUX AND SPECTRA MEASUREMENTS IN THE VOID TANK
OF THE TRIGA MARK-F REACTOR

Sandia Corporation, Albuquerque, N. M., SCR-480,
Feb., 1962, 18 pp

Avail: OTS

Neutron flux and spectra measurements were made in the void tank irradiation chamber of the TRIGA Mark-F reactor in support of radiation effects studies in that facility. Threshold foils were used for the measurements. Measurements were made with three lead-shielding thicknesses; 0, 3, and 4 inches between the reactor core shroud and the points of measurements.

17286

W. H. Buckalew

NEUTRON FLUX AND SPECTRA MEASUREMENTS IN THE SANDIA
PULSED REACTOR FACILITY (SPRF)

Sandia Corporation, Albuquerque, N. M., SCR-463,
Jan., 1962, 28 pp

Avail: OTS

Neutron flux measurements were made in the reactor building of the Sandia Pulsed Reactor Facility using threshold detectors for the neutrons with energies greater than 10 kev. Bare and cadmium-covered gold were used for measurement of the thermal neutron fluxes. Midplane measurements were made as a function of distance outward from the reactor vertical centerline in several different directions within the building. In addition, detailed measurements were made on a midplane traverse around the circumference and a vertical traverse from the base of the safety screen over the domed top and to the base on the opposite side. All measurements were "free field" in the sense that no spectrum-perturbing experiments were near the reactor during these measurements. The fluxes above 10 kev follow a $(1/r)^2$ attenuation, whereas the thermal fluxes show very little attenuation with distance. The reactor is, to a good approximation, a point isotropic neutron emitter.

17290

B. L. Cash and R. D. Longley
COMPARISON OF GAMMA IRRADIATION FACILITIES
General Dynamics Corporation, Fort Worth, Tex.,
ASD-TR-61-648, Feb., 1962, Tech. Documentary Rpt.
Aug., 1960 - July, 1961, AF 33(616)-7547, 37 pp
Avail: ASTIA, OTS

As part of a program to reduce experimental uncertainties in radiation-effects data, the Air Force provided General Dynamics/Fort Worth with a "portable" 2500-curie Cobalt-60 standard source to be used for comparing dosimetric techniques and source intensities at 12 gamma irradiation facilities. After the radiation profile and the dose rate in the standard irradiator were determined at GD/FW, the source, along with associated equipment and dosimetry, was transported in a trailer to each of the participating facilities. Measurements by participating facilities in the standard irradiator were compared to the calibration of the standard irradiator. Dose rates determined by GD/FW dosimetry in facility irradiators were compared to the dose rates determined by resident dosimetry.

17301

ACCELERATOR IN MISSISSIPPI
Physics Today, 15, (5), May, 1962, pp 84-85

An accelerator intended to provide intense radiation for solid-state studies is to be installed at the University of Mississippi in September. Construction was started last month on a building to house the machine, which will supply 3-Mev electrons or positive ions at beam currents of 10 ma, making it possible to obtain as many as 10^{13} neutrons per second.

17302

THE CAMBRIDGE ELECTRON ACCELERATOR
Physics Today, 15, (5), May, 1962, p 85

On Wednesday, March 7, the first high-energy electrons were produced by the new electron accelerator which was designed, has been built, and operated in Cambridge, Mass., as a joint project of the Massachusetts Institute of Technology and Harvard University. In its trial operations, the machine produced a beam of 2.2-Bev electrons, and at that time it was expected that the maximum design energy of about 6-Bev would be reached within a matter of weeks.

17303

Avivi I. Yavin
THE AVF CYCLOTRONS
Physics Today, 15, (5), May, 1962, pp 19-25

An informal account of one physicist's European and North American tour in search of first-hand information on a new breed of medium-energy AVF (Azimuthally Varying Field) cyclotrons is given.

17308

H. R. McK. Hyder, E.S.F. King, and D. J. Merrett,
AERE, Research Reactors Division, Harwell, Eng.
DESIGN AND SAFETY FEATURES OF DAPHNE
Nuclear Engineering, 7, (72), May, 1962, pp 178-183

Daphne (Dido and Pluto Handmaiden for Nuclear Experiments), is a zero energy reactor designed to aid the development and utilization of Dido, Pluto and the other reactors of the same class (DMTR of Dounreay, Hifar in Australia, the Dido type at Julich, W. Germany and the Pluto type at Riso, Denmark). D₂O moderated and enriched uranium-fueled Daphne consists of an aluminum reactor vessel into which lattice plates, fuel and thimbles can be loaded to mock-up either a Dido or a Pluto core arrangement. In addition to its primary function as an auxiliary to the high flux reactors, Daphne can be used for fundamental studies of the reactor physics of high neutron leakage D₂O systems, and for experiments on reactor kinetics. Improved methods of flux measurement and neutron spectrometry will also be tried out in Daphne.

17323

John E. Crawford, U. S. Bureau of Mines, Washington, D. C.
BUREAU OF MINES WILL HAVE VERSATILE COBALT-60 INSTALLATION
Nucleonics, 20, (5), May, 1962, pp 100-103

Begun in 1960, the 132,000-curie Cobalt-60 irradiation facility now nearing completion at the Albany (Oregon) Metallurgy Research Center provides the Bureau of Mines with the first high-intensity gamma irradiator devoted solely to research for the minerals industries. The facility includes a large irradiation cell equipped with two viewing windows and two pairs of master-slave manipulators and a 17-ft well for storage of the Cobalt-60. Twenty-four pre-irradiation encapsulated slugs, activated to ~5,500 curies/slug at Savannah River, will be used in a 30-in long x 15 in. dia cylindrical array to give dose rates as large as 10⁷ r/hr.

17350

R. A. Cameron, Jr., R. A. Williamson, and R.H.F.
Boothe
EVALUATION OF NUCLEAR BLAST EFFECTS ON AEC TEST-
SITE FACILITIES (Parts I, II, and III)
Holmes & Narver, Inc., Los Angeles, Calif.,
May 15, 1962, Operation Plumbbob, May-Oct., 1957,
164 pp
Avail: OTS

The objective of the studies was to obtain information of value for the design of blast-resistant structures. The project was divided into the three parts: Measurements of Retaining-Wall Displacements, Measurements of Tower Displacements, and Measurements on Underground Rigid Structures and Bell Covers.

17367

Michael Getler
N. Y. MAY GET NUCLEAR TEST FACILITY
Missiles and Rockets, 10, (25), June 18, 1962, p 36

A decision should be forthcoming next month on the establishment of a nuclear test and research facility in New York State. Three types of pulse reactors are known to be under study - The "Super Godiva" or Health Physics Research Reactor now in use at the Oak Ridge National Laboratory, Super TRIGA Reactor, and a new device based on advanced specifications supplied by the Defense Atomic Support Agency (DASA) through Ft. Monmouth.

17529

Rolland W. Ahrens and Edward J. Boudreaux
DESIGN OF A COBALT-60 IRRADIATION FACILITY
E. I. du Pont de Nemours & Co., Savannah River Lab.,
Aiken, S. C., DP-708, March, 1962, AT (07-2)-1,
12 pp
Avail: OTS

An underwater irradiation facility was designed and built for the study of the effects of gamma radiation on various materials. Radiation fields of reasonable uniformity and with intensities up to 2.2×10^6 r/hr are provided by 11,500 curies of Cobalt-60. Test samples up to 3 inches in diameter and 6 inches long can be irradiated in a uniform field.

17622

William D. Burnett, Harold L. Rarrick, George E. Tucker,
and Milton W. Tucker
HEALTH PHYSICS ASPECTS OF THE START-UP AND OPERATION OF
THE SANDIA PULSED REACTOR FACILITY (SPRAF)
Sandia Corp., Albuquerque, N. M., SC-4680(M), May, 1962,
21 pp

This report describes unusual health physics problems, such as shielding modifications required, encountered with start-up and operation of the Sandia pulsed reactor. Included are: (1) integral radiation doses received from primary and scattered neutron radiation; (2) gamma radiation doses resulting from fission products in the reactor itself; and (3) neutron-induced radioactivities in the air, walls, and floor of the reactor building. Also listed are present health physics procedures and personnel dose histories.

17628

R. E. Heffner, E. L. Morris, D. T. Jones, D. R. Seaman,
and M. K. Shane
SPERT IV FACILITY
Phillips Petroleum Co., Idaho Falls, Idaho, IDO-16745,
Feb. 22, 1962, AT(10-1)-205, 138 pp
Avail: OTS

The Special Power Excursion Reactor Test IV (Spert IV) reactor is a swimming-pool type nuclear research reactor which has been constructed to provide a facility for conducting reactor kinetic behavior and safety investigations especially in the field of reactor stability. The facility has been designed to incorporate a wide range of flexibility in flow rates and direction of flow, and has a heat removal capacity of 1 Mw thermal in addition to the heat sink capacity of the reactor pools. This report describes the engineering features of the reactor and supporting process equipment as constructed at the National Reactor Testing Station.

17652

A. M. Liebschutz, Lockheed-Georgia Co., Georgia
Nuclear Labs., Dawsonville, Ga.

MATERIALS TESTING AT CRYOGENIC TEMPERATURES IN A
NUCLEAR REACTOR

Paper presented at the AIEE Summer General Meeting,
Denver, Colo., June 17-22, 1962, 10 pp

Avail: AIEE as CP-62-1075

Beginning in December 1959, under Contract NASw-114 with the Flight Development Division of the National Aeronautics and Space Administration, Lockheed has planned and is executing an experimental program for determining the mechanical properties of materials at cryogenic temperatures under nuclear reactor irradiation. This program is in three parts: correlation testing, screening testing, and an intensive final test program. To date no combined cryogenic and radiation testing has been conducted.

SPACE

17271

John C. New

SCIENTIFIC SATELLITES AND THE SPACE ENVIRONMENT

Goddard Space Flight Center, Greenbelt, Md., NASA-TN-D-1340,
June, 1962, 22 pp

The general characteristics of the space environment, such as atmospheric structures, particles, and fields, are discussed. Major findings from satellites, such as the discovery of the Van Allen belts, the pear shape of the earth, and effects of solar radiation pressure, are briefly surveyed.

17278

Eugene M. Hart, Cornell Aeronautical Lab., Inc.,
Buffalo, N. Y.

EFFECTS OF OUTER-SPACE ENVIRONMENT IMPORTANT TO SIMULATION
OF SPACE VEHICLES

Wright-Patterson AFB, Behavioral Sciences Lab., Aeronautical
Systems Div., O., ASD-TR-61-201, Aug., 1961, Tech. Rpt.,
AF 33(616)-6858, 106 pp

Avail: ASTIA, AD 269014, OTS

The results of a literature survey undertaken to define the effects of the outer-space environment important to the simulation of space vehicles are presented. Only the natural environment of space is considered and the survey is limited to

the solar system with particular emphasis on the region in the near vicinity of the earth-moon system and at heights greater than 80 kilometers above the earth's surface. To specify those effects that need to be incorporated into a space training simulator, the exterior environment, its effects on the vehicle and crew, and the malfunctions that may result must be determined. These subjects are treated along with a consideration of the adequacy of the existing data in the study.

17279

P. D. Gray, N. A. Williams, R. G. Sandoval, G. K. Cornelius,
J. D. O'Donnell, and R. A. Brass
ROCKETS IN SPACE ENVIRONMENT PHASE I: PARAMETER STUDY
Aerojet-General Corp., Space Propulsion Division,
Azusa, Calif., AGC-2112, Oct. 27, 1961, Phase Rpt.,
June 30 - Sept. 30, 1961, AF 04(611)-7441, 120 pp

Environmental factors constituting the space environment between 300 and 22,000 n.mi altitude were defined. The propulsion-system materials and components most likely to be exposed to this environment were established, and available data regarding the behavior of these materials in the space environment were surveyed. Deficiencies in these data were determined, and appropriated tests were planned for obtaining data now lacking.

17283

SURVEY OF FACILITIES FOR SPACE ENVIRONMENT SIMULATION
Aerospace Industries Association of America, Inc.,
Aerospace Research and Testing Committee, Washington,
D. C., ARTC-6-60, April, 1962, Summary Rpt., 200 pp
Avail: NSA, Washington, D. C.

This report presents a compilation of the data received from the Project 6-60 survey. The main body of the report is separated into 11 sections in an attempt to best explain the function of specific equipment for space environmental simulation. When practical, a summary table has been added to the section giving general characteristics of the equipment. Sections are included on high vacuum, high temperature test facilities, hypersonic performance, acoustic, test facilities, vibration, systems simulators, human factors, radiation simulation, and general environmental test facilities.

17288

DESIGN CRITERIA FOR RADIATION RESISTANT FLIGHT CONTROL
SYSTEMS FOR AEROSPACE VEHICLES
Northrop Corporation, Norair Division, Hawthorne, Calif.,
April 24, 1962, Prog. Rpt., Feb. 1 - March 1, 1962,
AF 33(657)-7851, 8 pp
Avail: ASTIA

The main emphasis during this report period was on the definition of space radiation environment and specification of the flight control system to be studied.

17293

J. T. Bevans, E. E. Luedke, K. E. Nelson, and D. A. Russell

AN INVESTIGATION OF THE THERMAL RADIATION PROPERTIES OF CERTAIN SPACECRAFT MATERIALS

Thompson Ramo Wooldridge, Inc., Space Technology Labs.,
Inc., Redondo Beach, Calif., STL-8633-6005-SU-000,
April 16, 1962, Prog. Rpt., Period ending April 1, 1962,
NAS5-1102, 26 pp

The work has been directed toward developing coatings with useful reproducible thermal radiation properties for anodized aluminum alloys and similar coatings for other substrates, e.g., titanium. A set of 12 alloys and sulfuric anodized coating combinations are being evaluated and illustrative data is presented for the 5557 aluminum alloy. Results for high α / ϵ coatings on titanium and stainless are also presented. Initial ultraviolet and vacuum degradation tests have shown sulfuric anodize to be seriously affected by this specific test environment and a significant portion of the remaining effort of the program will be oriented towards indicating the important variables in this degradation.

17297

C. O. Matthews and W. L. Finch
REPORT ON THE LMSC SPACECRAFT MATERIALS RELIABILITY PROGRAM

Lockheed Missiles & Space Company, Sunnyvale, Calif.,
May 7, 1962, AF 04(647)-787, 71 pp

The environment of space and the reliability of engineering materials for use in spacecraft have been under investigation in the LMSC Research Laboratories for several years. An environmental model has been established, vehicle requirements surveyed, material development and testing conducted in specialized facilities, and specifications and handbook data prepared. This integrated program has been concerned with three primary areas encompassing materials for thermal control, mechanisms, and electrical functions. Therefore, in this review of the work, information is summarized on the applicable spacecraft environment, spacecraft materials requirements, the evaluation of environmental effects on materials, and the selection of promising materials. A spectrum of materials is covered, including surface coatings and finishes, optics and filters, lubricants, sliding electrical contacts, adhesives, seals, electronics component materials, antennas, solar cells, and infrared detectors. Both laboratory and on-orbit testing are in progress in support of space systems programs.

17300

FRICITION AND LUBRICATION OF SPACE MATERIALS
Materials in Design Engineering, 55, (5), May, 1962,
pp 150-154

This article is a generalized summary of a number of research reports on space friction problems, including high wear conditions, the tendency of sliding parts to fuse together, and the evaporation of lubricants. This article deals with the effects of vacuum only, not of any other space environment conditions.

17324

D. W. Swift, AVCO Corp.
THE EFFECT OF SOLAR X-RAYS ON THE IONOSPHERE
Journal of Atmospheric and Terrestrial Physics, 23,
Dec., 1961, pp 29-56

Quite often a large solar flare is accompanied by a Sudden Ionospheric Disturbance (SID) in which the electron density of the D region undergoes a rapid increase in a matter of minutes. The altitudes for peak production range from 95 km for 1 kev X-rays down to 60 km for 9 kev X-rays. Recent solar X-ray measurements are discussed and used for computing electron densities. Finally the computed electron distributions are compared with data deduced from ionospheric measurements.

17333

Harold H. Hormann, James H. Weaver, and James J. Mattice
IMPROVED COATINGS FOR TEMPERATURE CONTROL IN A SPACE
ENVIRONMENT
Wright-Patterson AFB, Aeronautical Systems Division,
O., May, 1962, Paper presented at the National
Symposium on The Effects of Space Environment On
Materials, St. Louis, Mo., May 7-9, 1962, 57 pp

A flat white TiO₂ pigmented silicone alkyd coating showed good vacuum-thermal and ultraviolet radiation stability. A wide range of τ/ϵ values based upon this coating (.20-.85) are available for various temperature control conditions. Weight loss and change in η_s in the TiO₂ and ZnS pigmented silicone alkyd systems show good stability up to 500 F. Of the two, the TiO₂ pigmented system is the more promising for use in a vacuum-thermal environment.

17346

Henry E. Frankel
A CRITICAL APPRAISAL OF MATERIALS TESTING
NASA, Goddard Space Flight Center, Greenbelt, Md.,
March 23, 1962, Paper presented at the National
Symposium on The Effects of Space Environment On
Materials, St. Louis, Mo., May 7-9, 1962, 13 pp

A continuing evaluation of the types of tests conducted under the generic title "Effect of Space Environment on Materials", leads one to the conclusion that perhaps a great deal of effort is being expended without much return for this expenditure. The most prevalent type of testing being carried out is best described as a "before exposure - after exposure" experiment, with the specimens generally being tested in an "earthly" atmosphere after exposure to the space environment. As a consequence, the true effects of a space environment on materials are not known. Examples illustrating the comparative effects of testing in a "space environment" as opposed to testing in a laboratory after exposure are presented.

17347

Harold E. Evans and Thomas W. Flatley
BEARINGS FOR VACUUM OPERATION - PHASE I
NASA, Goddard Space Flight Center, March 26, 1962,
Paper presented at the National Symposium on The
Effects of Space Environment On Materials, St.
Louis, Mo., May 7-9, 1962, 30 pp

The results show that thin metallic films as lubricants show real promise when used in a vacuum environment, pure gold plating is not as effective as the plating with additives, fully machined retainers provide good performance, relatively hard retainer materials significantly extend the useful life of the bearings, and the bearing failures tended to be catastrophic rather than gradual making the prediction of the onset of failure difficult.

17348

A. V. Montgomery, Jr.
EFFECT OF SPACE ON MAN
McDonnell Aircraft Corporation, May 8, 1962, Paper
Presented at the National Symposium on The Effects
of Space Environment On Materials, St. Louis, Mo.,
May 7-9, 1962, 8 pp

A few principles involved in the definition of a spacecraft environment are outlined and exemplified. These principles involve individual variations, duration of stimulus, discrete range of acceptability, and interactive effects between simultaneously applied environmental factors.

17620

R. K. Wilson, R. A. Miller, and R. L. Kloster
A STUDY OF SPACE RADIATION SHIELDING PROBLEMS FOR
MANNED VEHICLES
General Dynamics/Fort Worth, Fort Worth, Tex., FZK-144,
June 8, 1962, NAS5-1093, 201 pp

The resolution of the problem of protecting space vehicle crews from charged particles of either solar-flare or trapped radiation origin will probably depend upon some sort of shielding. The basic problem is concerned with determining quantitatively the attenuation requirement of the incident radiation and selecting an appropriate material to provide this shielding. The discussion given includes the hazards of space radiation, the methods of dose calculation, the development of a proton penetration procedure, a summary of cross section data, and the results of shielding calculations - with particular emphasis on contributions to the dose from secondary radiation.

17633

Thomas W. Flatley and Harold E. Evans
THE DEVELOPMENT OF THE ELECTRIC FIELD METER FOR THE
EXPLORER VIII SATELLITE [1960]
NASA-Goddard Space Flight Center, Greenbelt, Md.,
NASA-TN-D-1044, April, 1962, 35 pp

The electric field meter (EFM) was one of the sensors flown in the Explorer VIII satellite launched on November 3, 1960. The EFM, located on the spin axis of the payload, was designed to measure the strength of the electrostatic field caused by the ion sheath surrounding the satellite. Since the sensor required dc motor elements to operate in an ionospheric vacuum, methods were sought to avoid the catastrophic wear rate of standard commercial commutator brushes and ball bearings in a vacuum environment. After an extensive test program, gold-plated stainless steel ball bearings and carbon brushes with a molybdenum disulphide core lubricant were used in the EFM flight units. By using these special components, an EFM was developed with a life expectancy exceeding that of the battery power available.

17634

Henry H. Hilton, Paul H. Levine, Norbert N. Hankin,
and Francis H. Webb
MASSIVE HYPERVELOCITY PARTICLES BY ELECTRICAL MEANS
Electro-Optical Systems, Inc., Pasadena, Calif.,
EOS-Rpt-1470-Final, Nov. 13, 1961, Final Summary
Rpt., April 21, 1960 - Oct. 13, 1961, DA-04-495-ORD-2000,
146 pp

The program has been concerned with the investigation of techniques for obtaining hypervelocity particles by electrical means. The goals have been (1) to electrically explode conducting materials under suitable conditions to create a plasma of very high density where an appreciable fraction of the plasma is moving at a velocity above 25 km/sec using relatively small scale energy storage units; (2) to study the coupling of small projectiles weighing more than a microgram to these flows. The work under this contract has dealt only with projection techniques and the measurement of velocities of interest.

17691

Thomas W. Bailey
ELECTROSTATIC SHIELDING OF HIGH ENERGY PROTONS
Wright-Patterson AFB, Aeronautical Systems Div., Air
Force Systems Command, O., ASD-TDR-62-244, March, 1962,
Tech. Documentary Rpt., May - Dec., 1961, 17 pp
Avail: ASTIA, OTS

Electrostatic shielding was studied to determine if it should be considered for protecting manned space vehicles against solar cosmic rays. After this study, it was concluded that electrostatic shielding is feasible and that it has some advantages over other types of shields. However, considerable applied research will be necessary.

17692

W. E. Price
DESIGNER'S GUIDE TO SPACE RADIATION EFFECTS
Lockheed Aircraft Corp., Missiles and Space Div., Nuclear
Physics Dept., Sunnyvale, Calif., LMSC-5-10-61-29,
50 pp

This radiation-damage guide was compiled to aid in systems planning and engineering activities involving missions and operations in the space-radiation environment. This document also represents an effort to present a more generalized form and a declassified version of a previous LMSD classified document which covered a more specific area. A substantial portion of the work involved in the production of this volume has been done in conjunction with the MIDAS Reliability Program. This document is not available for wide spread distribution due to the effort of Lockheed personnel to insert new material as it becomes available.

This radiation-damage guide was compiled to aid in systems planning and engineering activities involving missions and operations in the space-radiation environment. This document also represents an effort to present a more generalized form and a declassified version of a previous LMSD classified document which covered a more specific area. A substantial portion of the work involved in the production of this volume has been done in conjunction with the MIDAS Reliability Program. This document is not available for wide spread distribution due to the effort of Lockheed personnel to insert new material as it becomes available.