

Third Pacific Area Meeting Papers

MATERIALS IN NUCLEAR  
APPLICATIONS



Published by the  
AMERICAN SOCIETY FOR TESTING MATERIALS  
1916 Race St., Philadelphia 3, Pa.

*ASTM Special Technical Publication No. 276*

# MATERIALS IN NUCLEAR APPLICATIONS

Symposium on Radiation Effects and Dosimetry  
Symposium on Postirradiation Effects in Polymers  
Papers on Industrial Water for Reactor Use  
Symposium on Ceramics in Nuclear Energy

---

Presented at the  
THIRD PACIFIC AREA NATIONAL MEETING  
AMERICAN SOCIETY FOR TESTING MATERIALS  
San Francisco, Calif., October 12, 14, 15, and 16, 1959



Reg. U. S. Pat. Off.

---

*ASTM Special Technical Publication No. 276*

---

Price \$8.25; to Members \$6.60

Published by the  
AMERICAN SOCIETY FOR TESTING MATERIALS  
1916 Race St., Philadelphia 3, Pa.

---

NOTE.—The Society is not responsible, as a body, for the statements  
and opinions advanced in this publication.

---

©BY AMERICAN SOCIETY FOR TESTING MATERIALS  
Library of Congress Catalog Card Number: 60-14734

---

Printed in Baltimore, Md.  
June, 1960

## FOREWORD

---

Interest continues in radiation effects on all materials that come into contact with ionizing radiation, whether in nuclear reactors or at the higher altitudes reached by missiles and modern aircraft. Design engineers must know the changes in properties of metals, plastics, ceramics, and refractories before constructing reactors and accessory equipment. Also, there is a great emphasis on standardization of dosimetry units and techniques to facilitate the correlation of results obtained by engineers throughout the world.

To meet this need, three symposia presented at the Third Pacific Area National Meeting of the Society have been combined into one volume entitled "Materials in Nuclear Applications." The symposia included are: "Radiation Effects and Dosimetry," "Postirradiation Effects in Polymers," and "Ceramics in Nuclear Energy."

In addition to the papers presented at these three symposia, a paper by Lew F. Porter on "Radiation Effects in Steels" has been included in the Symposium on Radiation Effects and Dosimetry since it is, in effect, a comprehensive review of the literature on the subject. Also included in this volume are two papers presented at the Symposium on Technical Development in the Handling and Utilization of Water and Industrial Waste Water: "Disposal of Industrial Radioactive Waste Waters at Hanford," by L. C. Schwendiman, R. E. Brown, J. F. Honstead, C. E. Linderoth, and D. W. Pearce, and "Determination of Radioactive Materials in Water," by Franklin B. Barker.

The paper on "Radiation Effects Problems in Unmanned Nuclear Propelled Vehicles," by G. L. Stiehl, Jr., from the Symposium on Radiation Effects and Dosimetry, and the paper on "Beryllium Oxide for Nuclear Applications," by J. E. Hove, from the Symposium on Ceramics in Nuclear Energy, are not included in this publication.

The Symposium on Radiation Effects and Dosimetry, sponsored by Committee E-10 on Radioisotopes and Radiation Effects, was held during three sessions on Wednesday and Thursday, October 14 and 15. Messrs. V. P. Calkins, General Electric Co., and A. N. Holden, Vallecitos Atomic Laboratory, acted as Symposium Co-Chairmen. Messrs. D. W. McLenegan, Hanford Atomic Products Operation, and G. W. Pomeroy, General Electric Co., presided over the morning session on Wednesday, while Mr. C. R. Sutton, International Nickel Co., presided over the afternoon session. At the Thursday session Messrs. E. W. Gardiner, California Research Corp., and S. Wenk, Applied Radiation Corp., presided.

The Symposium on Postirradiation Effects in Polymers, sponsored by the Joint Subcommittee II on Effects of Nuclear and High Energy Radiation of Committees D-9 on Electrical Insulating Materials and D-20 on Plastics,

was held on Friday, October 16. Mr. Donald J. Metz, Brookhaven National Laboratory, acted as Symposium Chairman; Mr. T. K. Cleveland, Philadelphia Quartz Co. of California, and Mr. Metz presided over the session.

The Symposium on Ceramics in Nuclear Energy, sponsored by Committee C-21 on Ceramic Whitewares and Related Products, was held during two sessions on Monday, October 12. Mr. J. H. Handwerk, Argonne National Laboratory, acted as Symposium Chairman; Messrs. M. C. Poulsen, Port Costa Brick Works, and E. D. Lynch, Argonne National Laboratory, presided over the morning session, while Messrs. C. R. Sutton, International Nickel Co., and R. M. Fulrath, University of California, presided over the afternoon session.

## CONTENTS

### Symposium on Radiation Effects and Dosimetry

	PAGE
Introduction—V. P. Calkins	1
The Radiochemical Determination of Uranium Burnup—Duane N. Sunderman	3
Recent Developments in Gamma Ray Dosimetry—S. I. Taimuty	9
Techniques for Measuring Reactor Neutron Spectra—J. B. Trice	18
Discussion	29
Reactor Monitoring by Calorimetry—K. Lynn Hall, Rudolf F. Klaver, James G. Carroll, and Robert O. Bolt	30
Discussion	39
Removal Dose for Monitoring Effects of X-rays and Gamma Rays—R. L. Hickmott	40
Dosimetry Nomenclature in the United States—A. N. Tschaeché	43
Dosimetry in Europe and the USSR—J. H. Guill and John Moteff	56
Effects of Gamma Radiation on Some Electrical Properties of TFE-Fluorocarbon Plastics—W. E. Loy, Jr.	68
Discussion	78
Standardization of Terminology for Gamma and Electron Beam Radiation Sources—George E. Danald	79
Atomistic Interpretation of Radiation Effects in Metals—A. Sosin	83
Irradiation of Some Pressure-Vessel Steels—L. P. Trudeau	102
Discussion	114
Neutron Radiation Embrittlement at 500 and 650 F of Reactor Pressure Vessel Steels—J. V. Alger and L. M. Skupien	116
Discussion	135
Dynamic Radiation Effects Testing Methods—D. M. Newell, E. E. Kerlin, R. R. Bauerlein, and R. F. Barrows	137
Radiation Effects in Steel—Lew F. Porter	147

### Symposium on Postirradiation Effects in Polymers

Introduction—Donald J. Metz	199
The Significance to ASTM of Postirradiation Effects in Irradiated Materials—D. S. Ballantine	201
Electron Spin Resonance Studies of Free Radicals in Irradiated Materials—Leo A. Wall	208
Postirradiation Oxidation and Molecular Weight Changes in Polystyrene and Poly-(Methyl Methacrylate)—W. W. Parkinson and D. Binder	224
Postirradiation Dielectric Properties of Silicones—C. G. Curran	233
Postirradiation Effects: Monomers and Polymers—E. F. Degering, G. J. Caldarella, and M. Mancini	244

### Papers on Industrial Water for Reactor Use

Disposal of Industrial Radioactive Waste Waters at Hanford—L. C. Schwendiman, R. E. Brown, J. F. Honstead, C. E. Linderoth, and D. W. Pearce	259
Discussion	275
Determination of Radioactive Materials in Water—Franklin B. Barker	278
Discussion	287

### Symposium on Ceramics in Nuclear Energy

Introduction—J. H. Handwerk	291
Some Refractory Uranium Compounds—Preparation and Properties—M. J. Snyder and A. B. Tripler, Jr.	293
Dry Pressing Ceramic Fuel Elements to Close Tolerances—F. J. Hartwig	301

	PAGE
Fabrication and Evaluation of Urania-Alumina Fuel Elements and Boron Carbide Burnable Poison Elements—L. G. Wisnyi and K. M. Taylor.....	311
Silicon Carbide Clad Graphite Matrix Fuel Elements—K. M. Taylor and C. H. Mc- Murty.....	318
Graphite as a Fuel Matrix—William C. Riley.....	324
Fabrication of $U_3O_8$ -Aluminum Dispersion Fuel Elements by Extrusion—R. A. Noland, D. E. Walker, and L. C. Hymes.....	336

