

*The Use of
Small-Scale Specimens
for Testing
Irradiated Material*



ASTM STP 888

Corwin/Lucas
EDITORS

The Use of Small-Scale Specimens for Testing Irradiated Material

A symposium
sponsored by
ASTM Committee E-10
on Nuclear Technology
and Applications
Albuquerque, N.M., 23 Sept. 1983

ASTM SPECIAL TECHNICAL PUBLICATION 888
W. R. Corwin, Oak Ridge National Laboratory,
and G. E. Lucas, University of California –
Santa Barbara, editors

ASTM Publication Code Number (PCN)
04-888000-35



1916 Race Street, Philadelphia, Pa. 19103

Library of Congress Cataloging-in-Publication Data

The Use of small-scale specimens for testing irradiated material.

(ASTM special technical publication; 888)

"A symposium sponsored by ASTM Committee E-10 on Nuclear Technology and Applications, Albuquerque, N.M., 23 Sept. 1983."

Includes bibliographies and index.

1. Materials—Effect of radiation on—Testing—
Congresses. I. Corwin, W. R. II. Lucas, Glenn E.,
1951— III. ASTM Committee on Nuclear Technology
and Applications. IV. Series.

TA418.6.U84 1986 620.1'1228 85-27487

ISBN 0-8031-0440-5

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1986
Library of Congress Catalog Card Number: 85-27487

NOTE

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

Foreword

The ASTM Symposium on The Use of Nonstandard Subsize Specimens for Irradiated Testing was held in Albuquerque, New Mexico, on 23 September 1983. Its sponsor was ASTM Committee E-10 on Nuclear Technology and Applications. W. R. Corwin, Oak Ridge National Laboratory, and G. E. Lucas, University of California - Santa Barbara, served as symposium chairmen and have edited this publication.

The title of this volume has been changed slightly from that of the symposium.

Related ASTM Publications

Effects of Radiation on Materials—12th International Symposium, STP 870 (1985), 04-870000-35

Zirconium in the Nuclear Industry: Sixth International Symposium, STP 824 (1984), 04-824000-35

Radiation Embrittlement and Surveillance of Nuclear Reactor Pressure Vessels: An International Study, STP 819 (1983), 04-819000-35

Creep of Zirconium Alloys in Nuclear Reactors, STP 815 (1983), 04-815000-35

Status of USA Nuclear Reactor Pressure Vessel Surveillance for Radiation Effects, STP 784 (1982), 04-784000-35

Effects of Radiation on Materials—11th International Symposium, STP 782 (1982), 04-782000-35

Effects of Radiation on Materials—10th International Symposium, STP 725 (1981), 04-725000-35

Irradiation Effects on Structural Alloys for Nuclear Reactor Applications, STP 484 (1971), 04-484000-35

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

ASTM Committee on Publications

ASTM Editorial Staff

**Allan S. Kleinberg
Janet R. Schroeder
Kathleen A. Greene
Bill Benzing**

Contents

Introduction	1
 STRENGTH AND DUCTILITY	
Use of the Disk Bend Test to Assess Irradiation Performance of Structural Alloys—M. L. HAMILTON AND F. H. HUANG	5
Miniaturized Disk Bend Test Technique Development and Application—M. P. MANAHAN, A. E. BROWNING, A. S. ARGON, AND O. K. HARLING	17
The MIT Miniaturized Disk Bend Test—O. K. HARLING, M. LEE, D-S SOHN, G. KOHSE, AND C. W. LAU	50
Disk-Bend Ductility Tests for Irradiated Materials—R. L. KLUEH AND D. N. BRASKI	66
General Discussion: Miniaturized Disk Bend Test	83
Development of Small Punch Tests for Ductile-Brittle Transition Temperature Measurement of Temper Embrittled Ni-Cr Steels—J.-M. BAIK, J. KAMEDA, AND O. BUCK	92
Discussion	110
Shear Punch and Microhardness Tests for Strength and Ductility Measurements—G. E. LUCAS, G. R. ODETTE, AND J. W. SHECKHERD	112
Discussion	139
Low-Load Microhardness Changes in 14-MeV Neutron Irradiated Copper Alloys—S. J. ZINKLE AND G. L. KULCINSKI	141
Discussion	159

Effects of Specimen Thickness and Grain Size on the Mechanical Properties of Types 304 and 316 Austenitic Stainless Steel— N. IGATA, K. MIYAHARA, T. UDA, AND S. ASADA	161
Failure Strain for Irradiated Zircaloy Based on Subsize Specimen Testing and Analysis— R. B. ADAMSON, S. B. WISNER, R. P. TUCKER, AND R. A. RAND	171
Discussion	185
Wire Tensile Testing for Radiation-Hardening Experiments— E. R. BRADLEY AND R. H. JONES	186
Discussion	200
Design and Use of Nonstandard Tensile Specimens for Irradiated Materials Testing— N. F. PANAYOTOU, S. D. ATKIN, R. J. PUIGH, AND B. A. CHIN	201
Discussion	219
Comparison of Mechanical Properties in Thin Specimens of Stainless Steel with Bulk Material Behavior— D. G. RICKERBY, P. FENICI, P. JUNG, G. PIATTI, AND P. SCHILLER	220
Discussion	231
A Miniaturized Mechanical Testing System for Small-Scale Specimen Testing— S.-P. HANNULA, J. WANAGEL, AND C.-Y. LI	233
Discussion	250
Post-Irradiation Creep Properties of Cold-Worked 316 Stainless Steel As Measured with Small Creep Specimens— W. VANDERMEULEN, M. SNYKERS, AND PH. VAN ASBROECK	252

FATIGUE AND FRACTURE

Miniature Center-Cracked-Tension Specimen for Fatigue Crack Growth Testing— A. M. ERMI AND L. A. JAMES	261
Use of Subsize Fatigue Specimens for Reactor Irradiation Testing— K. C. LIU AND M. L. GROSSBECK	276
Discussion	289
Use of Subsize Specimens for Evaluating the Fracture Toughness of Irradiated Materials— F. H. HUANG	290
Discussion	303

Subsized Bend and Charpy V-Notch Specimens for Irradiated Testing —G. E. LUCAS, G. R. ODETTE, J. W. SHECKHERD, P. McCONNELL, AND J. PERRIN	305
Discussion	324
Effect of Specimen Size and Material Condition on the Charpy Impact Properties of 9Cr-1Mo-V-Nb Steel —W. R. CORWIN AND A. M. HOUGLAND	325
Discussion	337
Specimen-Size Considerations in Crack-Arrest Testing of Irradiated RPV Steels —C. W. MARSCHALL, A. R. ROSENFELD, AND M. P. LANDOW	339
Experience in Subsized Specimen Testing —P. McCONNELL, J. W. SHECKHERD, J. S. PERRIN, AND R. A. WULLAERT	353
Summary	369
Index	371

ISBN 0-8031-0440-5