

Zirconium Production and Technology:



The Kroll Medal Papers 1975-2010

Editor:
Ronald B. Adamson

RPS2

Zirconium Production and Technology: The Kroll Medal Papers 1975–2010

Ronald B. Adamson, Editor

ASTM Stock Number: RPS2



ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in the U.S.A.

Library of Congress Cataloging-in-Publication Data

Zirconium production and technology : the Kroll Medal papers, 1975–2010
/ Ronald B. Adamson, editor.

p. cm.

“ASTM stock number: RPS2.”

Includes bibliographical references.

ISBN 978-0-8031-7018-6

1. Zirconium. 2. Zirconium—Research—Awards. I. Adamson, Ronald B.

QD181.Z7Z57 2010

620.1'89352—dc22

2010035156

Copyright © 2010 ASTM International, West Conshohocken, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use of specific clients, is granted by ASTM International provided that the appropriate fee is paid to ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9634; online:<http://www.astm.org/copyright/>

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

ASTM International does not endorse any products represented in this publication.

Printed in Baltimore, MD
November, 2010

DEDICATION

For the recipients of the Kroll Zirconium Medal, past and future.

ACKNOWLEDGEMENT

The editor gratefully acknowledges the efforts and contributions of the Kroll Medal Selection Committee, the ASTM International B10 Committee, with special thanks to John Bates, and the ASTM International staff particularly Kathy Dernoga for facilitating publication of this Retrospective Publication Series book.

FOREWORD

This Retrospective Publication Series (RPS2) contains papers and speeches from the Kroll Award recipients from the first award in 1975 to 2010. The publisher or copyright holder of the original paper and where it was originally published are noted on the divider page preceding each paper. Where possible, the original pagination is maintained throughout this volume to preserve the look of these original works. However, you will note the new running heads and pagination were added above the rule on each page to distinguish the pages of this RPS2 from those of the original papers.

This book, edited by Ronald B. Adamson, Zircology Plus, Fremont, CA, is sponsored by Committee B10 on Reactive and Refractory Metals and Alloys and is the second book in the ASTM Retrospective Publication Series.

TABLE OF CONTENTS

Introduction	1
The Decision to Use Zirconium in Nuclear Reactors, Admiral H. G. Rickover	9
Towards an Understanding of Zirconium Alloy Corrosion, B. Cox	21
Zirconium Technology—Twenty Years of Evolution, B. Lustman	41
Extractive Metallurgy of Zirconium—1945 to the Present, W. W. Stephens	57
Anisotropy in Zircaloy, M. L. Picklesimer	91
Mechanistic Modeling of Zircaloy Deformation and Fracture in Fuel Element Analysis, F. A. Nichols	105
Zirconium Activities in Europe: 1945–1984, R. P. Syre	125
Forty-One Years with Zirconium, Y. Mishima	139
The Origins of the Discovery of the New Cezus Process for Separating Zirconium and Hafnium by Extractive Distillation, J. Guerin, P. Besson, and P. Brun	149
The Irradiation Creep and Growth Phenomena, V. Fidleris	155
Metal Science Aspects of Zirconium-Base Reactor Material Production in the Soviet Union, A. V. Nikulina	179
Development of Zirconium-Barrier Fuel Cladding, J. S. Armijo, L. F. Coffin, and H. S. Rosenbaum	197
Zirconium Alloy Performance in Light Water Reactors: A Review of UK and Scandinavian Experience, D. O. Pickman	215
Learning from History: A Case Study in Nuclear Fuel, J. A. L. Robertson	231
Behavior and Properties of Zircaloys in Power Reactors: A Short Review of Pertinent, Aspects in LWR Fuel, F. Garzarolli, H. Stehle, and E. Steinberg	243
Effects of Neutron Irradiation on Microstructure and Properties of Zircaloy, R. B. Adamson	267
Understanding Hydrogen in Zirconium, A. Sawatzky and C. E. Ells	287
Microstructure and Properties of Zirconium Alloys in the Absence of Irradiation, D. Charquet	307
Simulating the Behavior of Zirconium-Alloy Components in Nuclear Reactors, C. E. Coleman	321
Physical Phenomena Concerning Corrosion Under Irradiation of Zr Alloys, C. Lemaignan	341
Evolution of the Beta-Quench Process: Kroll Medal Award Presentation, 2001, J. H. Schemel	353
ZIRLO™—An Alloy Development Success, G. P. Sabol	359

Review of Deformation Mechanisms, Texture, and Mechanical Anisotropy in Zirconium and Zirconium Base Alloys, E. Tenckhoff	383
In-Reactor Deformation of Zirconium Alloy Components, R. A. Holt	411
Microstructure Evolution in Zr Alloys during Irradiation: Dose, Dose Rate, and Impurity Dependence, M. Griffiths	429
Zirconium Corrosion Resistance: Key to Success of the Methanol Carbonylation Acetic Acid Process, B. J. Sanders.	439
Explosion Cladding: An Enabling Technology for Zirconium in the Chemical Process Industry, J. G. Banker	449
Performance of Zirconium Alloys in Light Water Reactors with a Review of Nodular Corrosion, D. G. Franklin	461
The Evolution of Microstructure and Deformation Stability in Zr-Nb-(Sn,Fe) Alloys Under Neutron Irradiation, V. N. Shishov.	479
The Development of Zr-2.5Nb Pressure Tubes for CANDU Reactors, B. A. Cheadle.	503



www.astm.org

Stock #: RPS2

ISBN#: 978-0-8031- 7018-6