

# **Materials in Clean Power Systems: Applications, Corrosion, and Protection**

# **Materials in Clean Power Systems: Applications, Corrosion, and Protection**

Edited by  
**Z. Gary Yang**  
**K. Scott Weil**  
**Michael P. Brady**

Symposium Sponsored by  
the Corrosion and Environmental Effects Committee of  
the Structural Materials Division (SMD) of  
TMS (The Minerals, Metals & Materials Society)

Held during the  
TMS 2006 Annual Meeting in  
San Antonio, Texas, USA  
March 12-16, 2006

A Publication of  
**TMS**

A Publication of **TMS (The Minerals, Metals & Materials Society)**  
184 Thorn Hill Road  
Warrendale, Pennsylvania 15086-7528  
(724) 776-9000

Visit the TMS web site at  
<http://www.tms.org>

Statements of fact and opinion are the responsibility of the authors alone and do not imply an opinion on the part of the officers, staff, or members of TMS, The Minerals, Metals, and Materials Society. TMS assumes no responsibility for the statements and opinions advanced by the contributors to its publications or by the speakers at its programs. Registered names and trademarks, etc., used in this publication, even without specific indication thereof, are not be considered unprotected by the law.

No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the publisher.

Printed in the United States of America  
Library of Congress 2006920379  
**ISBN: 978-0-87339-621-9**

Authorization to photocopy for internal or personal use beyond the limits of Sections 107 and 108 of the U.S. Copyright Law is granted by TMS, provided that the base fee of \$7.00 per copy is paid directly to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923 USA, [www.copyright.com](http://www.copyright.com). Prior to photocopying items for educational classroom use, please contact the Copyright Clearance Center, Inc.

For those organizations that have been granted a photocopy license by the Copyright Clearance Center, a separate system of payment has been arranged.

This consent does not extend to copying items for general distribution or for advertising or promotional purposes or to republishing items whole or in part in any work in any format.

Please direct republication or special copying permission requests to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923 USA; (978) 750-8400; [www.copyright.com](http://www.copyright.com).

The logo for The Minerals, Metals, and Materials Society (TMS) consists of the letters 'TMS' in a large, bold, black, sans-serif font. The letters are closely spaced and have a slightly irregular, hand-drawn appearance.

Copyright 2006, The Minerals, Metals, and  
Materials Society. All rights reserved.

If you are interested in purchasing a copy of this book, or if you would like to receive the latest TMS publications catalog, please telephone (800) 759-4867 (U.S. only) or (724) 776-9000, EXT. 270.

# Table of Contents

## Hydrogen Transport and Separation

Co-Synthesis of Mixed Conducting Composites for Hydrogen Separation: Compositional Considerations .....	3
<i>J.S. Hardy, N.L. Canfield, J.V. Crum, A. Bandyopadhyay, K.S. Weil, and L.R. Pederson</i>	

## Hydrogen Separation, Delivery, and Materials Issues in Clean Power Plants

Inorganic Membranes for Energy-Related Gas and Water Purification.....	15
<i>H. Venveij</i>	
Hydrogen-Rich Gas Production From Gasoline in a Short Contact Time Catalytic Reactor .....	25
<i>L. Bobrova, I. Zolotarsky, V. Sadykov, and V. Sobyenin</i>	

## Corrosion in Clean Coal Power Plants and Fuel Cells

Deposition of Al-Si Metallic Coating Precursor on Mo-Si-B Turbine Materials.....	39
<i>J.E. Jackson, D.L. Olson, B. Mishra, and I.M. Solomon</i>	
Anomalous Oxidation of Ferritic Stainless Steels in Air/Hydrogen Fuel Dual Environments .....	49
<i>Z. Yang, P. Singh, J.W. Stevenson, and G.-G. Xia</i>	

## Interconnection and Sealing in Fuel Cells I

Oxidation Behavior of Fe-Cr-Al Alloy: Metallic Interconnects for Solid Oxide Fuel Cell Applications .....	61
<i>V. Kamavaram, Q. Zheng, and R.G. Reddy</i>	
Effect of Ceramic Coating on Chemical Stability of a Composite Seal for Solid Oxide Fuel Cells .....	71
<i>S. Narasimhan, K. Ridgeway, and X. Huang</i>	

## **Interconnection and Sealing in Fuel Cells II**

Development of $(\text{Mn,Co})_3\text{O}_4$ Protection Layers on Ferritic Stainless Steels for SOFC Interconnect Applications .....	81
<i>Z. Yang, X. Li, P. Singh, J.W. Stevenson, G. Xia, and X. Zhou</i>	

## **Interconnection and Sealing in Fuel Cells III**

Effect of Cathode and Electrolyte Transport Properties on Chromium Poisoning in Solid Oxide Fuel Cells .....	93
<i>J.W. Fergus</i>	
Author Index .....	103
Subject Index .....	105

# Author Index

## B

Bandyopadhyay, A., 3  
Bobrova, L., 25

## C

Canfield, N.L., 3  
Crum, J.V., 3

## F

Fergus, J.W., 93

## H

Hardy, J.S., 3  
Huang, X., 71

## J

Jackson, J.E., 39

## K

Kamavaram, V., 61

## L

Li, X., 81

## M

Mishra, B., 39

## N

Narasimhan, S., 71

## O

Olson, D.L., 39

## P

Pederson, L.R., 3

## R

Reddy, R.G., 61  
Ridgeway, K., 71

## S

Sadykov, V., 25  
Singh, P., 49, 81  
Sobyanin, V., 25  
Solomon, I.M., 39  
Stevenson, J.W., 49, 81

## V

Venveij, H., 15

## W

Weil, K.S., 3

## X

Xia, G., 49, 81

## Y

Yang, Z., 49, 81

## Z

Zheng, Q., 61  
Zhou, X., 81  
Zolotarsky, I., 25

# Subject Index

## C

**Cathode Poisoning**, 93  
**Cerate**, 3  
**Cermet**, 3  
**Chemical Compatibility**, 71  
**Colloidal Processing**, 15  
**Composite**, 3  
**Composite Seal**, 71

## F

**Fe-Cr-Al Alloy**, 61

## G

**Gas Separation**, 3, 15  
**Gasoline**, 25

## H

**Hydrogen**, 3

## I

**Interconnect**, 49, 71, 81  
**Interconnect Oxidation**, 93  
**Ionic Conduction**, 3

## M

**Membrane(s)**, 3, 15  
**Monolith Reactor**, 25

## N

**Nanoscale**, 3  
**Nickel**, 3

## O

**Oxidation**, 61

## P

**Percolation**, 3  
**Proton**, 3

## S

**Sealing Glass**, 71  
**Solid Oxide Fuel Cell (SOFC)**, 49, 61, 71, 81, 93  
**Spinel Coating**, 81  
**Stainless Steel**, 49, 81  
**Syngas**, 25  
**Synthesis**, 3

## T

**Thermal Cycling**, 61

## W

**Water Purification**, 15