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Recent Developments in Oxide and Metal Epitaxy—Theory and Experiment

Editors: Mark Yeadon, Shirley Chiang, Robin F. C Farrow, James W. Evans and Orlando Auciello

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**MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 619**

Recent Developments in Oxide and Metal Epitaxy— Theory and Experiment

Symposium held April 23–26, 2000, San Francisco, California, U.S.A.

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Frontmatter
[More information](#)

CONTENTS

Dedication ix

Preface xi

Acknowledgments xiii

Materials Research Society Symposium Proceedings xiv

GROWTH AND DYNAMICS OF
METAL FILMS

*Control of Variants in Heteroepitaxy by Substrate Miscut 3
C.P. Flynn, S.M. Bonham, J.A. Eades, M. Ondrejcek, W. Swiech,
and G.L. Zhou

*Kinetic Roughening of Multilayer Ag/Ag(100) Films: Complex
Temperature-Dependence in a Simple System 15
C.R. Stoldt, K.J. Caspersen, M.C. Bartelt, C.J. Jenks, J.W. Evans,
and P.A. Thiel

Real Time Observations of Dislocation-Mediated Plasticity in the
Epitaxial Al (011)/Si(100) Thin Film System 27
Eric A. Stach, U. Dahmen, and W.D. Nix

*Spatial Correlations in Growing Films 35
M.C. Bartelt

Modeling of Metal(100) Homoepitaxial Film Growth at Very Low
Temperatures 49
K.J. Caspersen, C.R. Stoldt, P.A. Thiel, and J.W. Evans

STRUCTURE AND OXIDATION OF
METAL FILMS AND SURFACES

Observation of a New Ordered Structure of Oxygen on W(110) 57
D.E. Muzzall and S. Chiang

*Invited Paper

Cambridge University Press
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Recent Developments in Oxide and Metal Epitaxy—Theory and Experiment
Editors: Mark Yeadon, Shirley Chiang, Robin F. C Farrow, James W. Evans and Orlando Auciello
Frontmatter
[More information](#)

***Heteroepitaxy: The Missing Link Between Surface Chemistry and Dry Corrosion** 63
Judith C. Yang, Mridula Dixit Bharadwaj, and Lori Tropa

A Novel Method for True Work Function Determination of Metal Surfaces by Combined Kelvin Probe and Photoelectric Effect Measurements 73
Bert Lägél, Iain D. Baikie, Konrad Dirscherl, and Uwe Petermann

Thickness Dependent Tetragonal Relaxation of Iron in Epitaxial Fe/Pd Multilayer Films 79
T. Steffl, B. Rellinghaus, H. Mühlbauer, Ch. Müller, H. Herper, and G. Dumpich

Equilibrated Surface Alloys and the Influence of Strain 85
G.E. Thayer, V. Ozolins, A.K. Schmid, J.L. Stevens, S. Chiang, and R.Q. Hwang

Elaboration of Single Crystalline Au/Ni₈₀Fe₂₀/Cu/Ni₈₀Fe₂₀/NiO(111) Spin Valves 91
C. Mocuta, A. Barbier, S. Lafaye, and P. Bayle-Guillemaud

Reactive Cluster Epitaxy: CoSi₂ Nanoparticles on (111) Si 97
C.G. Zimmermann, M. Yeadon, M. Kleinschmit, R.S. Averbach, and J.M. Gibson

IN SITU STUDIES OF OXIDE GROWTH

***The Importance of *In Situ* Monitors in the Preparation of Layered Oxide Heterostructures by Reactive MBE** 105
D.G. Schlom, J.H. Haeni, C.D. Theis, W. Tian, X.Q. Pan, G.W. Brown, and M.E. Hawley

Oxidation Kinetics in SrTiO₃ Homoepitaxy 115
X.D. Zhu, Weidong Si, X.X. Xi, and Qidu Jiang

The Effect of Magnesium Oxide Buffer on the Epitaxial Growth of Zinc Oxide on Sapphire 123
Y.F. Chen, H.J. Ko, S.K. Hong, T. Hanada, T. Yao, and Y. Segawa

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Cambridge University Press
978-1-107-41308-5 - Materials Research Society Symposium Proceedings: Volume 619:
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Frontmatter
[More information](#)

Epitaxial Growth of Co₃O₄ Films by Low Temperature, Low Pressure Chemical Vapor Deposition	129
K. Shalini, Anil U. Mane, R. Lakshmi, S.A. Shivashankar, M. Rajeswari, and S. Choopun	
*In Situ Study of Barrier Layers Using Spectroscopic Ellipsometry and Mass Spectroscopy of Recoiled Ions	135
Y. Gao, A.H. Mueller, E.A. Irene, O. Auciello, A.R. Krauss, and J.A. Schultz	
*In Situ Real-Time Studies of Oxygen Incorporation in Complex Oxide Thin Films Using Spectroscopic Ellipsometry and Ion Scattering and Recoil Spectrometry	141
A.H. Mueller, Y. Gao, E.A. Irene, O. Auciello, A.R. Krauss, and J.A. Schultz	

EPITAXIAL GROWTH OF OXIDES

Metalorganic Molecular Beam Epitaxy of Magnesium Oxide on Silicon	149
F. Niu, B.H. Hoerman, and B.W. Wessels	
*Epitaxial Oxide Films on Silicon: Growth, Modeling and Device Properties	155
R. Droopad, J. Wang, K. Eisenbeiser, Z. Yu, J. Ramdani, J.A. Curless, C.D. Overgaard, J.M. Finder, J.A. Hallmark, V. Kaushik, B.Y. Nguyen, D.S. Marshall, and W.J. Ooms	
Optical Properties of Thin-Film SrTiO₃ on Si Grown by MBE	167
Stefan Zollner, A.A. Demkov, Ran Liu, J.A. Curless, Z. Yu, J. Ramdani, and R. Droopad	
Modeling of the Transition From Active to Passive Oxidation of Si(100)	173
Da-Jiang Liu, Cheol Ho Choi, Mark S. Gordon, and J.W. Evans	
Two Step Process for the Growth of a Thin Layer of Silicon Dioxide for Tunneling Effect Applications	179
Hugo Águas, Ana Cabrita, Pedro Tonello, Patricia Nunes, Elvira Fortunato, and Rodrigo Martins	

*Invited Paper

Cambridge University Press
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Frontmatter
[More information](#)

Structure Characterization of Epitaxial Strain Relaxation in YBa₂Cu₃O_{7-x}/PrBa₂Cu₃O₇ Superlattices	185
María Varela, Diego Arias, Zouhair Sefrioui, Carlos León, Carmen Ballesteros, and Jacobo Santamaría	
Epitaxial Growth of Cerium Oxide Buffer Layers on MgO, YSZ and Sapphire Substrates	191
A. Thorley, S. Gnanarajan, A. Katsaros, and N. Savvides	
Cracking and Delamination of Heteroepitaxial Barium Hexaferrite Films	197
S.A. Oliver, I. Kozulin, N.E. McGruer, S.D. Yoon, and C. Vittoria	
Solution Synthesis of Epitaxial Rare-Earth Oxide Thin Films on Roll-Textured Nickel	203
Jonathan S. Morrell, Ziling B. Xue, Mariappan Paranthaman, Thomas G. Chirayil, Catherine E. Vallet, David B. Beach, and Eliot D. Specht	
Microscopical Study of the Structural Evolution of Sol-Gel Derived Buffer Layers for the Integration of YBCO on Biaxially Textured Nickel	209
H. Dobberstein, R.W. Schwartz, P.G. Clem, D.L. Carroll, and R. Czerw	
Author Index	215
Subject Index	217

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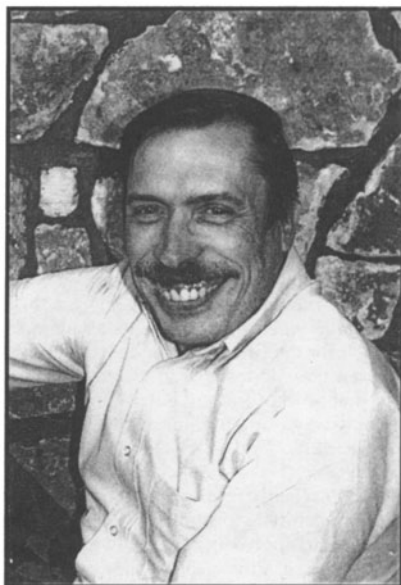
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Frontmatter

[More information](#)

DEDICATION



IN MEMORY OF ALAN KRAUSS

These proceedings are dedicated to the memory of Alan Krauss, who passed away on June 26, 2000 after a courageous battle against cancer. Alan Krauss was a Senior Scientist and Group Leader at Argonne National Laboratory, where he had a distinguished career making major contributions to various interdisciplinary fields of research and technology development.

Alan was one of those scientists who embodied a deep knowledge of several fields of research, which included ion and plasma interaction with solids and gases, materials science (including bulk materials and thin films), and the invention and development of unique instrumentation which made a critical impact on the advancement of materials, surface and thin film science.

The experimental and theoretical work of Alan Krauss in the fields mentioned above contributed to opening new avenues of research and to new technological developments. In this respect we can cite four major scientific and technological developments among Alan's contributions:

Alan Krauss contributed to develop the science and technology of unique alkali metal-based alloys, which made a major impact in the science and technology of fusion energy devices as well as on thin film-based cold cathodes for many important technologies such as field emission flat panel displays and high frequency devices. This work involved not only cutting-edge fundamental science but also technological developments that are now actively being considered for applications in revolutionary devices. The work in the field of alkali metal-based alloys has opened new fields of fundamental research and technology.

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Frontmatter

[More information](#)

Alan Krauss was the co-developer of a unique microwave plasma technique to produce nanocrystalline diamond thin films. This method involves novel C_{60}/Ar and CH_4/Ar plasma chemistries, which result in the unique film growth mechanism capable of producing nanocrystalline diamond films. This work opened a new field of fundamental research related to nanocrystalline diamond thin films. In addition, this work has opened the way for the development of 21st century technologies, such as field emission flat panel displays and microelectromechanical systems (MEMS) based on the unique electron emission and mechanical properties of the nanocrystalline diamond films.

Alan Krauss also made major contributions to the science and technology of multicomponent oxide thin films (e.g., high temperature superconductors and ferroelectrics). This work involved the use of surface analysis instrumentation developed by Alan and colleagues, which provided unique insights into the fundamental mechanism of oxide film growth and is providing the capability for understanding surface and interface phenomena necessary to develop the materials integration strategies needed for the fabrication of the next generation of non-volatile ferroelectric random access memories (NVFRAMs). Alan Krauss was also a co-developer of a unique time-of-flight ion scattering and direct recoil- spectroscopy surface analysis technique, which for the first time can be used in relatively high-pressure environments. This technique can provide insights to understanding film growth processes, not only for the materials discussed above but for any other known or unknown materials. This technique is opening a whole new way of performing fundamental and applied science related to thin films and surfaces in general.

Alan Krauss was not only a top scientist, but he also was one of those rare human beings who had an open mind and a gentle attitude towards his colleagues and other scientists. He always contributed to scientific discussions with constructive criticism and with challenging ideas. We as colleagues valued very much his positive approach to scientific discussions. Also, we could count on Alan when requesting from him contributions to conferences, invited papers, or articles for books. Alan was also an excellent teacher. He directed numerous theses of graduate students from several universities in the United States. Those students went on to successful careers and in turn established scientific relationships and joint programs with Alan, which speaks for itself about the lasting legacy of his teaching.

Alan Krauss received several awards for his scientific accomplishments, and he was author or co-author of five patents and eleven patents pending. He published numerous papers and edited books that will provide continuous inspiration to colleagues and students for years to come. His scientific talent, dedication, warm personality, and friendship will be deeply missed.

Orlando Auciello
Senior Scientist
Argonne National Laboratory

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Frontmatter

[More information](#)

PREFACE

The symposium on "Recent Developments in Oxide and Metal Epitaxy—Theory and Experiment," was held April 23–26 at the 2000 MRS Spring Meeting in San Francisco, California. It comprised six half-day sessions, including a tutorial on *In Situ* Characterization Techniques.

The symposium focused on progress in solving fundamental issues in the epitaxial growth of metals and oxides. Presentations were given covering both fundamental studies and technological applications, and were of extremely high quality. Insights from both experiment, and modeling and simulation, were combined to facilitate cross-fertilization of ideas and understanding. One particular aspect of the topic highlighted by the symposium was the use of *in situ* characterization techniques for enhancing the efficiency of materials development. Thin film research is often unavoidably empirical in nature. Techniques for minimizing the time spent exploring the complex parameter space in order to optimize growth and processing conditions are of value to the materials scientist. Among the techniques discussed during the symposium were spectroscopic ellipsometry and ion scattering and recoil spectrometry, LEEM (low energy electron microscopy), STM (scanning tunneling microscopy), TEM (transmission electron microscopy), and RHEED (reflection high energy electron diffraction).

The Editors would like to dedicate this MRS proceedings volume to the Memory of Dr. Alan R. Krauss of Argonne National Laboratory, a contributor to this proceedings and a pioneer in the field of *in situ* ion scattering and recoil spectrometry.

Mark Yeadon
Shirley Chiang
Robin F.C. Farrow
James W. Evans
Orlando Auciello

April 2000

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Frontmatter

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Ames Laboratory-U.S. Department of Energy
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We would also like to thank our invited speakers for contributing to this volume:

M.C. Bartelt
R. Droopad
C.P. Flynn
E.A. Irene
D.G. Schlom
P.A. Thiel
J.C. Yang

We thank all of the authors for the high quality of the oral and poster presentations, and their cooperation in the production of this permanent record of the symposium. Finally, we acknowledge the efficient support of the staff of the Materials Research Society, without which the symposium would not have been possible.

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