

MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 841

Fundamentals of Nanoindentation and Nanotribology III

November 29 –December 3, 2004
Boston, Massachusetts, USA

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571
www.proceedings.com

ISBN: 978-1-61567-618-7

Some format issues inherent in the e-media version may also appear in this print version.

Copyright (2005) by the Materials Research Society.
All rights reserved.

For permission requests, please contact the Materials Research Society at the address below.

Materials Research Society
Proceedings
506 Keystone Dr.
Warrendale, PA 15086
Phone: 724-779-3004 x 531
Fax: 724-779-4396
eproceedings@mrs.org

TABLE OF CONTENTS

Nanoindentation of Ion Implanted and Deposited Amorphous Silicon.....	1
<i>J.S. Williams, B. Haberl, J.E. Bradby</i>	
Cross-Sectional TEM Studies of Indentation-Induced Phase Transformations in Si: Indenter Angle Effects.....	6
<i>S. Wen, J. Bentley, J. Jang, G.M. Pharr</i>	
In-Situ Infrared (IR) Detection and Heating of the High Pressure Phase of Silicon During Scratching Test.....	12
<i>L. Dong, J.A. Patten, J.A. Miller</i>	
Micro-Raman Mapping and Analysis of Indentation-Induced Phase Transformations in Germanium	18
<i>J. Jang, M.J. Lance, S. Wen, J.J. Huening, R.J. Nemanich, G.M. Pharr</i>	
An Analytical Approach for Relating Hardness and Yield Strength for Materials with High Ratio of Yield Strength to Young Modulus.....	24
<i>L.J. Vandeperre, F. Giuliani, W.J. Clegg</i>	
On The Mechanics of Indentation Induced Lateral Cracking	30
<i>X. Chen</i>	
Modeling Indentation in Linear Viscoelastic Solids	36
<i>Y. Cheng, C. Cheng</i>	
Dislocation Nucleation at a Surface Step by a Multiscale Approach.....	42
<i>C. Li, D. Segall, G. Xu</i>	
Determination of Plastic Properties of Polycrystalline Metallic Materials by Nanoindentation – Experiments and Finite Element Simulations	48
<i>K. Durst, B. Backes, M. Goken</i>	
Modeling of Nanoindentation and Microstructural Ductile Behavior in Metallic Material Systems.....	54
<i>J.B. Ma, W. Ashmawi, M.A. Zikry, D. Schall, D.W. Brenner</i>	
A Nanoindentation Study of Thermally-Grown-Oxide Films on Silicon	60
<i>F. Helvacı, J. Cho</i>	
An Investigation of Non-linear Stress-strain Behavior of Thin Metal Films	66
<i>N. Huber, T. Dietz, E. Tyulyukovskiy</i>	
Nanoindentation of Multilayer PZT/Pt/SiO₂ Thin Film Systems on Silicon Wafers for MEMS Applications.....	72
<i>C. Chima-Okereke, M.J. Reece, A.J. Bushby, R.W. Whatmore, Q. Zhang</i>	
Microbridge Nanoindentation Testing of Plasma-Enhanced Chemical Vapor Deposited Silicon Oxide Films	78
<i>Z. Cao, T. Zhang, X. Zhang</i>	
Investigation of Indentation Methods for Properties Determination in Hard Film- Soft Substrate Systems.....	84
<i>M.S. Kennedy, N.R. Moody, D.F. Bahr</i>	

Non-Destructive Measurement of the Density of Thin Coatings by a Combination of Instrumented (Nano) Indentation and Acoustical Techniques.....	90
<i>N.M. Jennett, G. Aldrich-Smith, A.S. Maxwell</i>	
Measurement of Crystal Lattice Rotations under Nanoindents in Copper	96
<i>K.K. McLaughlin, N.A. Stelmashenko, S.J. Lloyd, L.J. Vandeperre, W.J. Clegg</i>	
An Experimental Evaluation of the Constant β Relating the Contact Stiffness to the Contact Area in Nanoindentation	102
<i>J.H. Strader, S. Shim, H. Bei, W.C. Oliver, G.M. Pharr</i>	
The Mechanics of Nanoimprint Forming	108
<i>G.L.W. Cross, R.M. Langford, B.S. O'Connell, J.B. Pethica</i>	
Correlated Single Molecule Fluorescence and Scanning Probe Microscopies: Applications to the Study of Soft Materials.....	120
<i>A.L. Slade, J.E. Shaw, G. Yang, N. Chhabra, C.M. Yip</i>	
Nanomechanical and Microstructural Properties of Bombyx Mori Silk Films.....	130
<i>D.M. Ebenstein, J. Park, D.L. Kaplan, K.J. Wahl</i>	
Nanoscale Characterisation of Salivary Pellicle	136
<i>M.E. Dickinson, A.B. Mann</i>	
Nanomechanical Testing of Hydrated Biomaterials: Sample Preparation, Data Validation and Analysis	142
<i>J.D. Kaufman, C.M. Klapperich</i>	
Elastic Modulus of Dental Enamel: Effect of Enamel Prism Orientation and Mineral Content.....	148
<i>V.L. Ferguson, A. Boyde, A.J. Bushby</i>	
Contribution of Collagen, Mineral and Water Phases to the Nanomechanical Properties of Bone	154
<i>A.K. Bembey, V. Koonjul, A.J. Bushby, V.L. Ferguson, A. Boyde</i>	
Nanoindentation of Bone in a Physiological Environment	160
<i>R. Akhtar, S. Morse, P.M. Mummery</i>	
Effect of Fluoride on Mechanical Properties of Teeth Demineralized by Use of Orthodontic Appliances	166
<i>C. Centeno, U. Ruiz, O. Contreras, E.C. Samano</i>	
Effects of Osteopontin Deficiency and Aging on Nanomechanics of Mouse Bone.....	172
<i>B. Kavukcuoglu, C. West, D.T. Denhardt, A.B. Mann</i>	
Spatially Dependent Mechanical Properties Of Rat Whiskers For Tactile Sensing	178
<i>E.K. Herzog, D.F. Bahr, C.D. Richards, R.F. Richards, D.M. Rector</i>	
Nano-Mechanical Investigation of the Byssal Cuticle, a Protective Coating of a Bio-Elastomer.....	183
<i>N. Holten-Andersen, N. Slack, F. Zok, J.H. Waite</i>	

On the Measurement of Creep by Nanoindentation with Continuous Stiffness Techniques	189
<i>A. Rar, S. Sohn, W.C. Oliver, D.L. Goldsby, T.E. Tullis, G.M. Pharr</i>	
Multiple-Frequency Nanoindentation Testing	195
<i>A.C. Fischer-Cripps</i>	
Measurements of Viscoelastic Properties of SWNT/Polymer Composite Films Using Nanoindentation	201
<i>H. Lu, G. Huang, B. Wang, A. Mamedov, S. Gupta</i>	
Displacement Modulation Based Dynamic Nanoindentation for Viscoelastic Material Characterization	211
<i>S.P. Singh, R.P. Singh, J.F. Smith</i>	
On the Measurement of Material Creep Parameters by Nanoindentation	217
<i>J.a. LaManna, W.C. Oliver, G.M. Pharr</i>	
High Temperature Nanoindentation for the Study of Flow Defects	223
<i>C.A. Schuh, J.K. Mason, A.C. Lund, A.M. Hodge</i>	
High Temperature Deformation of AlN/CrN Multilayers using Nanoindentation	229
<i>F. Giuliani, A. Goruppa, S.J. Lloyd, D. Teer, W.J. Clegg</i>	
Molecular Mobility and Confined Plasticity in NEMS Applications	235
<i>R.M. Overney, S. Sills</i>	
Nanomechanical Properties of UV Degraded TiO₂/Epoxy Nanocomposites	248
<i>S. Scierka, P.L. Drzal, A.L. Forster, S. Svetlik</i>	
On Factors Affecting the Extraction of Elastic Modulus by Nanoindentation of Organic Polymer Films	254
<i>F. Iacopi, M. Laknin, A. Mulloy, J.M.J. Den Toonder, D. Vanhaeren, S.H. Brongersma</i>	
Viscoelastic Characterization of Polymers Using Dynamic Instrumented Indentation	260
<i>C.C. White, P.L. Drzal, M.R. Vanlandingham</i>	
Indentation Creep and Relaxation Measurements of Polymers	266
<i>M.R. Vanlandingham, P.L. Drzal, C.C. White</i>	
Nanomechanical Quantification of Polymer Energy Absorption	278
<i>C.A. Tweedie, J.F. Smith, K.J. Van Vliet</i>	
Spherical Indentation Creep Following Ramp Loading	284
<i>M.L. Oyen</i>	
Some Issues of Rough Surface Contact Plasticity at Micro- and Nano-Scales	290
<i>Y.F. Gao, A.F. Bower, K.S. Kim</i>	
Multiscale Modeling of Two Dimensional Rough Surface Contacts	296
<i>B. Luan, S. Hyun, M.O. Robbins, N. Bernstein</i>	
Mechanical Properties of Wear Tested LIGA Nickel	306
<i>N.R. Moody, J.M. Jungk, M.S. Kennedy, S.V. Prasad, D.F. Bahr, W.W. Gerberich</i>	

Acoustic Emission Analysis of Nanoindentation-Induced Fracture Events.....	312
<i>P. Dyjak, R.P. Singh</i>	
Nano Scratching of Clear Coats and Relation to Mechanical Material Properties.....	318
<i>R. Nothhelfer-Richter, E. Klinke, C.D. Eisenbach</i>	
Initial Contact Behavior of Nanograined Ni-25at.%Al Film During Nanoindentation.....	324
<i>H. Li, A.H.W. Ngan</i>	
TEM Observation of Microstructural Change of Silicon Single Crystal Caused by Scratching Tests Using SPM	330
<i>M. Takagi, K. Onodera, H. Iwata, T. Imura, K. Sasaki, H. Saka</i>	
The Atomic Scale Removal Mechanism During Chemomechanical Polishing of Silicon: An Atomic Force Microscopy Study	336
<i>F. Katsuki, J. Watanabe</i>	
Fracture Mechanisms of GaAs Under Nanoscratching	342
<i>J.M. Solletti, M. Parlinska-Wojtan, J. Tharian, K. Wasmer, J. Michler, C. Ballif, D. Schulz, A. Karimi</i>	
Friction and Wear Properties of ALD Coated MEMS	348
<i>C. Nistorica, I. Gory, G.D. Skidmore, F.M. Mantiziba, B.E. Gnade</i>	
Aspects of Tip Shape Characterization for Nanoindentation of Compliant Materials	354
<i>M.R. Vanlandingham, T.F. Juliano, M.J. Hagon</i>	
Effects of Surface Stress on the Load-Depth Curves of Depth-Sensing Indentation	360
<i>Q. Wang, K. Ozaki</i>	
A Critical Examination fo teh Berkovich vs. Conical Indentation Based on 3D Finite Element Calculation.....	366
<i>S. Shim, W.C. Oliver, G.M. Pharr</i>	
Spherical Load Indentation in Submicron NiTiCu Shape Memory Thin Films.....	372
<i>R. Hassdorf, J. Feydt, S. Thienhaus, L. Buform, N. Conte, O. Pykhtev, M. Kruzik, N. Botkin, M. Moske</i>	
Effect of Alloying Elements (Ga, Ge, Si) on Pseudoelasticity in Fe₃Al Single Crystals	378
<i>H.Y. Yasuda, T. Kase, Y. Umakoshi</i>	
Author Index	