



## William Nix

Lee Otterson Professor in the School of Engineering, Emeritus  
Materials Science and Engineering

### Bio

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#### BIO

I have been engaged in the study of mechanical properties of materials for nearly 50 years. My early work was on high temperature creep and fracture of metals, focusing on techniques for measuring internal back stresses in deforming metals and featuring the modeling of diffusional deformation and cavity growth processes. My students and I also studied high temperature dispersion strengthening mechanisms and described the effects of threshold stresses on these creep processes. Since the mid-1980's we have focused most of our attention on the mechanical properties of thin film materials used in microprocessors and related devices. We have developed many of the techniques that are now used to study of thin film mechanical properties, including nanoindentation, substrate curvature methods, bulge testing methods and the mechanical testing of micromachined (MEMS) structures. We are also known for our work on the mechanisms of strain relaxation in heteroepitaxial thin films and plastic deformation of thin metal films on substrates. In addition we have engaged in research on the growth, characterization and modeling of thin film microstructures, especially as they relate to the development of intrinsic stresses. Some of our recent work dealt with the mechanical properties of nanostructures and with strain gradients and size effects on the mechanical properties of crystalline materials. Our most recent work deals with the mechanical properties of lithiated nanostructures that are being considered for lithium-ion battery applications.

#### ACADEMIC APPOINTMENTS

- Professor Emeritus, Materials Science and Engineering

#### HONORS AND AWARDS

- Member, National Academy of Engineering
- Fellow, American Academy of Arts and Sciences
- Member, National Academy of Sciences
- Acta Metallurgica, Gold Medal (1993)
- The Metallurgical Society, Educator Award (1995)
- ASM Gold Medal, ASM International (1998)
- Honorary Doctorate of Engineering, Colorado School of Mines (2001)
- Nadai Medal, ASME (2001)
- A.E. White Distinguished Teacher Award, ASM International (2002)
- Albert Sauveur Achievement Award, ASM International (2003)
- Honorary Doctorate of Engineering, University of Illinois, Urbana-Champaign (2007)
- Von Hippel Award, Materials Research Society (2007)
- Fellow, Materials Research Society (2011)

- Heyn Medal, German Society of Materials Science (2011)
- Honorary Doctorate of Science, Northwestern University (2012)

## BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Member, National Academy of Sciences (2013 - present)
- Member, National Academy of Engineering (2013 - present)
- Member, American Academy of Arts and Sciences (2013 - present)

## PROFESSIONAL EDUCATION

- PhD, Stanford University (1963)

## Publications

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### PUBLICATIONS

- **Stochastic behaviors in plastic deformation of face-centered cubic micropillars governed by surface nucleation and truncated source operation** *ACTA MATERIALIA*  
Ryu, I., Cai, W., Nix, W. D., Gao, H.  
2015; 95: 176-183
- **Kinetics and fracture resistance of lithiated silicon nanostructure pairs controlled by their mechanical interaction** *NATURE COMMUNICATIONS*  
Lee, S. W., Lee, H., Ryu, I., Nix, W. D., Gao, H., Cui, Y.  
2015; 6
- **Instrumented nanoindentation and 3D mechanistic modeling of a shale at multiple scales** *ACTA GEOTECHNICA*  
Bennett, K. C., Berla, L. A., Nix, W. D., Borja, R. I.  
2015; 10 (1): 1-14
- **Mechanical behavior of electrochemically lithiated silicon** *JOURNAL OF POWER SOURCES*  
Berla, L. A., Lee, S. W., Cui, Y., Nix, W. D.  
2015; 273: 41-51
- **Kinetics and fracture resistance of lithiated silicon nanostructure pairs controlled by their mechanical interaction.** *Nature communications*  
Lee, S. W., Lee, H., Ryu, I., Nix, W. D., Gao, H., Cui, Y.  
2015; 6: 7533-?
- **Robustness of amorphous silicon during the initial lithiation/delithiation cycle** *JOURNAL OF POWER SOURCES*  
Berla, L. A., Lee, S. W., Ryu, I., Cui, Y., Nix, W. D.  
2014; 258: 253-259
- **Microscopic model for fracture of crystalline Si nanopillars during lithiation** *JOURNAL OF POWER SOURCES*  
Ryu, I., Lee, S. W., Gao, H., Cui, Y., Nix, W. D.  
2014; 255: 274-282
- **Modeling a distribution of point defects as misfitting inclusions in stressed solids** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Cai, W., Sills, R. B., Barnett, D. M., Nix, W. D.  
2014; 66: 154-171
- **A LABORATORY EXPERIMENT USING NANOINDENTATION TO DEMONSTRATE THE INDENTATION SIZE EFFECT** *JOURNAL OF MATERIALS EDUCATION*  
Wright, W. J., Feng, G., Nix, W. D.  
2013; 35 (5-6): 135-143
- **25th Anniversary Article: Understanding the Lithiation of Silicon and Other Alloying Anodes for Lithium-Ion Batteries** *ADVANCED MATERIALS*  
McDowell, M. T., Lee, S. W., Nix, W. D., Cui, Y.  
2013; 25 (36): 4966-4984

- **Plasticity of bcc micropillars controlled by competition between dislocation multiplication and depletion** *ACTA MATERIALIA*  
Ryu, I., Nix, W. D., Cai, W.  
2013; 61 (9): 3233-3241
- **In Situ TEM of Two-Phase Lithiation of Amorphous Silicon Nanospheres** *NANO LETTERS*  
McDowell, M. T., Lee, S. W., Harris, J. T., Korgel, B. A., Wang, C., Nix, W. D., Cui, Y.  
2013; 13 (2): 758-764
- **Critical-temperature/Peierls-stress dependent size effects in body centered cubic nanopillars** *APPLIED PHYSICS LETTERS*  
Han, S. M., Feng, G., Jung, J. Y., Jung, H. J., Groves, J. R., Nix, W. D., Cui, Y.  
2013; 102 (4)
- **Reaction Front Evolution during Electrochemical Lithiation of Crystalline Silicon Nanopillars** *ISRAEL JOURNAL OF CHEMISTRY*  
Lee, S. W., Berla, L. A., McDowell, M. T., Nix, W. D., Cui, Y.  
2012; 52 (11-12): 1118-1123
- **Studying the Kinetics of Crystalline Silicon Nanoparticle Lithiation with In Situ Transmission Electron Microscopy** *ADVANCED MATERIALS*  
McDowell, M. T., Ryu, I., Lee, S. W., Wang, C., Nix, W. D., Cui, Y.  
2012; 24 (45): 6034-?
- **Fracture of crystalline silicon nanopillars during electrochemical lithium insertion** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*  
Lee, S. W., McDowell, M. T., Berla, L. A., Nix, W. D., Cui, Y.  
2012; 109 (11): 4080-4085
- **Size dependence of the yield strength of fcc and bcc metallic micropillars with diameters of a few micrometers** *PHILOSOPHICAL MAGAZINE*  
Lee, S., Nix, W. D.  
2012; 92 (10): 1238-1260
- **Size-dependent fracture of Si nanowire battery anodes** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Ryu, I., Choi, J. W., Cui, Y., Nix, W. D.  
2011; 59 (9): 1717-1730
- **Novel Size and Surface Oxide Effects in Silicon Nanowires as Lithium Battery Anodes** *NANO LETTERS*  
McDowell, M. T., Lee, S. W., Ryu, I., Wu, H., Nix, W. D., Choi, J. W., Cui, Y.  
2011; 11 (9): 4018-4025
- **Size effect in compression of single-crystal gold microparticles** *ACTA MATERIALIA*  
Mordehai, D., Lee, S., Backes, B., Srolovitz, D. J., Nix, W. D., Rabkin, E.  
2011; 59 (13): 5202-5215
- **Effects of focused-ion-beam irradiation and prestraining on the mechanical properties of FCC Au microparticles on a sapphire substrate** *JOURNAL OF MATERIALS RESEARCH*  
Lee, S., Mordehai, D., Rabkin, E., Nix, W. D.  
2011; 26 (14): 1653-1661
- **Interconnected Silicon Hollow Nanospheres for Lithium-Ion Battery Anodes with Long Cycle Life** *NANO LETTERS*  
Yao, Y., McDowell, M. T., Ryu, I., Wu, H., Liu, N., Hu, L., Nix, W. D., Cui, Y.  
2011; 11 (7): 2949-2954
- **Dislocation junctions and jogs in a free-standing FCC thin film** *MODELLING AND SIMULATION IN MATERIALS SCIENCE AND ENGINEERING*  
Lee, S., Aubry, S., Nix, W. D., Cai, W.  
2011; 19 (2)
- **Extracting thin film hardness of extremely compliant films on stiff substrates** *THIN SOLID FILMS*  
Han, S. M., Guyer, E. P., Nix, W. D.  
2011; 519 (10): 3221-3224
- **BEYOND THE LAB Develop and follow your own passion** *MRS BULLETIN*  
Nix, W. D.

2011; 36 (1): 14-15

- **Micro-pillar plasticity controlled by dislocation nucleation at surfaces** *PHILOSOPHICAL MAGAZINE*  
Nix, W. D., Lee, S.  
2011; 91 (7-9): 1084-1096
- **Size effects on strength and plasticity of vanadium nanopillars** *SCRIPTA MATERIALIA*  
Han, S. M., Bozorg-Grayeli, T., Groyes, J. R., Nix, W. D.  
2010; 63 (12): 1153-1156
- **Electromigration-Induced Plastic Deformation in Cu Interconnects: Effects on Current Density Exponent, n, and Implications for EM Reliability Assessment** *Symposium on Phase Stability, Phase Transformation and Reactive Phase Formation in Electronic Materials VII*  
Budiman, A. S., Hau-Riege, C. S., Baek, W. C., Lor, C., Huang, A., Kim, H. S., Neubauer, G., Pak, J., Besser, P. R., Nix, W. D.  
SPRINGER.2010: 2483-88
- **What is the Young's Modulus of Silicon?** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Hopcroft, M. A., Nix, W. D., Kenny, T. W.  
2010; 19 (2): 229-238
- **A physically based model for indenter tip shape calibration for nanoindentation** *JOURNAL OF MATERIALS RESEARCH*  
Berla, L. A., Allen, A. M., Han, S. M., Nix, W. D.  
2010; 25 (4): 735-745
- **Geometrical analysis of 3D dislocation dynamics simulations of FCC micro-pillar plasticity** *MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIALS PROPERTIES MICROSTRUCTURE AND PROCESSING*  
Lee, S., Nix, W. D.  
2010; 527 (7-8): 1903-1910
- **Modelling dislocations in a free-standing thin film** *MODELLING AND SIMULATION IN MATERIALS SCIENCE AND ENGINEERING*  
Weinberger, C. R., Aubry, S., Lee, S., Nix, W. D., Cai, W.  
2009; 17 (7)
- **Study of strain softening behavior of Al-Al3Sc multilayers using microcompression testing** *ACTA MATERIALIA*  
Han, S. M., Phillips, M. A., Nix, W. D.  
2009; 57 (15): 4473-4490
- **Uniaxial compression of fcc Au nanopillars on an MgO substrate: The effects of prestraining and annealing** *ACTA MATERIALIA*  
Lee, S., Han, S. M., Nix, W. D.  
2009; 57 (15): 4404-4415
- **Electromigration-Induced Plasticity: Texture Correlation and Implications for Reliability Assessment** *JOURNAL OF ELECTRONIC MATERIALS*  
Budiman, A. S., Besser, P. R., Hau-Riege, C. S., Marathe, A., Joo, Y., Tamura, N., Patel, J. R., Nix, W. D.  
2009; 38 (3): 379-391
- **A quantitative analysis for the stress field around an elastoplastic indentation/contact** *SPEM Research Conference on the Sedimentary Record of Meteorite Impacts*  
Feng, G., Qu, S., Huang, Y., Nix, W. D.  
CAMBRIDGE UNIV PRESS.2009: 704-18
- **Microstructure Effect on EM-Induced Degradations in Dual Inlaid Copper Interconnects** *IEEE TRANSACTIONS ON DEVICE AND MATERIALS RELIABILITY*  
Sukharev, V., Kteyan, A., Zschech, E., Nix, W. D.  
2009; 9 (1): 87-97
- **Storage and loss stiffnesses and moduli as determined by dynamic nanoindentation** *SPEM Research Conference on the Sedimentary Record of Meteorite Impacts*  
Wright, W. J., Nix, W. D.  
CAMBRIDGE UNIV PRESS.2009: 863-71
- **Exploiting New Opportunities in Materials Research by Remembering and Applying Old Lessons** *MRS BULLETIN*  
Nix, W. D.

2009; 34 (2): 82-91

- **Yielding and Strain Hardening in Metallic Thin Films on Substrates: an Edge Dislocation Climb Model** *MATHEMATICS AND MECHANICS OF SOLIDS*  
Nix, W. D.  
2009; 14 (1-2): 207-219
- **Indentation size effects in single crystal copper as revealed by synchrotron x-ray microdiffraction** *JOURNAL OF APPLIED PHYSICS*  
Feng, G., Budiman, A. S., Nix, W. D., Tamura, N., Patel, J. R.  
2008; 104 (4)
- **A model for power law creep controlled hillock growth** *MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIALS PROPERTIES MICROSTRUCTURE AND PROCESSING*  
Berla, L. A., Joo, Y., Nix, W. D.  
2008; 488 (1-2): 594-600
- **Formation of chiral branched nanowires by the Eshelby Twist** *NATURE NANOTECHNOLOGY*  
Zhu, J., Peng, H., Marshall, A. F., Barnett, D. M., Nix, W. D., Cui, Y.  
2008; 3 (8): 477-481
- **Nanoscale deformation - Seeing is believing** *NATURE MATERIALS*  
Hemker, K. J., Nix, W. D.  
2008; 7 (2): 97-98
- **A search for evidence of strain gradient hardening in Au submicron pillars under uniaxial compression using synchrotron X-ray micro diffraction** *ACTA MATERIALIA*  
Budiman, A. S., Han, S. M., Greer, J. R., Tamura, N., Patel, J. R., Nix, W. D.  
2008; 56 (3): 602-608
- **Size dependence in mechanical properties of gold at the micron scale in the absence of strain gradients** *APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING*  
Greer, J. R., Nix, W. D.  
2008; 90 (1): 203-203
- **A model for electromigration-induced degradation mechanisms in dual-inlaid copper interconnects: Effect of microstructure** *JOURNAL OF APPLIED PHYSICS*  
Sukharev, V., Zschech, E., Nix, W. D.  
2007; 102 (5)
- **A model for hillock growth in Al thin films controlled by plastic deformation** *ACTA MATERIALIA*  
Hwang, S., Nix, W. D., Joo, Y.  
2007; 55 (15): 5297-5301
- **An analytical expression for the stress field around an elastoplastic indentation/contact** *ACTA MATERIALIA*  
Feng, G., Qu, S., Huang, Y., Nix, W. D.  
2007; 55 (9): 2929-2938
- **In-situ observation of electromigration in eutectic SnPb solder lines: Atomic migration and hillock formation** *JOURNAL OF ELECTRONIC MATERIALS*  
Yoon, M., Ko, M., Kim, O., Park, Y., Nix, W. D., Joo, Y.  
2007; 36 (5): 562-567
- **Deformation at the nanometer and micrometer length scales: Effects of strain gradients and dislocation starvation** *Symposium on Mechanical Behavior of Thin Films and Small Structures held at the 2005 TMS Annual Meeting*  
Nix, W. D., Greer, J. R., Feng, G., Lilleodden, E. T.  
ELSEVIER SCIENCE SA.2007: 3152-57
- **An improved analysis for viscoelastic damping in dynamic nanoindentation** *INTERNATIONAL JOURNAL OF SURFACE SCIENCE AND ENGINEERING*  
Wright, W. J., Maloney, A. R., Nix, W. D.  
2007; 1 (2-3): 274-292
- **Microstructure effect on EM-induced degradations in dual-inlaid copper interconnects** *9th International Workshop on Stress-Induced Phenomena in Metallization*

- Kteyan, A., Sukharev, V., Meyer, M., Zschech, E., Nix, W. D.  
AMER INST PHYSICS.2007: 42-55
- **Plasticity-amplified diffusivity: Dislocation cores as fast diffusion paths in Cu interconnects** *45th Annual IEEE International Reliability Physics Symposium*  
Budiman, A. S., Hau-Riege, C. S., Besser, P. R., Marathe, A., Joo, Y., Tamura, N., Patel, J. R., Nix, W. D.  
IEEE.2007: 122-127
  - **Electromigration-induced plasticity and texture in Cu interconnects** *9th International Workshop on Stress-Induced Phenomena in Metallization*  
Budiman, A. S., Hau-Riege, C. S., Besser, P. R., Marathe, A., Joo, Y. C., Tamura, N., Patel, J. R., Nix, W. D.  
AMER INST PHYSICS.2007: 56-65
  - **Indentation of a hard film on a soft substrate: Strain gradient hardening effects** *INTERNATIONAL JOURNAL OF PLASTICITY*  
Zhang, F., Saha, R., Huang, Y., Nix, W. D., Hwang, K. C., Qu, S., Li, M.  
2007; 23 (1): 25-43
  - **Comparison of Line stress predictions with measured electromigration failure times** *IEEE International Integrated Reliability Workshop*  
Morusupalli, R. R., Nix, W. D., Patel, J. R.  
IEEE.2007: 124-127
  - **Single layer mesoporous silica thin films as templates for metallic nanoscale arrays** *JOURNAL OF APPLIED PHYSICS*  
Hussen, G. N., Shirakawa, H., Nix, W. D., Clemens, B. M.  
2006; 100 (11)
  - **Size effect in contact compression of nano- and microscale pyramid structures** *ACTA MATERIALIA*  
Wang, J., Lian, J., Greer, J. R., Nix, W. D., Kim, K.  
2006; 54 (15): 3973-3982
  - **A model of size effects in nano-indentation** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Huang, Y., Zhang, F., Hwang, K. C., Nix, W. D., Pharr, G. M., Feng, G.  
2006; 54 (8): 1668-1686
  - **Crystal plasticity in Cu damascene interconnect lines undergoing electromigration as revealed by synchrotron x-ray microdiffraction** *APPLIED PHYSICS LETTERS*  
Budiman, A. S., Nix, W. D., Tamura, N., Valek, B. C., Gadre, K., Maiz, J., Spolenak, R., Patel, J. R.  
2006; 88 (23)
  - **Nanoscale gold pillars strengthened through dislocation starvation** *PHYSICAL REVIEW B*  
Greer, J. R., Nix, W. D.  
2006; 73 (24)
  - **A study of the mechanical properties of nanowires using nanoindentation** *JOURNAL OF APPLIED PHYSICS*  
Feng, G., Nix, W. D., Yoon, Y., Lee, C. J.  
2006; 99 (7)
  - **Microstructural length-scale effects in the nanoindentation behavior of thin gold films** *ACTA MATERIALIA*  
Lilleodden, E. T., Nix, W. D.  
2006; 54 (6): 1583-1593
  - **Determining hardness of thin films in elastically mismatched film-on-substrate systems using nanoindentation** *ACTA MATERIALIA*  
Han, S. M., Saha, R., Nix, W. D.  
2006; 54 (6): 1571-1581
  - **Size dependence in mechanical properties of gold at the micron scale in the absence of strain gradients (vol 53, pg 1821, 2005)** *ACTA MATERIALIA*  
Greer, J. R., OLIVER, W. C., Nix, W. D.  
2006; 54 (6): 1705-1705
  - **Anelastic behavior of copper thin films on silicon substrates: Damping associated with dislocations** *ACTA MATERIALIA*  
Choi, D. H., Nix, W. D.  
2006; 54 (3): 679-687

- **Electromigration-induced plastic deformation in Cu damascene interconnect lines as revealed by Synchrotron X-Ray Microdiffraction** *Symposium on Materials, Technology and Reliability of Low-k Dielectrics and Copper Interconnects held at the 2006 MRS Spring Meeting*  
Budiman, A. S., Tamura, N., Valek, B. C., Gadre, K., Maiz, J., Spolenak, R., Patel, J. R., Nix, W. D.  
MATERIALS RESEARCH SOCIETY.2006: 295–304
- **Mechanism-based strain gradient crystal plasticity** *IUTAM Symposium on Size Effects on Material and Structural Behavior at Micron- and Nano-Scales*  
Han, C., Gao, H., Huang, Y., Nix, W. D.  
SPRINGER.2006: 163–171
- **Remarks** *MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIALS PROPERTIES MICROSTRUCTURE AND PROCESSING*  
Nix, W. D.  
2005; 409 (1-2): 5-6
- **Mechanism-based strain gradient crystal plasticity - II. Analysis** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Han, C. S., Gao, H. J., Huang, Y. G., Nix, W. D.  
2005; 53 (5): 1204-1222
- **Size dependence of mechanical properties of gold at the sub-micron scale** *APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING*  
Greer, J. R., Nix, W. D.  
2005; 80 (8): 1625-1629
- **Mechanism-based strain gradient crystal plasticity - I. Theory** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Han, C. S., Gao, H. J., Huang, Y. G., Nix, W. D.  
2005; 53 (5): 1188-1203
- **Combinatorial studies of mechanical properties of Ti-Al thin films using nanoindentation** *ACTA MATERIALIA*  
Han, S. M., Shah, R., Banerjee, R., Viswanathan, G. B., Clemens, B. M., Nix, W. D.  
2005; 53 (7): 2059-2067
- **Size dependence of mechanical properties of gold at the micron scale in the absence of strain gradients** *ACTA MATERIALIA*  
Greer, J. R., OLIVER, W. C., Nix, W. D.  
2005; 53 (6): 1821-1830
- **A microbeam bending method for studying stress-strain relations for metal thin films on silicon substrates** *JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS*  
Florando, J. N., Nix, W. D.  
2005; 53 (3): 619-638
- **Critical thickness enhancement of epitaxial SiGe films grown on small structures** *JOURNAL OF APPLIED PHYSICS*  
Liang, Y., Nix, W. D., Griffin, P. B., Plummer, J. D.  
2005; 97 (4)
- **Misfit dislocation dissociation and Lomer formation in low mismatch SiGe/Si heterostructures** *JOURNAL OF MATERIALS RESEARCH*  
Marshall, A. F., Aubertine, D. B., Nix, W. D., McIntyre, P. C.  
2005; 20 (2): 447-455
- **Comparison of the telephone cord delamination method for measuring interfacial adhesion with the four-point bending method** *ACTA MATERIALIA*  
Lee, A., Litteken, C. S., Dauskardt, R. H., Nix, W. D.  
2005; 53 (3): 609-616
- **Comparison of line stress predictions with measured electromigration failure times** *11th Symposium on Thin Film - Stresses and Mechanical Properties held at the MRS Spring Meeting*  
Morusupalli, R. R., Nix, W. D., Patel, J. R., Budiman, A. S.  
MATERIALS RESEARCH SOCIETY.2005: 313–318
- **Comparison of line Stress predictions with measured electromigration failure times** *Symposium on Materials, Technology and Reliability of Advanced Interconnects held at the 2005 MRS Spring Meeting*  
Morusupalli, R. R., Nix, W. D., Patel, J. R., Budiman, A. S.  
MATERIALS RESEARCH SOCIETY.2005: 253–258

- **Indenter tip radius effect on the Nix-Gao relation in micro- and nanoindentation hardness experiments** *JOURNAL OF MATERIALS RESEARCH*  
Qu, S., Huang, Y., Nix, W. D., Jiang, H., Zhang, F., Hwang, K. C.  
2004; 19 (11): 3423-3434
- **Quantitative impedance measurement using atomic force microscopy** *JOURNAL OF APPLIED PHYSICS*  
O'Hayre, R., Feng, G., Nix, W. D., Prinz, F. B.  
2004; 96 (6): 3540-3549
- **Studies of the driving force for room-temperature microstructure evolution in electroplated copper films** *JOURNAL OF VACUUM SCIENCE & TECHNOLOGY B*  
Lee, H., Nix, W. D., Wong, S. S.  
2004; 22 (5): 2369-2374
- **Indentation size effect in MgO** *SCRIPTA MATERIALIA*  
Feng, G., Nix, W. D.  
2004; 51 (6): 599-603
- **Sample dimensions influence strength and crystal plasticity** *SCIENCE*  
Uchic, M. D., Dimiduk, D. M., Florando, J. N., Nix, W. D.  
2004; 305 (5686): 986-989
- **Shear band spacing under bending of Zr-based metallic glass plates** *ACTA MATERIALIA*  
Conner, R. D., Li, Y., Nix, W. D., Johnson, W. L.  
2004; 52 (8): 2429-2434
- **Stress induced delamination methods for the study of adhesion of Pt thin films to Si** *ACTA MATERIALIA*  
Lee, A., Clemens, B. M., Nix, W. D.  
2004; 52 (7): 2081-2093
- **Anelasticity and damping of thin aluminum films on silicon substrates** *JOURNAL OF MICROELECTROMECHANICAL SYSTEMS*  
Choi, D. H., Kim, H., Nix, W. D.  
2004; 13 (2): 230-237
- **Coherency and surface stress effects in metal multilayers** *SCRIPTA MATERIALIA*  
Ramaswamy, V., Nix, W. D., Clemens, B. M.  
2004; 50 (6): 711-715
- **Mechanical property measurements of pure Ni, Ni<sub>3</sub>Al, and Ni-base superalloys at the micron-size scale** *5th Global Innovations Symposium held at the 2004 TMS Annual Meeting*  
Uchic, M. D., Dimiduk, D. M., Seekely, M. J., Florando, J. N., Nix, W. D.  
MINERALS, METALS & MATERIALS SOC.2004: 321-321
- **Some challenges in understanding mechanical properties at the nanometer and micrometer length scales** *5th Global Innovations Symposium held at the 2004 TMS Annual Meeting*  
Nix, W. D., Gang, F., Greer, J. R.  
MINERALS, METALS & MATERIALS SOC.2004: 273-273
- **Unexpected mode of plastic deformation in Cu damascene lines undergoing electromigration** *Symposium on Materials, Technology and Reliability for Advanced Interconnects and Low-k Dielectrics held at the 2004 MRS Spring Meeting*  
Budiman, A. S., Tamura, N., Valek, B. C., Gadre, K., Maiz, J., Spolenak, R., Caldwell, W. A., Nix, W. D., Patel, J. R.  
MATERIALS RESEARCH SOCIETY.2004: 345-350
- **The prospects for mechanical ratcheting of bulk metallic glasses** *Symposium on Amorphous and Nanocrystalline Metals held at the 2003 MRS Fall Meeting*  
Wright, W. J., Dauskardt, R. H., Nix, W. D.  
MATERIALS RESEARCH SOCIETY.2004: 319-324
- **Early stage of plastic deformation in thin films undergoing electromigration** *JOURNAL OF APPLIED PHYSICS*  
Valek, B. C., Tamura, N., Spolenak, R., Caldwell, W. A., MacDowell, A. A., Celestre, R. S., Padmore, H. A., Braman, J. C., Batterman, B. W., Nix, W. D., Patel, J. R.  
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Greaney, P. A., Chrzan, D. C., Clemens, B. M., Nix, W. D.  
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