

# Program

## NANOMECHANICAL TESTING IN MATERIALS RESEARCH & DEVELOPMENT

October 11-16, 2009

Il Ciocco Hotel and Conference Center  
Castelvecchio /Barga (Tuscany), Italy

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University Erlangen-Nürnberg, Germany

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## **Sunday, 11 October 2009**

16:00 - 18:00 Arrival & Registration

18:00 - 19:00 Dinner

### **Opening Session**

19:00 - 19:30

#### **Welcome and Opening**

Mathias Göken, University of Erlangen-Nürnberg, Erlangen, Germany  
Herman Bieber, ECI, New York, USA

19:30 - 20:10

#### **Adhesion of biomimetic patterned surfaces (Plenary)**

Eduard Arzt, INM, Saabrucken, Germany

20:10 - 20:50

#### **Insights into plasticity and fracture obtained by miniaturized mechanical testing (Plenary)**

Gerhard Dehm, Erich Schmid Institute, Leoben, Austria

21:00 - 22:00

Opening Reception (Sponsor: Agilent)

### **Key for talks**

P: Plenary talk

E: extended, invited talk

R: regular contribution

### NOTES

- Audiotaping, videotaping and photography of presentations are prohibited.
- Speakers – Please leave at least 5 minutes for questions and discussion.
- Please do not smoke at any conference functions.
- Turn your cellular telephones to vibrate or off during technical sessions.
- Payment for the optional tour should be made directly to Il Ciocco front desk.
- Be sure to make any corrections to your name/contact information on the Master Participant List or confirm that the listing is correct. A corrected copy will be sent to all participants after the conference.

## **Monday, 12 October 2009**

07:30 - 09:00

Breakfast

### **Fundamentals**

09:00 - 09:40

**Nanoscale behavior of BCC metals—orientation and temperature dependence (Plenary)**

Andrea M. Hodge, University of Southern California, Los Angeles, USA

09:40 - 10:10

**The impact of point and line defect density on the onset of plasticity during nanoindentation (E)**

David F. Bahr, Washington State University, Pullman, USA

10:10 - 10:40

**On the role of surfaces in nanomechanical testing (E)**

Juergen Biener, Lawrence Livermore National Laboratory, Livermore, USA

10:40 - 11:10

Coffee break

11:10 - 11:40

**Comparison of plasticity size effects in uniaxial and non-uniform loading (E)**

Andy Bushby, Queen Mary University of London, London, UK

11:40 - 12:10

**Nanoindentation using atomic force microscope (E)**

Alfonso H.W. Ngan, University of Hong Kong, Hong Kong, China

12:10 - 12:30

**The correlation between the internal material length scale and the microstructure of metallic materials (R)**

Bjorn Backes, Stanford University, Stanford, USA

12:30 - 12:50

**Finite element analysis of the penetration depth/tip radius ratio dependence on the correction factor in indentation testing of elastic - plastic materials (R)**

Fazilay Abbes, University of Reims Champagne Ardenne, Reims, France

13:00 - 14:00

Lunch

14:00 - 16:30

Free time / ad hoc discussions

### **Modeling**

16:30 - 17:10

**Probing mechanical properties of interfaces with nanoindentation: Results of large scale atomistic simulations (Plenary)**

Alexander Hartmaier, ICAMS, Bochum, Germany

17:10 - 17:30

**Crystal plasticity analysis of nanoindentation in intermetallic gamma TiAl (R)**

Claudio Zambaldi, Max-Planck-Institute for Iron Research, Düsseldorf, Germany

17:30 - 17:50

**Continuum crystal plasticity analysis of pyramidal nanoindentation experiments in thin metallic films (R)**

Jorge Alcala, Polytechnic University of Catalunya (UPC), Barcelona, Spain

17:50 - 18:10

**Local effects on the fibre matrix interfacial adhesion testing in fibre matrix reformed composites by the push-in/ pull-out test (R)**

Jon M. Molina-Aldareguia, IMDEA - Materials, Madrid, Spain

18:15 - 18:45

Refreshments

**Monday, 12 October 2009**

18:45 - 20:00

**Poster Preview I**

20:00 - 21:00

Dinner

21:00 - 23:00

**Poster Session I** / Social hour

## Tuesday, 13 October 2009

07:30 - 09:00

Breakfast

### Testing of Small Specimens

09:00 - 09:40

**Prestraining and annealing of gold micropillars: Strengthening and weakening turned upside down (Plenary)**

William D. Nix, Stanford University, Stanford, USA

09:40 - 10:10

**Probing the mechanisms of small-scale plasticity by nanoindentation pop-in and micro-pillar compression testing (E)**

George M. Pharr, University of Tennessee and Oak Ridge National Laboratory, Knoxville, USA

10:10 - 10:40

**In-situ investigation of nano-scale mechanical properties via homogeneous deformation of nano-pillars (E)**

Julia R. Greer, California Institute of Technology, Pasadena, USA

10:40 - 11:10

Coffee break

11:10 - 11:40

**Micro-compression in the spotlight of a synchrotron (E)**

Helena Van Swygenhovem, Paul Scherrer Institute, Villigen, Switzerland

11:40 - 12:00

**Dislocation structures in solid and porous gold nanopillars after deformation (R)**

Brian Derby, University of Manchester, Manchester, UK

12:00 - 12:20

**The effect of orientation and size on the microcompression behavior of MgO (R)**

Sandra Korte, University of Cambridge, Cambridge, UK

12:20 - 12:40

**Anisotropy in the elastic and plastic behavior of alpha titanium micro cantilever beams (R)**

Jicheng Gong, Department of Materials, University of Oxford, Oxford, UK

12:40 - 13:10

**Determining the dimensionality of size effects by indentation with different shaped indenters and uniaxial compression of different shaped pillars (E)**

Nigel M. Jennett, National Physical Laboratory, Teddington, UK

13:00 - 14:00

Lunch

14:00 - 16:30

Free Time / ad hoc discussions / *CSM-sponsored Scientific Session*

### In-Situ Testing

16:30 - 17:00

**Complementary in-situ methods for nanoscale materials characterization (E)**

Ralph Spolenak, ETH Zurich, Zurich, Switzerland

17:00 - 17:30

**In-situ mechanical testing of nanowires and nanodots (E)**

Johann Michler, EMPA, Thun, Switzerland

17:30 - 18:00

**In-situ fracture analysis of nanostructures (E)**

William Gerberich, University of Minnesota, Minnesota, USA

18:00 - 18:30

**In-situ TEM study of dislocation nucleation in confined crystalline volumes (E)**

Marc Legros, CNRS, Toulouse, France

**Tuesday, 13 October 2009 (continued)**

18:30 - 19:00	Refreshments
19:00 - 20:00	<b><u>Poster Preview II</u></b>
20:00 - 21:00	Dinner
21:00 - 23:00	<b><u>Poster Session II</u></b> / Social Hour



## Wednesday, 14 October 2009

- 07:30 - 09:00 Breakfast
- Thin Films and Fracture**
- 09:00 - 09:40 **Indentation fracture and toughness assessment for very thin oxide coatings on glass (Plenary)**  
Steve Bull, Newcastle University, Newcastle, UK
- 09:40 - 10:10 **Buckle driven delamination in thin film compliant substrate systems- tests and simulations (E)**  
Neville R. Moody, Sandia National Laboratories, Livermore, USA
- 10:10 - 10:30 **New testing method for ductility of thin Al films (R)**  
Michael Coulombier, Universite catholique de Louvain (UCL), Louvain-la-Nueve, Belgium
- 10:30 - 11:00 Coffee break
- 11:00 - 11:20 **Residual stress measurement at the micrometer scale: Focused Ion Beam (FIB) milling and nanoindentation testing (R)**  
Marco Sebastiani, University of Rome Tre, Rome, Italy
- 11:20 - 11:40 **Quantification of the micro-plastic response of amorphous silicate through mirco-Raman mapping of residual indentation strain (R)**  
E. Barthel, CNRS/ Saint - Gobain, Aubervilliers, France
- 11:40 - 12:00 **Evaluation of residual stress with a Knoop indenter (R)**  
Seung-Kyun Kang, Seoul National University, Seoul, Korea
- 12:00 - 12:20 **Indentation fracture toughness measurement of thin nanoporous films (R)**  
Dylan Morris, NIST, Gaithersburg, USA
- 12:30 Lunch boxes distributed in Il Ciocco reception lobby
- 12:45 - 18:00 **Conference Excursion to Lucca and a Luchese villa** (optional)
- New Instrumentations and Developments**
- 19:00 – 19:20 **In- situ techniques for mechanical testing of nanoscale structures**  
Julia Nowak, Hysitron, USA
- 19:20 – 19:40 **Using the DCM II to make mechanical measurements at the nanoscale**  
Warren Oliver, Nanomechanics, Inc., Oak Ridge, USA
- 19:40 – 20:00 **Recent nanotest breakthroughs – environmental control for reliable cold (to -50°C) and hot nanoindentation (to 750°C), and improved nano-cratch and wear testing**  
Ben Beake, Micro Materials Ltd., Wrexham, Wales, UK
- 20:00 – 20:20 **Apex as new nano and micro indentation, scratch and imaging instrument for nano-mechanical testing of materials**  
Norm Gitis, CETR, California, USA
- 20:30 - 21:30 Dinner
- 21:30 - 22:30 Social hour (sponsored by Agilent Technologies)

**Thursday, 15 October 2009**

- 07:30 - 09:00 Breakfast
- Applications, high temperature and different environments**
- 09:00 - 09:40 **Shape memory and superelasticity of Cu-Al-Ni in confined volumes (Plenary)**  
Ying Chen, MIT, Cambridge, USA
- 09:40 - 10:10 **Micromechanical testing for superplasticity at the nanoscale (E)**  
Amiya K. Mukherjee, University of California, Davis, USA
- 10:10 - 10:40 **The effect of hydrogen and grain boundaries on dislocations by means of nanomechanical testing methods (E)**  
Horst Vehoff, Saarland University, Saarbrücken, Germany
- 10:40 - 11:10 Coffee break
- 11:10 - 11:40 **Local modifications in ultra low-k (ULK) insulating materials in micro-electronic products studied with nanoindentations and FM-AFM (E)**  
Ehrenfried Zschech, Globalfoundries Inc, Dresden, Germany
- 11:40 - 12:00 **High Temperature instrumented microindentation: a local probe to test the mechanical behavior of turbine materials (R)**  
Michel Fajfrowski, Michalex, Orsay, France
- 12:00 - 12:20 **High temperatures nanoindentation: The effect of indenter temperature on apparent material response (R)**  
Nicola M. Everitt, University of Nottingham, Nottingham, UK
- 12:20 - 12:40 **Plasticity of the new MAX - Phase material Ti/SnC studied by nanoindentation (R)**  
Christophe Tromas, Universite de Poitiers, Chassenuel, France
- 13:00 - 14:00 Lunch
- 14:00 - 16:30 Free Time / ad hoc discussions
- Soft Matter (Polymers and Bio)**
- 16:30 - 17:00 **Nanomechanical dynamic testing of tissues and tissue surrogate materials (E)**  
Krystyn J. Van Vliet, MIT, Cambridge, USA
- 17:00 - 17:20 **Dynamic nanoindentation of articular cartilage (R)**  
Oliver Franke, MIT, Cambridge, USA
- 17:20 - 17:40 **Quantifying arterial stiffness changes due to diabetes using nanoindentation (R)**  
Riaz Akhtar, University of Manchester, Manchester, UK
- 17:40 - 18:10 Refreshments
- 18:10 - 18:40 **Dynamics of confined polymer deformation during mechanical processing for nanostructure fabrication (E)**  
Graham L. W. Cross, Trinity College Dublin, Dublin, Ireland
- 18:40 - 19:00 **Nanoindentation and the mechanical characterization of viscoelastic solids (R)**  
Erik G. Herbert, University of Tennessee, Oak Ridge, USA

**Thursday, 15 October 2009 (continued)**

20:00 - 22:00

Conference Banquet (Sponsor: Hysitron)

**Friday, 16 October 2009**

07:30 – 09:00

Breakfast

09:00 – 12:00

**General Discussion** (Optional)

12:30

Lunch and Departures

## Poster Session I

- 1. Hydrogen embrittlement: Quantitative evaluation of sensitivity in extremely small volumes via in situ electrochemical nanoindentation**  
Afrooz Barnoush, Saarland University, Germany
- 2. Analysis of the inverse square - root plasticity size effect**  
Andy Bushby, Queen Mary University of London, UK
- 3. Towards a safe procedure for measuring the unloading stiffness in instrumented indentation**  
Jon Alkorta, CEIT, Spain
- 4. Nanoindentation: considerations on the area function calibration**  
Peter Nagy, CRC Hungarian Academy of Sciences, Hungary
- 5. Reversible deformation and incipient plasticity during nanoindentation test in MgO**  
Christophe Tromas, Université de Poitiers, France
- 6. Mechanical properties of individual inorganic fullerene-like nanoparticles**  
Ofar Tevet, Weismann Institute of Science, Israel
- 7. Mechanical properties of wear-tested (001) nickel using nanoindentation techniques**  
Neville Moody, Sandia National Laboratories, USA will present for Megan J. Cordill, Erich Institute, Austrian Academy of Sciences
- 8. Modulus Mapping – Mechanical testing at ultralow loads**  
Ude Hangen, Hysitron, Inc., USA
- 9. Techniques for the analysis of indentation experimental data**  
Warren Oliver, Nanomechanics, Inc., USA
- 10. TEM study of deformation mechanisms during nanoindentation of NiTi**  
Janine Pftzing-Micklich, Ruhr University Bochum, Germany
- 11. Calibration issues in nanoindentation experiments**  
Alberto Barone, Istituto Italiano di Tecnologia, Italy
- 12. Time dependent effects on glass indentation**  
Carlos Mauricio Lepienski, Univerdidade Federal do Paraná, Brazil
- 13. The concept of instrumented indentation hardness of lamellar materials**  
Carlos Mauricio Lepienski, Univerdidade Federal do Paraná, Brazil
- 14. The hardness of amorphous solids**  
Joseph Jakes, University of Wisconsin-Madison, USA
- 15. Influence of pre-straining and indenter angle on the indentation size effect of single-crystal Mo and W**  
Benedikt Scharfe, University of Erlangen-Nürnberg, Germany
- 16. A critical reassessment of the elastic unloading in sharp instrumented indentation experiments: Mechanical properties extraction**  
Sara Rodriguez Pulecio, University of São Paulo, Brazil
- 17. Effects of plastic indenter deformation on spherical instrumented indentation tests: The reduced elastic modulus**  
Sara Rodriguez Pulecio, University of São Paulo, Brazil
- 18. Indentation size effect at elevated temperatures**  
Oliver Franke, Massachusetts Institute of Technology, USA

- 19. Determination of dislocation density from atomistic data**  
Jun Hua, Ruhr University Bochum, Germany
- 20. Nanoindentation experiments with mixed load for the determination of Young's modulus and Poisson's ratio: A comparison between analytical theory, FEM and measurement**  
Andre Clausner, TU Chemnitz, Germany
- 21. Effective indenter concept for the determination of thin films Young's modulus and yield strength**  
Matthias Herrmann, Chemnitz University of Technology, Germany
- 22. Experimental and numerical study of the indentation response of granular materials**  
Guillaume Kermouche, University of Lyon, France
- 23. The effect of surface roughness on nanoindentation of hard coatings: Simulation and experiment**  
Claudia Walter, University of Leoben, Austria
- 24. Effect of hydrostatic pressure on mechanical properties of ZDTP tribofilms investigated by nanoindentation**  
Sandrine Bec, UMR CNRS 5513, Ecole Centrale de Lyon, France
- 25. Measuring the elastic modulus and residual stress of free-standing thin films using nanoindentation techniques**  
Erik Herbert, University of Tennessee, USA
- 26. Investigations of the fracture toughness of thin films with bulge testing – Thickness dependence in silicon nitride films**  
Benoit Merle, University of Erlangen-Nürnberg, Germany
- 27. The experimental study of the perimeter plastic deformation during scratch hardness test**  
Alexey Useinov, Technological Institute for Superhard and Novel Carbon Materials, Russia
- 28. Determination of fracture toughness of bulk materials and thin films by nanoindentation**  
Kirsten Schiffmann, Fraunhofer IST, Germany
- 29. Preparation and characterization of model porous silica thin films**  
Etienne Barthel, CNRS/Saint-Gobain, France
- 30. Scratching behavior of nanostructured Ti-Al-N and Ti-Al-Si-N protective coatings**  
Peter Nagy, CRC Hungarian Academy of Sciences, Hungary
- 31. Local residual stress and delamination behavior of industrial DLC coatings**  
Jens Schaufler, University of Erlangen-Nürnberg, Germany

## **Poster Session II**

- 32. A combinatorial approach to investigate solid solution hardening by nanoindentation**  
Oliver Franke, Massachusetts Institute of Technology, USA
- 33. Mechanical behavior of products from Zr-based alloys**  
Yuriy Perlovich, Moscow State University Engineering Physics Institute, Russia
- 34. Challenges and applications of elevated temperature nanoindentation**  
Ben Beake, Mico Materials, Ltd., UK
- 35. Indentations on YSZ thermal barrier coating layers deposited using different morphologies of starting powders**  
Kee Sung Lee, Kookmin University, Korea
- 36. Nanomechanical Testing of Nanofibers**  
Adam Parviz, Islamic Azad University-Naragh Branch
- 37. Influence of the dendritic/interdendritic chemical composition on the mechanical properties of a 4th generation superalloy studied by nanohardness cartography**  
Christophe Tromas, PHYMAT, Université de Poitiers, France
- 38. Grinding additive effect on fatigue sensitivity of brittle material tested with nanoindentation**  
Christell Guerret, LTDS/Ecole Centrale de Lyon/CNRS, France presenting for Mathieu Skrzypczak
- 39. Nanoindentation at sample temperatures up to 900° K**  
Wolfgang Stein, SURFACE, Germany
- 40. Mechanical behavior of thermal barrier bondcoats with high temperature instrumented microrindentation**  
Michel Fajfrowski, Michalex, France
- 41. Influence of the production process of ultrafine AL99.5 on the local and macroscopic mechanical behavior in terms of the strain rate sensitivity**  
Verena Maier, University of Erlangen-Nürnberg, Germany
- 42. Experimental and numerical investigations of the scratch response of amorphous polymers: Recovery and healing phenomena**  
Guillaume Kermouche, University of Lyon, ENISE, LTDS, France
- 43. Nanomechanical investigations on polyoxazolines**  
Erik Rettler, Friedrich-Schiller-University-Jens, Germany
- 44. Fast feedback control for nanoindentation on polymers**  
Ude Hangen, Hysitron, Inc., USA
- 45. Investigation of polymers with an ultra high stability nanoindentation tester**  
Nicholas Conte, CSM Instruments SA, Switzerland
- 46. Links between microstructure, mechanical properties and scratching behavior of injection-moulded polypropylene**  
Sandrine Bec, UMR CNRS 5513, Ecole Centrale de Lyon, France
- 47. Direct measurement of contact area in macro indentatin of viscoelastic polymers**  
Tanya Ekers, Queen Mary University of London, UK
- 48. Probing mechanical properties of fully hydrated, electrochemically stimulated polymer composites via instrumented nanoindentation**  
Zeynep Kalcioglu, Massachusetts Institute of Technology, USA

49. **Uniaxial compression of sub-micron sized pillars milled in nanolayered AL/PD thin films displaying layer-thickness dependent strengthening**  
Pranesh Dayal, University of New South Wales, Australia
50. **Microcompression behavior of silicon between 25 and 400°**  
Sandra Korte, University of Cambridge, UK
51. **Size dependent brittle to ductile transition in semiconductors**  
Rudy Ghisleni, EMPA, Switzerland
52. **Loss of mechanical size effect in micropillars of an ODS superalloy**  
Baptiste Girault, Leibniz Institute for New Materials, Germany
53. **Correlation between critical temperature and strength of small-scale bcc pillars**  
Andreas Schnieder, Leibniz Institute for New Materials, Germany
54. **Enhanced superlayer test method for the characterization of thin film adhesion**  
Michael Coulombier, UCL/iMMC, Belgium presenting for Alexandre Boé
55. **In-situ Laue diffraction during compression of Mo pillars**  
Julien Zimmermann, Paul Scherrer Institute, Switzerland
56. **Indentation fracture toughness measurement of thin film nanoporous films**  
Dylan Morris, National Institute of Standards & Technology, USA
57. **In-situ electron backscatter diffraction (EBSD) during the compression of micropillars**  
Johann Michler, EMPA, Switzerland will present for Christoph Niederberger
58. **Free edge and heterophase interface effects in nanoindentation measurements**  
Joseph Jaks, University of Wisconsin-Madison/USFS Forest Products Laboratory, USA