SYMPOSIUM MS01

Extreme Mechanics
December 2 - December 6, 2019

Symposium Organizers
Basile Audoly, CNRS et École polytechnique
Irene Beyerlein, University of California, Santa Barbara
Chiara Daraio, California Institute of Technology
Avinash Dongare, University of Connecticut

* Invited Paper

SESSION MS01.01: Session I
Session Chairs: Chiara Daraio, Lihua Jin and Claire Lestringant
Monday Morning, December 2, 2019
Hynes, Level 1, Room 109

8:00 AM *MS01.01.01
Modeling Shape Transforming Truss Metamaterials with a Geometrically Exact Beam Model Claire Lestringant and Dennis Kochmann
ETH Zurich, Switzerland
California Institute of Technology, United States

8:30 AM *MS01.01.02
Designing Nano-Architected Materials for Extreme Mechanical Properties Lorenzo Valdevit, Jens Bauer, Cameron Crook, Anna Guell Izard, Meng-Ting Hsieh, Yunfei Zhang and Marti Sala
University of California, Irvine, United States

9:00 AM MS01.01.03
A Next Generation Auxetic Reinforced Self-Confining Concrete Metamaterial Simos Gerasimidis and Andrew Gross
University of Massachusetts, Amherst, United States
Harvard University, United States

9:15 AM MS01.01.04
Shape-Morphing Shells with Programmed Temporal Behaviors Ruslan Gussev, Connor G. McMahan, Jesus Perez, Chiara Daraio and Bernd Bickel
IST Austria, Austria
California Institute of Technology, United States

9:30 AM *MS01.01.05
Phase-Transforming Metamaterials Lihua Jin
University of California, Los Angeles, United States

10:00 AM BREAK

10:30 AM *MS01.01.06
Undulating Sheets are Shape-Switching Metamaterials with Martin van Hecke
Leiden University & Amolf, Netherlands

11:00 AM MS01.01.07
Stretchable Mechanical Metamaterial Fibers with Extreme Toughness Christopher B. Cooper and Michael Dickey
North Carolina State University, United States

11:15 AM MS01.01.08
Experimental Realization of a New Zero Poisson's Ratio Structure Vladimir Gaal, Varlei Rodrigues, Socrates O. Dantas, Douglas S. Galvão and Alexandre F. Fonseca
State University of Campinas, Brazil
Universidade Federal de Juiz de Fora, Brazil

11:30 AM MS01.01.09
Tunable Strain Rate-Adaptive Impact Energy Dissipation via Liquid-Crystalline Elastomers Seung-Yeol Jeon, Zeyu Zhu, Lichen Fang, Nicholas Traugutt, Christopher Yakacki, Thao Nguyen and Sung H. Kang
Johns Hopkins University, United States
University of Colorado Denver, United States

11:45 AM MS01.01.10
Graphene-Based Nanoscale Version of Da Vinci’s Reciprocal Structures Alexandre F. Fonseca and Douglas S. Galvao
State University of Campinas, Brazil

SESSION MS01.02: Session II
Session Chairs: Chiara Daraio, Jonathan Hopkins, Dirk Mohr and Pablo Zavattieri
Monday Afternoon, December 2, 2019
Hynes, Level 1, Room 109

1:30 PM *MS01.02.01
Mechanics of Optical-Tweezer Fabricated Micro-Granular Crystals Samira Chizari, Miles Lim, Michael Porter, Sydney Austin and Jonathan Hopkins
University of California, Los Angeles, United States

2:00 PM MS01.02.02
Enhancing the Recoverability of Ceramic Nanolattices through Double Hollow Tube Architectures Marianna Diamantopoulou, Thomas Tancogne-Dejean, Jeffrey Wheeler and Dirk Mohr
ETH Zurich, Switzerland

2:30 PM MS01.02.03
Stress- and Temperature-Induced Phase Transformation in Architectured Materials Yunlan Zhang, Kristiaan Hector, Mirian Velay, David Restrepo, Nilesch Mankame and Pablo D. Zavattieri
Purdue University, United States
The University of Texas at San Antonio, United States
General Motors Research and Development, United States

3:00 PM BREAK

3:30 PM *MS01.02.05
Increasing the Structural Efficiency of Mechanical Metamaterials—Moving from Truss- to Plate-Lattice Architectures for Optimal Stiffness and Energy Absorption Thomas Tancogne-Dejean, Marianna Diamantopoulou, Colin Bonatti and Dirk Mohr
ETH Zürich, Switzerland

4:00 PM MS01.02.06
Extraordinary Energy Absorption via High Rate Deformation of Multiwall Carbon Nanotube Mats Edwin L. Thomas, Jinho Hyon, Owale Lawal and Ramasathan Thevamanil
Rice University, United States
Eglin Air Force Base, United States
University of Wisconsin–Madison, United States

4:15 PM MS01.02.07
Elastocapillary Assembly of Cellular Structures Shucong Li, Belei Deng and Joanna Aizenberg
Harvard University, United States

4:30 PM MS01.02.08
Pulse-Driven Robot—Motion via Solitary Waves Belei Deng and Katia Bertoldi
Harvard University, United States
SESSION MS01.03: Session III
Session Chairs: Marino Arroyo, Katia Bertoldi, Antonio DeSimone and Ryan Elliott
Tuesday Morning, December 3, 2019
Hynes, Level 1, Room 109

8:15 AM MS01.03.01
A Viscoelastic Beam Theory of Polymer Jets with Application to Rotary Jet Spinning Qihan Liu1,2 and Kevin Kit Parker1,2; 1Harvard University, United States; 2Wyss Institute for Biologically Inspired Engineering, United States

8:30 AM *MS01.03.02
Extreme Mechanics of Epithelial Monolayers Marino Arroyo; Universitat Politècnica de Catalunya, Spain

9:00 AM MS01.03.03
Domain Formations and Pattern Transitions via Instabilities in Soft Heterogeneous Materials Jian Li1 and Stephan Rudykh; 1Technion–Israel Institute of Technology, Israel; 2University of Wisconsin – Madison, United States

9:15 AM MS01.03.04
3D Helicoidally Architectured Thin-Film Composite for Tougher Bio-Inspired Material Komal Agarwal1, Sahay Rahul1, Anbazhagan Subramani1, Avinash Baji2 and Arief S. Budiman1; 1Singapore University of Technology and Design, Singapore; 2La Trobe University, Australia

9:30 AM *MS01.03.05
The Wild Complexity Born from a Simple Nonlinearity and How to Tame It—A Reprise of the "Beam on an Elastic Foundation" Ryan S. Elliott1, Timothy J. Healey2, Nicolas Triantafyllidis1, Shrinidhi Pandurangi1 and Ariel Ibarra Pino1; 1University of Minnesota, United States; 2Cornell University, United States; 3École Polytechnique, France

10:00 AM BREAK

10:30 AM *MS01.03.06
Extreme Mechanics of Soft Structures Katia Bertoldi; Harvard University, United States

11:00 AM MS01.03.07
Snap-Shaping Origami Sheets Anne Meeussen1,2 and Martin van Hecke1,2; 1AMOLF, Netherlands; 2Leiden University, Netherlands

11:15 AM MS01.03.08
Interplay of Origami Structure Properties in Fold Path Bifurcation Analysis Andrew S. Gillman, Matthew Grasinger and Phil Buskohl; Air Force Research Laboratory, United States

11:30 AM *MS01.03.09
Morphing and Shape Control—From Mechano-Biology to New Technologies Antonio DeSimone1,2; 1SISSA, Italy; 2Scuola Superiore Sant’Anna, Italy

SESSION MS01.04: Session IV
Session Chairs: Javier Segurado and Zhigang Suo
Tuesday Afternoon, December 3, 2019
Hynes, Level 1, Room 109

1:30 PM *MS01.04.01
Highly Fatigue-Resistant Stretchable Materials Zhigang Suo; Harvard University, United States

2:00 PM MS01.04.02
Negative Creep Behaviour and Thermomechanical Alleviation in Titanium Alloys under Cyclic Loading Yihan Xu and Fionn Dunne; Imperial College London, United Kingdom

2:15 PM MS01.04.03
Atomistic Modeling of Cyclic Loading and Heat Treatment Processes for Tuning the Mechanical Properties of Amorphous Alloys Nikolai Priezjev; Wright State University, United States

2:30 PM MS01.04.04
Extreme Fatigue Life of Graphene Teng Cui1, Sankha Mukherjee1, Parambath M. Sudeep1, Guillaume Colas2, Farzin Najaf3, Jason Tam1, Pulickel Ajayan2, Chandra V. Singh1, Yu Sun1 and Tobin Fillreter1; 1University of Toronto, Canada; 2Rice University, United States

2:45 PM MS01.04.05
Ultrahigh Temperature In Situ TEM Single Boundary Coble Creep Experiments Shen J. Dillon; University of Illinois at Urbana Champaign, United States

3:00 PM BREAK

3:30 PM *MS01.04.06
Coupled Models for Polycrystalline Deformation—Creep and Deformation at High Strain Rates Javier Segurado1,2, Marco Magri1, Jifeng Li1,2 and Ignacio Romero1,2; 1Technical University of Madrid (UPM), Spain; 2IMDEA-Materials Institute, Spain; 3Technical University of Madrid, Spain

4:00 PM MS01.04.07
Plasticity Effects in the Buckling of Supported Thin Films Junyu Yang, Sameer Damle, Spandan Mati and Soehin Velankar; University of Pittsburgh, United States

4:15 PM MS01.04.08
Ductile-to-Brittle Transition of Micron-Sized Niobium at Cryogenic Temperature Gyoho Song and Seok-Woo Lee; University of Connecticut, United States

4:30 PM MS01.04.09
High Heat and Particle Damage Effects on Tungsten and Tungsten Carbide Mosaic Seg Vint C. Chintrron1, Alec M. Cacheris2, Sean R. Kosslow1, John R. Echols1 and Leigh Winfrey1; 1The Pennsylvania State University, United States; 2The University of Tennessee, Knoxville, United States; 3Oak Ridge National Laboratory, United States

4:45 PM MS01.04.10
Investigation of Indentation Cracking of 6H-SiC at Elevated Temperatures Using HR-EBSD and FIB Tomography Bo-Shuian Li, Anna Kareer, Junliang Liu, Phani Karunchad, Angus J. Wilkinson and David Armstrong; University of Oxford, United Kingdom
8:30 AM *MS01.05.01
Understanding Multicomponent Alloy Phenomena via Quantitative Imaging and Spectroscopy Mitra L. Taheri1,2; 1Drexel University, United States; 2Johns Hopkins University, United States

9:00 AM MS01.05.03
Ultra-High Stress Mediated Lattice Disturbance and Twinning Nucleation Scott X. Mao; University of Pittsburgh, United States

9:15 AM *MS01.05.04
Healing of Nano-Cracks in Metals Due to Stresses Induced by Mechanically-Driven Grain Boundary Migration Ta Duong1, Abhilash Mokkeri1, Christopher Barr2, Ankit Srivastava1, Khalid Hattar2, Brad Boyce3 and Michael J. Demkowicz4; 1Texas A&M University, United States; 2Sandia National Laboratory, United States

9:45 AM MS01.05.05
Grain Boundary Engineering Leading to Enhanced Mechanical Properties of Superhard Boron Carbide Qi An1, Dezhou Guo1 and Madhav Reddy2; 1University of Nevada, Reno, United States; 2University of Missouri–Kansas City, United States

10:00 AM BREAK

10:30 AM MS01.05.06
Interface-Microstructure-Enabled Mechanical Behavior of Metallic Nanocomposites Amit Misra; University of Michigan–Ann Arbor, United States

11:00 AM MS01.05.07
Advanced Multimodal Studies of Microstructural Evolution under Shear Deformation Arun Devaraj1, Bharat Gwalani1, Aran Devaraj2, Brianna Collins1, Tamas Varga1, Changyong Park2, Jorge D. Santos3, Tiffany Kaspar1, Peter V. Sushko1, Suvene N. Mathaudhu1 and Cynthia Powell2; 1Pacific Northwest National Laboratory, United States; 2Argonne National Laboratory, United States; 3North Carolina A&T State University, United States

11:15 AM MS01.05.08
Shear-Induced Deformation under a Microscope—Intermixing and Metastability in Heterolayers Peter V. Sushko1, Tiffany Kaspar2, Jinhui Tao1, Bharat Gwalani1, Aran Devaraj2, Brianna Collins1, Tamas Varga1, Yang He1, Chengmin N. Wang1, Aashish Rohatgi1 and Suvene N. Mathaudhu2; 1Pacific Northwest National Laboratory, United States; 2University of Washington, United States; 3University of California, Berkeley, United States

11:30 AM *MS01.05.09
The Influence of 3D Atomic-Level Interface Structure on the Mechanical Behavior of Nanocomposites Nathan Mahr1, Justin Y. Cheng1, Youxing Chen2, Nan Li1, Kevin Baldwin1 and Irene J. Beyeler1; 1University of Minnesota, United States; 2University of North Carolina at Charlotte, United States; 3Los Alamos National Laboratory, United States; 4University of California, Santa Barbara, United States

2:00 PM MS01.06.02
Nanosecond Resolved Temperatures of Shock Initiated Insensitive Energetic Materials Meysam Akhtar and Dana D. Dlott; University of Illinois at Urbana-Champaign, United States

2:15 PM MS01.06.03
Tracking Hot Spot Growth and Temperatures in a Model Plastic-Bonded Explosive Under Shock Compression Belinda P. Johnson, Hoya Ihara and Dana D. Dlott; University of Illinois at Urbana-Champaign, United States

2:30 PM BREAK

3:30 PM *MS01.06.04
Novel Contributions to Deformation and Properties in Gradient Materials Suveen N. Mathaudhu1,2; 1University of California, Riverside, United States; 2Pacific Northwest National Laboratory, United States

4:00 PM MS01.06.05
Distinct Driven Steady States Emerge from Diverse Initial Textures in Rolled Nanocomposites Ian Chesser1, Elizabeth A. Holm1 and Michael J. Demkowicz2; 1Carnegie Mellon University, United States; 2Texas A&M University, United States

4:15 PM *MS01.06.06
A Dynamic Look at MAX Phase Deformation and Damage Behavior Leslie Lamberson1, Xingyuan Zhao1, Hussien Badr1, Maxim Sokol2, Garritt Tucker3 and Michel Barsoum4; 1Colorado School of Mines, United States; 2Drexel University, United States

4:45 PM MS01.06.07
High Strain Rate Compressive Behavior of Nanocrystalline Nickel Microlattices Rajaprabh Ramachandranmorthy1, Patrik Schirch1, Jakob Schwiederzik1, Thomas E. Edwards1, Damian Frey2, Jean-Marc Breguet2, Laetitia Philippe3 and Johann Michler3; 1Empa-Swiss Federal Laboratories for Materials Science and Technology, Switzerland; 2Alemnis AG, Switzerland

SESSION MS01.07: Session VII
Session Chairs: Curt Bronkhorst, Abigail Hunter and Jeffrey Lloyd
Thursday Morning, December 5, 2019
Hynes, Level 1, Room 109

8:00 AM MS01.07.01
Hydrostatic Compression of the Portland Cement Clinker Minerals—Computational Modeling Investigations Nirmalay Barua, Ingrid Espinosa and Ram V. Mohan; North Carolina A&T State University, United States

8:15 AM MS01.07.02
Continuum Dislocation Dynamics-Based Grain Fragmentation Modeling Georges Ayoub1, Ali Al-Hadi Kobaissy2 and Mu'Tasem Shehadeh3; 1University of Michigan, United States; 2American University of Beirut, Lebanon

8:30 AM *MS01.07.03
Scale Bridging Damage Model for Quasi-Brittle Metals Informed with Crack Evolution Statistics Kevin Larkin1, Esteban Roguier2, Viet Chau2, Gowri Srinivasan2, Abdessattar Abdelkefi3 and Abigail Hunter2; 1New Mexico State University, United States; 2Los Alamos National Laboratory, United States

9:00 AM *MS01.07.04
Finite Amplitude Buried Blast Loading on Additively Manufactured Lattice Structures Jeffrey Lloyd1, Christopher Cummins1 and Eric Faierson2; 1U.S. Army Research Laboratory, United States; 2Western Illinois University, United States
MS01.09.03  Designing a Mechanical Metamaterial Inspired from Crystalline Quartz  Hye-in Na and In-Suk Choi; Seoul National University, Korea (the Republic of)

MS01.09.04  High Temperature Mechanical Behavior of 3D Printed Inconel 718 Observed by In Situ Transmission Electron Microscopy  Supriya Koul, Le Zhou, Yongho Sohn and Akihiro Kushima; University of Central Florida, United States

MS01.09.05  Revealing the Photo-Induced Non-Thermal Amorphization Mechanism of Phase Change Material  Subodh C. Tiwari1, Aichiro Nakano1, Fuyuki Shimjo2, Rajiv Kalia3, Paulo Branicio1 and Priya Vashishta3; 1University of Southern California, United States; 2Kumamoto University, Japan

MS01.09.06  Stabilizing Laser Shock Peening Induced Compressive Residual Stresses for High Temperature Applications of Additively Manufactured Parts  Ali Behesthi1, Kasra Momeni1, Lloyd Hackel1 and Keivan Davami2; 1George Mason University, United States; 2Louisiana Tech University, United States; 3Metal Improvement Company, Surface Technologies, Curtiss Wright, United States; 4The University of Alabama, United States

MS01.09.07  Microstructure Evolution During Shear Banding in Compressed Nanocrystalline Ceramic Nanopillars Observed In Situ  Haw-Wen Hsieh, Shu Li, Karin Dahmen and Jian-Min Zuo; University of Illinois at Urbana-Champaign, United States

MS01.09.08  Carbon Schwarzites Behavior Under Ballistic Impacts  Levi C. Felix3, Cristiano F. Woellner2 and Douglas S. Galvao1; 1University of Campinas, Brazil; 2Federal University of Paraná, Brazil

MS01.09.09  Role of Anisotropy in Swelling-Driven Fracture of Phase-Transforming Battery Materials  Ataollah Mesgarnejad and Alain Kroma; Northeastern University, United States

MS01.09.10  Microstructure and Tensile Behavior of Nanostructured Gradient TWIP Steel  Jie Ding, Zhongxia Shang, Jin Li, Haiyan Wang and Xinghang Zhang; Purdue University, United States

MS01.09.11  Low Temperature Compression of Glassy Carbon  Dougal G. McCulloch1, Sherman Wong1, Thomas Shiel2, Brenton Cook2, Jodie Bradby2 and David McKenziel; 1RMIT University, Australia; 2Carnegie Institute of Washington, United States; 3The Institution of Mechanical Engineers, United Kingdom; 4Massachusetts Materials Technologies, United States

MS01.09.12  Engineering Impact Modification of Polypropylene for Energy Absorption under Extreme Loading Conditions  Chinmay Saraf and Alan J. Lesser; University of Massachusetts Amherst, United States

MS01.09.13  The Role of High-Temperature Annealing of Graphene Aerogels  Martin Silhavik, Zahid Ali Zafar and Jiri Cervenka; Institute of Physics of the Czech Academy of Sciences, Czechia

MS01.09.14  High Rate Mechanical Characterization of Glassy Polymer Thin Films Using High-Rate Micro-Particle Impact Test  Shawn H. Chen, Amanda Souna, Edwin P. Chan, Christopher Soles and Stephan J. Stranick; National Institute of Standards and Technology, United States

MS01.09.15  Limit of Temporal Resolution with Atomically-Engineered Probes while Preserving Picometer Range Spatial Resolution  Onur E. Dugeviren; Yale University, United States

MS01.09.16  WITHDRAWN 11/20/2019  MS01.09.16  Flexoelectric Metamaterials  Irene Arias, Alice Mocci and Amir Abdollahi; Universitat Politècnica de Catalunya - BarcelonaTech, Spain

MS01.09.17  Carbon Nanotube Peapods under High-Strain Rate Conditions—A Molecular Dynamics Investigation  José M. de Sousa1, Cristiano F. Woellner2, Leonardo D. Machado1, Pedro A. Autredo3 and Douglas S. Galvao1; 1Instituto Federal do Piauí, Brazil; 2Federal University of Paraíba, Brazil; 3Federal University of Rio Grande do Norte, Brazil; 4Federal University of ABC, Brazil; 5University of Campinas, Brazil

MS01.09.18  Understanding Mechanical Behaviors of Auxetic Foams via Pore Structure Characterization Using X-Ray Tomography  Lamei Du and Ye Ma; Beihang University, China

MS01.09.19  Characterization of Metal Strength and Toughness through Frictional Sliding Contact Mechanics  Soheil Safari Loalahan, Ryan Lacy, Parth Patel, Steven Palkovic and Simon Bellemare; Massachusetts Materials Technologies, United States

MS01.09.20  Magneto-Active Elastomers with Strong Mechnano-Magnetic Interaction—A Theoretical Framework for Numerical Simulations  mb Yin Liu and Changyong Cao; Michigan State University, United States

MS01.09.21  Development of Energy Absorption Materials by Using the Fractal-Cut Concept  Juhee Kim1, Vivek A. Karuppasamy2, Young-Joo Lee3, Jeong-Yun Sun1, In-Suk Choi1, Myoung-Gyu Lee1 and Kijung Lee3; 1Seoul National University, Korea (the Republic of); 2Korea Institute of Science and Technology, Korea (the Republic of); 3University of Pennsylvania, United States

MS01.09.22  Mechanical Property Changes of Tungsten Thin Films Due to Hydrogen or Helium Implantation  Yoshiaki Habu, Heun Tae Lee, Akira Nagakubo, Hirotsugu Ogī, Kenzo Iibano and Yoshio Ueda; Osaka University, Japan

MS01.09.23  Enhanced Damage Tolerance of Pre-Deformed Tungsten Microwires with High Dislocation Density  Chaqun Deng and Yang Lu; City University of Hong Kong, Hong Kong

MS01.09.24  Size Effects on Creep and Creep Fracture Mechanisms of Single-Crystal Metallic Nanomaterials  Hirokuki Hirakata, Takayuki Nagashima, Kotoro Yanaguchi and Takahiro Shimada; Kyoto University, Japan

MS01.09.25  Metal Doping Effects on the Sinterability and Mechanical Properties of Boron Carbide  Yoshihiko Oka, Ryuichiro Koyama, Koug Nakamura, Junya Watanabe and Satomi Maruyama; Tokyo City University, Japan

MS01.09.26  Super Ductile Iron—Nano-Sized Structure and Fatigue Behavior  Wentao Zhou, Kewen Dong and Cheng Liu; Yangzhou University, China
Defect Formation in 4 nm Au Nanocrystals under High Pressure
Abhinav Parakh1, Sangryun Lee2, Lindsey Hanson3, Mehrdad T. Kiani3, David Doan4, Martin Kunz4, Andrew Doran4, Seunghwa Ryu2 and Wendy Gu1; 1Stanford University, United States; 2Korea Advanced Institute of Science and Technology, Korea (the Republic of); 3Trinity College, United States; 4Lawrence Berkeley National Laboratory, United States

Heterostructured Metastable Aluminum-Magnesium System Processed by High-Pressure Torsion Megumi Kawasaki1, Jae-Kyung Han1 and Klaus-Dieter Lise2; 1Oregon State University, United States; 2Guangdong Technoton-Israel Institute of Technology, China

The Transformation of Glassy Carbon to Diamond at High Pressure Using Pulse Laser Heating Brenton Cook1, Thomas Shiel2, Sherman Wong3, David McKenzie4, Matthew Field1, Bianca Haberl4, Reinhard Boehler4, Jodie Bradby4 and Dougal G. McCulloch4,5; 1RMIT University, Australia; 2Carnegie Institution of Washington, United States; 3The University of Sydney, Australia; 4Oak Ridge National Laboratory, United States; 5The Australian National University, Australia

Anomalies in Mechanical Response During Microscale Extrusion of Metals Bin Zhang and Wen Jin Meng; Louisiana State University, United States

Quasi-Plastic Zone Characterization of Regular and Si-Doped Boron Carbide Sisi Xiang and Kelvin Y. Xie; Texas A&M University, United States

Superior Energy Dissipation by Nanoscale Semi-Crystalline Polymer Films under High-Speed Micro-Projectile Impacts Jizhe Cai and Ramathasan Thevamaran; University of Wisconsin-Madison, United States

Microstructural Instability of Polycrystalline Zirconia under High Temperature and Extreme Electrochemical Conditions Yanhao Dong1, I-Wei Chen2 and Ju Li1; 1Massachusetts Institute of Technology, United States; 2University of Pennsylvania, United States

Suboptimal Toughness of Uniform Grain Boundary Distribution Edwin Chu, Michael J. Demkowicz and Ankit Srivastava; Texas A&M University, United States

Thermal Conductivity of Earth Minerals at Extreme Conditions Irina Chuvashova, Zachary Geballe and Alexander Goncharov; Carnegie Science, United States