

Topic:	**High Temperature Nanomechanics**
Speaker:	**Prof. Javier LLorca** IMDEA Materials Institute | Polytechnic University of Madrid, Spain
Date:	**30 October 2013, Wednesday**
Time:	**10.00am to 11.00am**
Venue:	**EA-06-05** *(map of NUS can be found at http://map.nus.edu.sg/)*
Host:	**Dr. Shailendra P Joshi**

Abstract

Nanomechanics and micromechanics experiments have become very popular in recent years as they provide unique evidence of the deformation and damage processes at the μm and nm scale. This information is of paramount importance to design novel materials with optimized properties, to develop physically-based models (as opposed to phenomenological ones) of the mechanical behaviour and to explore size effects in the realm of nanotechnology. Basic experimental techniques to achieve these goals involve either *in situ* mechanical testing within a microscope (so the actual deformation and damage processes can be resolved at the submicron scale), instrumented nanoindentation (in which a very small volume is deformed) or a combination of both. In addition to the experimental challenges, nanomechanics often requires the use of sophisticated simulations tools (atomistics, dislocation dynamics, crystal plasticity, etc.) to interpret the results.

A further challenge in nanomechanics is the extension to high temperature. This is important from the theoretical point of view, as many deformation mechanisms are thermally-activated, as well as from the engineering side. In fact, many current or intended applications of nanostructured materials (metal-ceramic nanoscale multilayers in integrated circuits interconnects, high absorbance coatings in thermo-solar applications, radiation-resistant nanostructured metals, etc.) involve operation at high temperature. However, the field of high temperature nanomechanics is a rather unexplored area because of the challenges associated with thermal drift (while trying to measure nm), oxidation, chemical reactions and microstructure evolution in very small specimens or nanostructured materials.

In this seminar, the current activities at IMDEA Materials Institute on the area of high temperature nanomechanics will be reviewed. They include the competition among different deformation mechanisms (slip and twinning) in Mg-Al-Zn and Mg-Mn-RE alloys as a function of temperature [1-2], and the determination of the size and temperature effects on deformation mechanisms of LiF [111] micropillars [3] and of Al/SiC metal-ceramic nanoscale multilayers [4-5]. Experimental results will be interpreted and understood to the light of dislocation dynamics and crystal plasticity simulations (in the case of LiF micropillars) and of finite element modelling (Al/SiC multilayers).

[1] C. J. Boehlert, Z. Chen, I. Gutiérrez-Urrutia, J. LLorca, M. T. Pérez-Prado **Acta Materialia, 60**, 1889-1904, 2012.
[2] C. Boehlert Z. Chen, I. Gutiérrez-Urrutia, J. LLorca, J. Bohlen, S. Yi, D. Letzig, M. T. Pérez-Prado. **Philosophical Magazine, 93**, 598-617, 2013.
[3] R. Soler, J. M. Molina-Aldareguía, J. Segurado, J. LLorca, R. I. Merino, V. M. Orera. **International Journal of Plasticity, 36**, 50-63, 2012.
[4] S. Loftian, J. M. Molina-Aldareguía, K. E. Yazzie, J. LLorca, N. Chawla. **Philosophical Magazine Letters, 92**, 362-367, 2012.
[5] S. Lotfian, M. Rodríguez, K. E. Yazzie, N. Chawla, J. LLorca, J. M. Molina-Aldareguía. **Acta Materialia, 61**, 4439-4451, 2013.

About the Speaker

Prof. Javier LLorca earned his Ph. D. in Materials Science at Polytechnic University of Madrid in 1986 and was appointed Associate Professor in the Department of Materials Science in 1987 and Professor in 1995. Since 2007, he is director of the Madrid Institute for Advanced Studies in Materials and head of the research group on "Advanced Structural Materials and Nanomaterials" at the Polytechnic University of Madrid. His research activities have been focused in the systematic application of computational tools (molecular dynamics, dislocation dynamics, crystal plasticity, computational micromechanics, homogenization theory, etc.) and multiscale modeling strategies (in the range nm to m) to establish the link between the microstructure and the macroscopic mechanical behaviour of a wide range of materials including metallic alloys, ceramics, amorphous and crystalline polymers, high performance fibres and biological materials. A key feature of his contributions is the use of novel experimental techniques to determine the properties of the phases and interfaces in the material at the microscopic level. These tools have become the foundation of the modern techniques of virtual testing, which are starting to be used by the aerospace industry to minimize the number of costly mechanical tests to characterize and certify composite materials.

Prof. LLorca, a Fulbright scholar, is a Fellow of the European Mechanics Society. He currently holds the Prof. Brahm Prakash Visiting Professorship, India Institute of Science and is a Guest Professor of Shanghai Jiao-Tong University and has held visiting positions at Brown and Cornell Universities. He has received numerous awards, including the Research Award from the Spanish Royal Academy of Sciences, the Research award from the Polytechnic University of Madrid and the Gold Medal from the Spanish Structural Integrity Society. He is currently Associate Editor of *Modelling and Simulation in Materials Science and Engineering*, *Composites Science and Technology, Materials Science and Engineering A*, and *International Journal of Engineering Sciences*. He has co-authored over 160 research papers in international peer-reviewed journals, holds an h-index of 37, and has given more than one hundred invited talks at national and international conferences and research centers throughout the world.

Admission is free. All are welcome to attend.