



# Institute for Materials Science

UNCLASSIFIED

## IMS Distinguished Lecturer Series



Dr. Johann Michler  
Empa- Thun, Switzerland  
Mechanics of Materials and Nanostructures

### **Mechanical Properties of Materials at the Microscale under Extreme Conditions: A Swiss Journey from Mechanical Watches to Human Bone**

Wednesday, October 18, 2017  
2:00 - 3:00 pm  
MSL Auditorium (TA-03 - Bldg 1698 - Room A103)

**Abstract:** The talk will give first an overview on the activities of the Swiss Federal Laboratories for Materials Science and Technology. Then several recently developed techniques used to measure mechanical properties at small length scales under conditions will be presented. One of the techniques allows for variable temperature and variable strain rate testing of micron sized samples within a scanning electron microscope for in-situ observation. By utilising a displacement-controlled micro-compression setup, which applies displacement using a miniaturized piezo-actuator, the attainable range of strain rates has been recently extended up to  $\sim 10^4$  s<sup>-1</sup> as well as cyclic loading up to 10<sup>7</sup> cycles. With this system it is also possible to achieve stable variable temperature indentation and micro-compression experiments at temperatures as low as -150°C and up to 700°C. Additionally, recent developments have allowed for the capability to conduct electron backscatter diffraction (EBSD) during micro-mechanical testing. Combined with the cross-correlation technique (HR-EBSD), the strain/stress field and the GNDs distribution can be mapped at several steps during progressive deformation. Using these new capabilities, the size dependent plasticity and fracture mechanics of a number of materials have been explored, ranging from monocrystalline silicon to nanocrystalline and amorphous metals. Activation parameters such as activation volume and activation energy were determined and discussed in view of the most probable deformation mechanism. An example will be given for micropillar compression in titanium, followed by in-situ EBSD observation to analyse the local shear stress on the active twin variant. Finally, a number of thin films with complex microstructure were examined using samples fabricated in a novel vacuum deposition system combining ALD, PVD, and inert gas condensation of nanoparticles. Throughout the talk, a number of industrial and medical applications will be highlighted ranging from Swiss watches, MEMS based Gyroscopes, hard coatings for cutting tools, and biological applications ranging from wood to human bone.

**Bio:** Johann Michler is head of the Laboratory of Mechanics of Materials and Nanostructures at Empa the Swiss Federal Laboratories for Materials Science and Technology. He received his diploma in Materials Science at the University of Erlangen-Nürnberg in Germany in 1995 and a PhD degree in Materials Science at the Swiss Federal Institute of Technology Lausanne, Switzerland in 2000. He is lecturer at EPFL since 2005. At EMPA he started his activities as staff scientist directly after his phd. He liked it there very much and stayed ever since. His current research interest focuses on scale dependent mechanical properties of materials. His research efforts include the development of in-situ SEM and Raman, based mechanical testing methods and novel synthesis methods for metals and semiconductors like electrochemical, atomic layer or physical vapor deposition. He is the author or co-author of more than 300 publications and is co-founder of two start-up companies.

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To be on Dr. Michler's Agenda, to participate in the Early Career Lunch, or for general information contact  
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Hosted by Alexander Balatsky \* Director of the institute for Materials Science