

## Materials Science and Engineering

## The 2012 Jerome B. Cohen Distinguished Lecture Series

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### “The White Spot on the Map - Complex Metallic Alloys”

The year 2012 marks the 30<sup>th</sup> anniversary of the discovery of quasicrystals. In the past three decades scientists tried to understand why quasicrystals are forming, what is behind their particular structure and how this structure influences the particular physical properties. Searching for answers to these questions it was found that there exists an extended class of metallic alloys whose short-range atomic order is quite similar to that found in quasicrystals but, in contrast to the latter, their structure is nevertheless periodic exhibiting classical point-group symmetry. Their crystal lattice is based on giant unit cells comprising hundreds to thousands of atoms [1, 2]. In contrast to the family of quasicrystals these alloys, termed *Complex Metallic Alloys (CMAs)*, are quite abundant. Many of their physical properties are similar to those of quasicrystals, others scale with the size of the unit cell. An interesting topic is the study of the plastic deformation behavior. It is based on the propagation of so called metadislocations comprising hundreds of atoms per unit-cell thickness in the dislocation core [3]. The fascinating result of the studies on metadislocations is that the alloys make use of transformations to a number of closely related phases whose particular atomic structure relaxes the elastic energy [4]. This novel mechanism of plasticity indicates that studying the plastic behavior of alloys is still good for surprises. The lecture will give an introduction into the field of *Complex Metallic Alloys* and elaborate on the extraordinary plastic behavior. In order to be able to follow no particular knowledge of quasicrystal or CMA crystallography is required.

[1] Urban, K. & Feuerbacher, M. (2004). Structurally complex alloy phases. *J. Non Cryst. Sol.* 334, 143 - 153.

[2] Dubois, J.-M., Belin-Ferré, E. & Urban, K. Edts (2010). *Complex Metallic Alloys: Fundamentals and Applications*, Wiley-VCH (Weinheim).

[3] Heggen, M., Houben, L. & Feuerbacher, M. (2010). Plastic-deformation mechanism in complex solids. *Nature Materials* 9, 332 - 336.

[4] Heggen, M., Houben, L. & Feuerbacher, M. (2011). Metadislocations in the complex metallic alloys T–Al–Mn– (Pd, Fe). *Acta Materialia* 59, 4458 – 4466.

**Professor Knut Urban** studied physics at the Technical University of Stuttgart where he also received his Doctor degree in natural sciences 1972. He was a staff scientist at the Max Planck Institute for Metal Research in Stuttgart from 1972 till 1986 when he became Professor for General Materials Properties at the University of Erlangen-Nuremberg. In 1987 he took over a Chair for Experimental Physics at RWTH Aachen University, and he became Director at the Institute for Solid State Research at the Research Center Juelich. In 2004 he founded the Ernst Ruska Centre for Microscopy and Spectroscopy with Electrons at Juelich as an international user center in the field of advanced electron optics.

He retired from his position at Juelich in August 2010. And took over an appointment as JARA Senior (Distinguished) Professor at RWTH Aachen University. He spent extended times as Guest Professor at Bhabha Research Centre, Mumbai/India, at Saclay Research Centre in Paris/France and at Tohoku University Sendai/Japan. Currently he is also affiliated as a Professor to Tsinghua University, Beijing, and Jiaotong University, Xi'an, China.

His research interests range from ultra-high resolution electron optics to the physics of complex alloys, dielectrics, oxide superconductors and Josephson-effect based Terahertz spectroscopy. Together with Max Haider and Harald Rose he developed during the nineties aberration-corrected electron optics and on this basis atomic-resolution electron microscopy.

From 2004 to 2006 he was President of the German Physical Society. Among his awards are the 2007 Karl-Heinz Beckurts Prize for Innovation, the 2007 Von Hippel Award of MRS and the 2008 Honda Prize for Ecotechnology. In 2011 he was awarded the Wolf Prize in Physics.