MSE-Colloquium@NTU

26 September 2016, 2.30 pm
Lecture Theatre 9, Nanyang Technological University

Interfacial States and Thermodynamic Transitions at Interfaces

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About the Talk

Since the 1980s it has been recognized that the structure of grain boundaries in polycrystalline ceramics can have a diffuse nature, characterized by a ~1nm thick nominally amorphous film. More recently, the structure of grain boundaries has been described following diffuse interface theory, stating that the structure and chemistry of grain boundaries, interfaces and surfaces can go through two dimensional transitions between thermodynamic states (sometimes termed complexions). As an example, surface reconstruction is a first order complexion transition, equivalent to a discontinuous change in the level of adsorbed excess. As such complexions for interfaces are analogous to phases in bulk, although they are not bulk phases. In the past these conclusions had been reached based on structural characterization of grain boundaries and interfaces correlated with mechanical and electrical properties, and more recently it has been shown that specific complexions can have a significant influence on grain boundary mobility, and thus the morphology of an evolving microstructure. To date, almost all of these studies have been conducted at grain boundaries in single phase polycrystalline systems, which by definition are not at equilibrium, and in some cases it is not even clear if the identified complexions are at steady-state. Similar questions have been raised for studies focusing on metal-ceramic interfaces from thin film studies, where the deposition process used to form the samples may be very far from equilibrium. This presentation will focus on an experimental approach to address the structure, chemistry and energy of (metal-ceramic) interfaces which are fully equilibrated, from which it can be demonstrated that formation of a distinct structural and chemical state at equilibrium minimizes interface energy. This will be compared with solid-liquid interfaces, where a region of ordered liquid exists adjacent to the interface at equilibrium, and the details of a reconstructed solid-solid interfaces where the reconstructed interface structure accommodates lattice mismatch for a nominally incoherent interface. These three systems will be compared to known reconstructed solid surfaces, which can also be described within a more generalized Gibbs adsorption isotherm.

About the Speaker

Professor Wayne D. Kaplan is the Executive Vice President for Research at the Technion, and is a full professor in the Department of Materials Science and Engineering at the Technion where he holds the Karl Stoll Chair in Advanced Materials. He completed his BSc in Mechanical Engineering, and his MSc and DSc in Materials at the Technion. He then spent a year as a Humboldt Fellow at the renowned Max-Planck Institute in Stuttgart Germany before joining the Technion faculty in 1995. During the past 20 years Prof. Kaplan's research activities at the Technion have focused on the structure, chemistry and energy of interfaces between metals and ceramics. Applications from these basic studies include the development of metal-ceramic composites for use in high temperature applications (such as jet engines and automobile brake-pads), flash memory devices, and defense (transparent ballistic armor). In addition to his fundamental research in materials engineering, Prof. Kaplan works on the development of electron microscopy techniques for characterization at the sub-nanometer length-scale. Prof. Kaplan, whose research aims at understanding how the arrangement of atoms at metal-ceramic interfaces influences the material's properties, makes intensive use of the Technion's special high resolution transmission electron microscope (the Titan) at the Electron Microscopy Center. Prof. Kaplan is the author of more than 130 scientific articles, including 4 publications in Science, as well as two textbooks: Joining Processes and Microstructural Characterization of Materials, both published by Wiley. In 2006 he received the Henry Taub Prize for Academic Excellence. He is a fellow of the American Ceramic Society, a member of the Israel Microscopy Society, and was an editor of the Journal of Materials Science (Springer).

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