

## MICROSTRUCTURAL PROCESSES OF CYCLIC DEFORMATION AND FATIGUE OF ULTRAFINE-GRAINED METALS

Prof. H. Mughrabi  
Department of Materials Science and Engineering  
University of Erlangen-Nurnberg  
Germany

**15<sup>th</sup> October 2009, Thursday, 4:00 p.m. – 5:00 p.m**  
**Science Lecture Theatre S11**

Bulk ultrafine-grained (UFG) metals and alloys prepared by techniques of severe plastic deformation (SPD), in particular by equal channel angular pressing (ECAP), exhibit exceptional mechanical properties. With respect to potential applications of this new class of very fine-grained bulk materials, the cyclic deformation and fatigue behaviour, compared with that of conventional grain (CG) size materials, is of crucial importance. Research performed on fatigued very fine-grained bulk materials during the last few years will be presented. The discussion will focus on fatigue of simple materials and of some alloys and structural materials. In order to capture the effects of fatigue strength in high cycle fatigue (HCF), as displayed in a Wöhler (S-N) plot, and of fatigue ductility in low cycle fatigue (LCF), represented in the Coffin-Manson plot, it is best to display the data in total strain fatigue life diagrams. In general, UFG materials exhibit a considerably improved fatigue strength in the HCF regime. However, at the same time, microstructural instabilities in the form of cyclic softening, fatigue-induced grain coarsening (by dynamic recrystallization at rather low homologous temperature!) and massive shear banding impair in particular the LCF performance. Mild annealing treatments leading to so-called bimodal grain structures have been partially successful in improving the LCF strength by enhancing the ductility at the expense of a moderate loss of strength. The circumstances of the occurrence of such bimodal grain structures and their effects on the mechanical properties will be discussed critically. Examples of modelling of the cyclic deformation and fatigue properties will be presented, and some directions of future research will be outlined.

Professor Hael Mughrabi specialized in metal physics and performed research in the fields of crystal defects, mechanical properties and microstructural characterization. He joined the University of Erlangen-Nürnberg in 1984 as a professor of Materials Science and Engineering and Head of the Institute of General Materials Properties. In subsequent years, he held positions as Department Head and Dean of the School of Engineering. He has published 300 papers and book chapters and has been editor/co-editor of several books and conference proceedings on crystal plasticity, materials characterization, metal fatigue, high-temperature mechanical properties of nickel-base superalloys and modelling of mechanical behaviour. He is Honorary Member of the German Materials Society (Deutsche Gesellschaft für Materialkunde, DGM) and is the recipient of several national and international awards, including the highest award of DGM, the Heyn-Denk Münze.

Visitors are most welcome: Please note the parking arrangements. There is a designated Visitors Car Park (N1) clearly ground-marked by white paint and tickets, at a cost of \$3/day, are available from a dispensing machine. ('Blue' permit designated areas are for Monash members only.). It is also possible to park at other designated Visitors Car Parks (E1, S1 and S2) on the Clayton Campus, but tickets are \$1.4/hour.

Convenor: Prof. Jian-Feng Nie  
Tel: 9905 9605  
Email: [nie@eng.monash.edu.au](mailto:nie@eng.monash.edu.au)