EXPERIMENTAL ANALYSIS OF MATERIAL DEFORMATION AT THE MICRO- AND MESO- SCALES

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Focus Material: Metals

Focus of the Presentation:
(ii) Multi-scale data acquisition, characterization and experiments at different scales;

Abstract

The last decade has seen considerable advances in methods at the micro- and meso-scale for characterizing the response of metallic alloys to mechanical stimuli. A wealth of small-scale mechanical testing methods have emerged; often facilitated by focused ion beam instruments to machine small test-pieces at selected microstructural features and nano-indenters with the sensitivity to test them. At the same time spatially resolved electron and X-ray methods for characterizing stress, strain and dislocation density variations at the meso-scale have been developed. There is great synergy between these experimental advances and those being made in physically-based micro-mechanical modelling.

Examples will be given from our work on micro-cantilever testing which we have used to isolate different slip systems in hcp metals and extract critical resolved shear stress values which can then be used with crystal plasticity finite element simulations of polycrystal behaviour [1]. A recent extension of quasi-static cantilever testing to dynamical excitation for probing (very) high cycle fatigue properties will be described.

The high angular resolution electron backscatter diffraction (HR-EBSD) method for mapping lattice strain and rotation variations will also be described. Its utility will be illustrated by examining statistical variations in stress and dislocation density in relation to position in the microstructure [2].

References

[1] Gong J, Britton TB, Cuddihy MA, Dunne FPE, Wilkinson AJ, 2015, "〈a〉 Prismatic, 〈a〉 basal, and 〈c+a〉 slip strengths of commercially pure Zr by micro-cantilever tests", Acta Materialia **96**, pp. 249-257.

[2] Jiang J, Britton TB, Wilkinson AJ, 2015, "Evolution of intragranular stresses and dislocation densities during cyclic deformation of polycrystalline copper", Acta Materialia **94**, pp. 193-20.