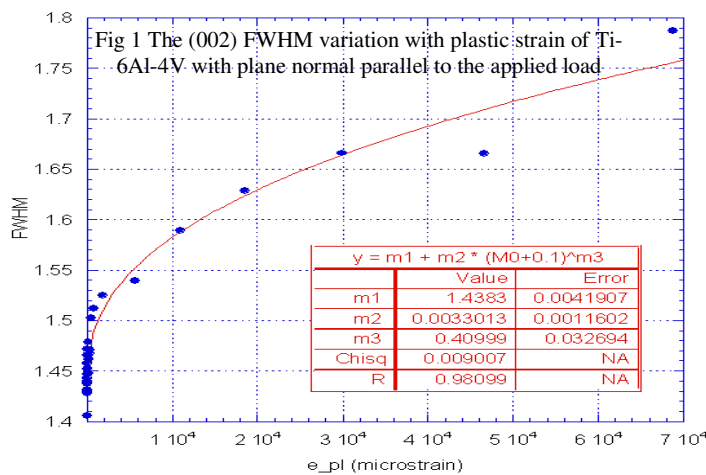


ELASTIC-PLASTIC DEFORMATION OF A POLYCRYSTALLINE TITANIUM ALLOY STUDIED IN SITU BY ENERGY-DISPERSIVE SYNCHROTRON X-RAY DIFFRACTION

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Elastic lattice strain in polycrystalline assemblies evolves as a function of applied load due to elastic and plastic deformation mechanisms. The detailed nature of this deformation is complex and depends on the local arrangement of grains, their morphology and orientation, etc. To obtain mesoscopic (intermediate) scale description of polycrystal deformation, one approach that can be adopted is to measure the average lattice strain response of grain groups sharing common orientation by diffraction as the sample is subjected to increasing uniaxial load [1]. This reveals the anisotropy of the response of individual reflections (orientation grain groups), and enables the determination of the inhomogeneous fields of elastic and eventually plastic strain, if the measurements are combined with suitable interpretation and modeling approaches. Regions of localized macroscopic plasticity may be identified, and the prediction of fatigue crack initiation may also be addressed using energy dissipation at the micro-scale [2].

In the present study in situ loading and synchrotron X-ray diffraction experiments on Ti-6Al-4V alloy were performed. Multiple diffraction peaks were obtained from the experiments and both single peak fitting and Pawley pattern refinement were used for interpretation. The calculation of stress-strain response of hkl lattice planes based on the a and c lattice parameters obtained from Pawley pattern refinement was in good agreement with the results obtained by single peak fitting. The orientation dependence of polycrystal lattice stiffness and strain is discussed and a modified profile function for pattern refinement is proposed to provide an improved description of anisotropic behavior. Diffraction peak broadening was considered and the correlation between peak width and plastic strain was found (Fig 1). The intergranular strain responses for differently oriented crystallites obtained from the diffraction experiments were compared to the crystal plasticity finite element model predictions and used for validation of the model.



[1] D. Dye, H.J. Stone, R.C. Reed, Intergranular and interphase microstresses, *Current Opinion in Solid State and Materials Science* 5 (2001) 31–37

[2] X. Song, S Y Zhang, D Dini and A M. Korsunsky, Inter-granular residual stresses in polycrystalline aggregates: finite element modelling and diffraction post-processing, *Proceedings of MECA SENS IV* (2007)