Study of Elasto-plastic Deformation in Mg Alloy Using Synchrotron Radiation

Mina Golshan[a], David Laundy[a], Shu Yan Zhang[b], Willem Vorster[b], Daniele Dini[b], Alexander Korsunsky[b], David Latham[b], [a]*Daresbury Laboratory, Warrington,Cheshire, UK.* [b]*Department of Engineering,University of Oxford, UK.* E-mail: m.golshan@dl.ac.uk

Strain scanning using monochromatic and white beam X-rays is becoming increasingly popular for measuring the residual and live stresses within engineering samples and test pieces.

This work presents the results of a study of elasto-plastic deformation in bent bars of magnesium alloy using 68.5 keV monochromatic synchrotron X-rays and white radiation. We have developed a fast monochromatic method where an aperture is scanned across an image plate exposing a fresh part of the plate at each step, and the sample is simultaneously scanned through the X-ray beam. A complete set of 'diffraction segments' are recorded on the image plate showing peak positions, texture and peak broadenings as a function of position in the sample. The measurements made with the energy dispersive, white beam technique are consistent with the new monochromatic method. We demonstrate that information about plastic deformation can be successfully extracted not only from peak shape variation, but also from the relative peak positions (difference strains) between different reflections. The difference arises as a consequence of elastic and plastic anisotropy of grains in response to loading, and sheds light on the micromechanics of polycrystalline systems. The plastic strain distribution obtained in this way provides a general correlation between plastic deformation history and the properties of the observed diffraction peaks.

Keywords: strain scanning, synchrotron radiation, magnesium alloy