THE EFFECT OF CRYSTALLOGRAPHIC ORIENTATION ON NANOHARDNESS AND ELASTIC MODULUS IN PURE MAGNESIUM AND AZ31 MAGNESIUM ALLOY

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Abstract

Magnesium alloys appear to be a suitable candidate for weight saving structural materials in many applications due to their low density and high specific strength. However, their hexagonal closed-packet (hcp) crystal lattice causes undesired anisotropic mechanical properties. In this study we examined anisotropy of mechanical properties by in-situ nanoindentation technique. Pure magnesium and the most common magnesium alloy AZ31 (nominally 3 wt. % Al, 1 wt. % Zn, 0.3 wt. % Mn, balance Mg) were used as a model case in the present work. Crystal orientations of individual grains were mapped by Electron Backscatter Diffraction (EBSD) camera fitted with Scanning Electron Microscope (SEM). Thereafter, hardness and elastic modulus were measured by in-situ nanoindentation in the SEM and correlated with orientation data. We show that mechanical properties of pure magnesium and AZ31 alloy are dependent on crystallographic orientation. Both hardness and elastic modulus are higher when indentation direction is normal to the basal plane and lower when direction is normal to the prismatic plane. We also show correlation between crystal orientation and indentation size effect (ISE) for measured materials.

Keywords: Mechanical properties, nanoindentation, nanohardness, magnesium, AZ31, EBSD, ISE

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