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Study of the precipitation strengthening in Mg-Sn-Zn alloy using synchrotron radiation

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In this work, SAXS/WAXS and powder diffraction beamlines at the Australian synchrotron were employed to study the mechanical response of an Mg-Sn-Zn alloy. First, volume fraction and particle size of Mg₂Sn precipitates as a function of aging time (0h, 2h, 4h, 10h, 24h) at 200 °C was evaluated using small angle x-ray scattering (SAXS). Then the corresponding samples were deformed in-situ using the powder diffraction beamline to determine internal strains and deformation mode activity. Mg₂Sn precipitates were found to provide a strong electronic density contrast and thus act as strong X-Ray scatterers, which is ideal for SAXS. The SAXS data were analysed assuming spherical precipitate morphology to yield the size distribution and volume fraction. Elastic strains were determined to an accuracy of $\pm 2 \times 10^{-4}$. Relaxation of internal stresses (indicated by internal strain measurements) were used to determine the onset of basal slip. Intensity changes were used to mark the onset of twinning. The results show a good correlation between precipitate volume fractions and onset of plasticity. Internal stresses within the precipitates reveal negligible influences of back-stresses. These findings provide important insight into the mechanism of strengthening

Keywords

Mg, precipitate, SAXS, powder diffraction, elastic lattice strain, deformation

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