Structure Determination of Embedded Precipitates by Precession Electron Diffraction and Synchrotron Radiation: A Comparison

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Phases that appear in industrially important materials are often difficult to prepare in a form suitable for structure determination by standard X-ray methods. The metastable, η′-phase in age-hardened Al-Zn-Mg alloys occurs only as nano-sized semicoherent precipitates embedded in the alloy matrix. Previous X-ray [1], and HRTEM [2] work have not provided a satisfactory structure solution. The η′ structure has therefore been analyzed by us, using three-dimensional electron diffraction data collected from thin-foils prepared from the age-hardened 88.12 at%Al, 10.2 at%Zn, 1.68 at%Mg alloy, as well as synchrotron radiation data obtained from individual grains extracted from a specially prepared alloy casting.

Structure analysis of the η′-phase is met with several complications: Faults are frequent, composition and density are not known; the diffraction patterns are superpositions of four equivalent orientations of the hexagonal η′-lattice relative to the aluminum matrix ($a^*_{\eta'}$ =(1/3) $[220]_{Al}$; $c^*_{\eta'}$ = (1/6)$[1\text{-}11]_{Al}$). The data are thus incomplete, due to overlap of reflections - and are in the electron case severely influenced by matrix-precipitate double diffraction. The latter effect was suppressed in our study, by the precession technique [3]. A three-dimensional data set to was collected by merging intensities from five projections. Synchrotron data from the same projections were extracted from a continuous three-dimensional intensity recorded on a MAR image plate.

Patterson and Fourier maps calculated from the incomplete intensity data obtained by either technique led to a structure model, in the space group, $P6_3mm/c$ (194). Comparisons between selected area and precession electron diffraction with the synchrotron data will be presented.

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