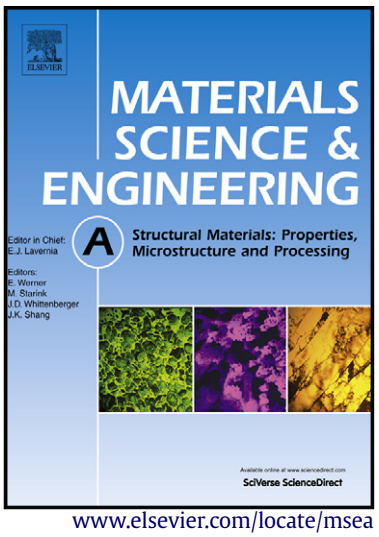

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Effect of pre-straining on the aging behavior and mechanical properties of an Al-Cu-Mg-Ag alloy

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Abstract. The effects of cold deformation prior to aging on the precipitation behavior, microstructure and mechanical properties of an Al-5.6Cu-0.72Mg-0.5Ag-0.32Mn-0.17Sc-0.12Zr (in wt. %) alloy were investigated. Pre-straining disrupts the formation of Mg-Ag co-clusters, modifying normal precipitation sequence. A strong increase in the dislocation density by a factor of 100 leads to a ~40% decrease in the number density, N, of the Ω-phase at pre-strains of $\varepsilon \geq 1\%$ ($\varepsilon \geq 0.01$). The aspect ratios of the platelets in this phase increased from ~21 to ~42 after a negligible pre-strains of ≤1% ($\varepsilon \leq 0.01$) and further decreased to ~25 in the pre-strain interval 1-80% ($\varepsilon \sim 0.01$-1.61). In addition, the nucleation of the Cu-rich θ′-phase occurs on dislocations. The heterogeneous nucleation of the thick Ω-phase particles with low aspect ratios (~12) and equiaxed particles of S-phase with dimension ≤5 nm on the deformation-induced boundaries was found. After peak aging, the yield stress (YS) and ultimate tensile strength (UTS) increased from 478±4 MPa and 522±8 MPa for as-quenched alloy to 516±4 MPa and 568±6 MPa in the longitudinal and 554±5 MPa and 601±3 MPa in the transversal directions, respectively, for the alloy subjected to pre-straining with a rolling reduction of 80% ($\varepsilon \sim 1.61$). Cold rolling prior to aging induces the anisotropy in mechanical behavior through the formation of deformation bands.

Keywords aluminium alloys; thermomechanical processing; ageing; hardening; precipitation; mechanical characterization

1. Introduction

Age-hardenable aluminum alloys belonging to the Al-Cu-Mg-Ag system are used in the aerospace industry due to their attractive combination of high specific strength, good fracture toughness and enhanced creep resistance attributed to the highly efficient strengthening by the Ω-phase [1-10]. This phase is a coherent modification of the equilibrium θ-phase (Al_2Cu) that forms as a uniform dispersion of thin, hexagonal plates with large aspect ratios (diameter/thickness) on the $\{111\}_\alpha$ habit planes [2-5,11-15]. The replacement of the Al atoms in the entire first and second layers on the broad face of the Ω-phase plate in the direction normal to the Ω/Al interface with either Ag or Mg, respectively, lowers the interfacial energy of the $(001)_\Omega//(111)_\alpha$ interface and aids in accommodation of the misfit and the volumetric strain that exist between the Ω-phase and the Al lattice [4,5]. Thus, Ag and Mg segregation at the interfaces provides a high degree of coherence on