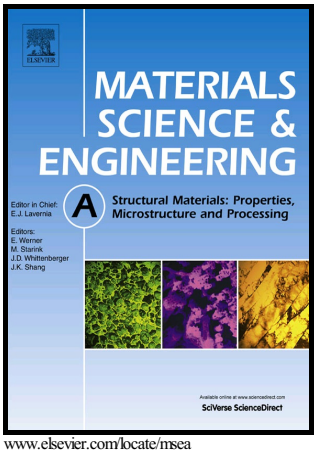
Effect of plastic deformation on the ageing behaviour of an Al–Cu–Mg alloy with a high Cu/Mg ratio

Ivan Zuiko, Rustam Kaibyshev



www.elsevier.com/locate/msea

PII: S0921-5093(18)31218-8
DOI: https://doi.org/10.1016/j.msea.2018.09.017
Reference: MSA36898

To appear in: *Materials Science & Engineering A*

Received date: 18 June 2018
Revised date: 6 September 2018
Accepted date: 7 September 2018

Cite this article as: Ivan Zuiko and Rustam Kaibyshev, Effect of plastic deformation on the ageing behaviour of an Al–Cu–Mg alloy with a high Cu/Mg ratio, *Materials Science & Engineering A*, https://doi.org/10.1016/j.msea.2018.09.017

Effect of plastic deformation on the ageing behaviour of an Al–Cu–Mg alloy with a high Cu/Mg ratio

Ivan Zuiko[1, a *], Rustam Kaibyshev[1, b]

[1]Belgorod State University, Pobeda 85, Belgorod 308015, Russia

[a]zuiko_ivan@bsu.edu.ru, [b]rustam_kaibyshev@bsu.edu.ru

* Corresponding author.

Abstract

The effect of tensile strain ranging from 1 to 7% on the decomposition sequence and mechanical properties of an AA2519 alloy with low Si content is studied. Pre-straining promotes the precipitation of θ′- and Ω-phases at dislocations and suppresses the precipitation of GP-zones and θ″-phase. The aspect ratio (AR) of the homogeneously nucleated Ω_I-phase is higher than that of the Ω_{II}-phase nucleated on the θ′-phase/Al interfaces by a factor of ~4. Replacement of θ″-phase by a dispersion of θ′- and Ω-phases took place under peak-ageing condition and thus imparted only a minor hardening effect, despite a seven-fold increase in the volume fraction of the strengthening precipitates. An increase in the yield stress by 30% with increasing pre-strain from 1 to 7% is attributed to an increase in the lattice dislocation density. Over-ageing leads to replacement of the Ω_{II}-phase by the θ′-phase.

Keywords: Aluminium alloys; Thermomechanical processing; Mechanical properties; Precipitation; Deformation structure; Ageing.

1. Introduction

Al–Cu–Mg alloys with a high Cu/Mg ratio are used as armor plates and components in aerospace due to their excellent combination of strength and ductility [1,2]. The superior mechanical properties of the AA2519 alloy, which belongs to this system, are achieved through thermomechanical processing (TMP), which involves solution treatment, cold working by rolling or stretching and subsequent artificial ageing [1-4]. Minor Mg addition to an Al–Cu solid solution results in a complex ageing behaviour [3-5], including the classic precipitation sequence wherein transition phases have plate-like shapes and $\{001\}_\alpha$ habit planes:

$$SSSS \rightarrow \text{GP-zones } (Al_3Cu) \rightarrow \theta'' (Al_3Cu) \rightarrow \theta' (Al_2Cu) \rightarrow \theta (Al_2Cu) \quad (1)$$

as well as a decomposition sequence that provides the precipitation of the transition Ω-phase with $\{111\}_\alpha$ habit planes:

$$SSSS \rightarrow \{111\} \text{ clusters} \rightarrow \Omega (Al_2Cu) \rightarrow \theta\text{-phase} \quad (2)$$

where SSSS is a supersaturated solid solution, the Guinier-Preston (GP) zones are single layers of pure Cu atoms on $\{001\}_\alpha$ planes, the θ″-phase with coherent broad faces is comprised of two $\{001\}_{Cu}$ layers separated by three $\{001\}_\alpha$ planes, the θ′-phase has a bct structure with coherent broad faces along the $\{100\}_{Al}$ planes and semi-coherent interfaces at their peripheries, the θ-phase is the thermodynamic equilibrium form of Al_2Cu with a bct lattice and incoherent interfaces, and the Ω phase having orthorhombic lattice forms as thin hexagonal-shaped plates [1,6-11]. The Ω-phase does not appear to