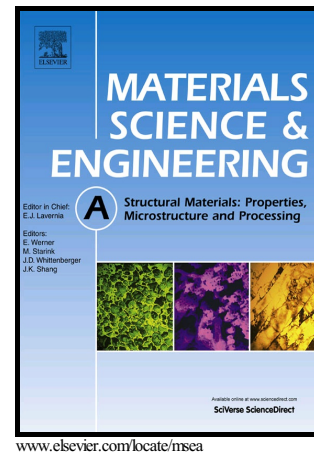


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Experimental investigation of multi-step stress-relaxation-ageing of 7050 aluminium alloy for different pre-strained conditions

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Abstract

A novel insight into the whole two-step stress relaxation ageing process during T74 multi-step ageing treatment (120 °C for 6 hours and subsequently 177 °C for 7 hours), which is typically experienced by extra-large aircraft components that contain high residual stresses, has been established. Stress relaxation ageing (SRA) tests, tensile tests and transmission electron microscopy (TEM) were performed on AA7050 samples to determine the relationship between internal microstructure and macroscopic behaviour during the stress relaxation and precipitate evolution process. Samples were subjected to SRA at different initial stresses (220-360 MPa) after being pre-strained to different extents (i.e. 0%, 1%, 3%). Room temperature tensile tests were then performed on interrupted SRA test specimens to examine the corresponding strengthening phenomenon. TEM was performed on a selection of peak-aged and T74 over-aged samples to study the precipitate distribution. At 120 °C typical stress relaxation behaviour was observed and the data followed a logarithmic curve. Subsequently at 177 °C, dislocation-creep dominated stress relaxation behaviour, with no apparent threshold stress, was observed. The absence of a threshold stress at 177 °C may be attributed to the continuous over-ageing phenomenon. The effect of pre-deformation levels and initial stresses on SRA has also been investigated. Pre-stretching, which creates uniformly distributed dislocations, promotes stress relaxation and ageing. No significant influence of initial stress level on SRA was observed at 120 °C, but noticeable effects were seen at 177 °C. The calculated stress exponent n at 177 °C is found independent of the initial stresses. These findings provide clear scientific guidance for residual stress reduction during the multi-step ageing process of AA7050 and provide the basis for residual stress prediction models.

Keywords: Stress relaxation ageing, residual stress, aluminium alloys, pre-strain, T74 multi-step ageing, precipitation process

1 Introduction

Precipitation hardening 7000 series aluminium alloys are widely used for extra-large aircraft structural components. This is due to their excellent mechanical properties, particularly their good strength-to-weight

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