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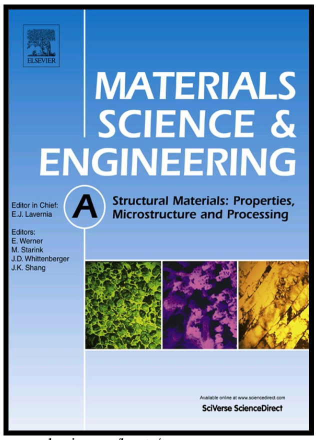

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Development of a high temperature high strength Al alloy by addition of small amounts of Sc and Mg to 2219 alloy

S. Mondol[a], T. Alam[b], R. Banerjee[b], S. Kumar[a] and K. Chattopadhyay[a*]

[a]Department of Materials Engineering, Indian Institute of Science, Bangalore-560012, India

[b]Advanced Materials and Manufacturing Processes Institute and Department of Materials Science and Engineering, University of North Texas, Denton, TX 76203-5017, USA

[*]Corresponding author: kamanio@materials.iisc.ernet.in

Abstract

The paper reports a significant improvement in tensile properties, in particular at 200°C, of commercial 2219 Al alloy by addition of small amounts of Sc (0.8 wt%) and Mg (0.45 wt%), and employing copper mould suction casting followed by natural ageing and cold rolling. Microstructural examination and measurement of hardness were performed in order to explain the effects of Sc and Mg at each processing step. It is found that the remarkable improvement of room temperature strength occurs due to fine grain size, Al_3Sc and $Al_3(Sc,Zr)$ dispersoids, GP zones on {100} and {111} planes, and work hardening. On exposure at 200°C, the GP zones transform primarily to θ′ precipitates and a few Ω precipitates. Sc and Mg atoms segregate at the θ′/matrix interface, which suppress the coarsening of θ′ precipitates and make them stable at higher temperatures. Thus, the work reports extremely high 0.2% proof stress of 542 MPa at room temperature, 378 MPa at 200°C and 495 MPa at room temperature after 200 h exposure at 200°C accompanied by reasonable ductility. Theoretical yield strength is calculated on the basis of the observed microstructure and is found to be in good agreement with the experimentally obtained value.

Keywords: 2219 Al alloys; Processing; High temperature strength; Precipitation hardening; Atom probe tomography

1. Introduction

Aluminium alloys have significant industrial importance because of their excellent properties, which include low weight, high specific strength, good corrosion resistance, and high electric and thermal conductivity. One of the primary areas of demand for Al alloys is aerospace applications. Materials for aerospace applications must exhibit high specific strength, good weldability and substantial toughness over a wide range of temperature, high damage tolerance, and good creep properties. Because of these requirements, 2xxx and 7xxx Al alloys are extensively used in aerospace industries [1,2]. 7xxx Al alloys possess the