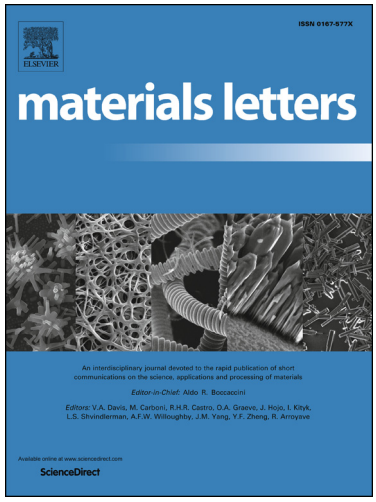

Featured Letter

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Microstructure and mechanical properties of novel Al-Mg-Mn-Zr-Sc-Er alloy

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Abstract

Microstructure and mechanical properties of a novel Al-Mg-Mn-Zr-Sc-Er alloy with low Sc concentration were investigated. Significant grain refinements and the formation of Al_3Er and ternary (Al,Mg,Er) phases were found by scanning electron microscopy and an X-ray analysis with Er addition. A high hardening effect in 30 HV was obtained after annealing at 370 °C for 4-10 h. The maximum level of mechanical properties was found after rolling with a greater part of cold deformation. The research showed that YS = 480 MPa, UTS = 524 MPa at El. = 4.2% after rolling, and YS = 370 MPa, UTS = 470 MPa at El. = 9.5% after subsequent annealing at 200 °C for 1 hour.

Keywords: Metals and alloys, Microstructure, X-ray techniques, Mechanical properties

Introduction

Rear earth elements scandium and zirconium are commonly used for improving mechanical properties of aluminum alloys. The effect of hardening is reached by forming $Al_3(Zr,Sc)$ nanosized dispersoids [1-12]. In most cases, Sc and Zr, used as alloying elements in Al-Mg alloys, increase the mechanical properties at the expense of the nonrecrystallization structure of the deformed material [1, 3-10]. For example, the authors [5] found that the yield stress was 140-170 MPa in alloys containing 5-6% Mg [5]. At the same time, the Al-6Mg-Sc alloy (1570) after hot rolling had YS = 240 MPa, UTS = 375 MPa and El = 29% [10], and the Al-6Mg-Zr-Sc alloy (in the state W) had YS = 225 MPa, UTS = 365 MPa, and El = 9% [11]. However, scandium is the most expensive alloying element in aluminum alloys. In recent years, Er has attracted much attention as an alloying element in aluminum alloys [13-22]. In [13-14], it was shown that Er significantly increased microhardness of Al-Sc-Zr and Al-Zr alloys after homogenization at 640 °C. Er with Al, Zr, and Sc formed nanosized dicpersoids Al_3Er, $Al_3(Zr,Er)$, and $Al_3(Zr,Sc,Er)$ during annealing of as cast alloys [13-18]. In [19], it was shown that Er increased thermal stability of $Al_3(Sc,Zr)$ dispersoids after annealing at 370 °C. In [20-21], the authors demonstrated that Zr and Er improved the quality of welded Al-Mg alloys at the expense of grain refinement.