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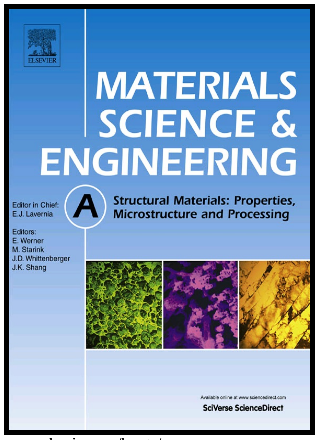

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# Role of silicon in the precipitation kinetics of dilute Al-Sc-Er-Zr alloys

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## Abstract

The precipitate nanostructure and the strength of an Al-0.055Sc-0.005Er-0.02Zr at.% alloy with Si additions, in the range 0-0.18 at.%, were investigated utilizing micro-hardness, electrical conductivity, scanning electron microscopy and atom-probe tomography techniques. Si-containing alloys are cost-effective due to the existence of Si in commercial purity Al. In all studied alloys, homogenization for at least 0.5 h at 640 °C is needed to eliminate $Al_3Er$ primary precipitates. Alloys containing the higher Si concentrations achieve higher microhardness by increasing the heterogeneous nucleation current of $(Al,Si)_3(Sc,Zr,Er)$ precipitates. The alloy containing 0.18 at.% Si achieves an 60 % improvement in peak-microhardness compared to the Si-free alloy, during isothermal aging at 400 ºC. Silicon additions reduce the peak-aging time in the temperature range 300-400 °C, indicating that the Er and Sc diffusion kinetics are accelerated. Silicon also enhance the Zr diffusion kinetics, accelerating precipitate growth during aging at 300 °C and precipitate coarsening at 400 °C. Addition of Si modifies the concentration profiles within the nanoprecipitates, enhancing the chemical homogeneity of Sc and Er in their cores, rather than forming Er-enriched-cores/Sc-enriched-shells that we have observed in prior research. Finally, the microhardness of the alloys, containing 0.12 and 0.18 at.% Si, only diminishes slightly from the peak values after isothermal aging at 375 ºC for about 2000 h, suggesting that the studied alloys can be practically utilized at this operating temperature. (225 words)

*Keywords: Al-Er-Sc-Zr alloy; atom-probe tomography; strengthening; high-temperature*