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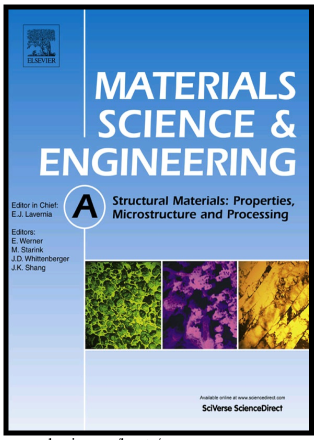

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Microstructure and superelasticity control by rolling and heat treatment in columnar-grained Cu-Al-Mn shape memory alloy

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Abstract:

The effects of rolling and heat treatment on the microstructure and superelasticity of columnar-grained $Cu_{71}Al_{18}Mn_{11}$ shape memory alloy were investigated in this paper. Two different rolling strategies were adopted: (i) multipass high-temperature rolling (HR); (ii) one-pass HR followed by several-pass cold rolling (HR+*n*CR). For the first rolling strategy, the results showed that columnar-grained microstructure was reserved after one-pass HR at 800 °C with rolling reduction of above 80%, and recrystallization would occur if more HR processes were applied. The superelastic strain could reach 5.9% in multipass HR sample through microstructure control by annealing at 800 °C. For the second rolling strategy, after the first pass HR with the reduction of 80% and annealing at 550 °C, the alloy could be cold rolled at room temperature with total reduction of 50% ~ 70%. The columnar-grained microstructure still existed in the cold-rolled alloy which consisted of two phases (i.e. $\beta_1+\alpha$). After recrystallization annealing, the HR+*n*CR alloy tend to form <011> texture along the rolling direction, which was helpful to obtain high superelasticity. Finally, the grain growth heat treatment was used to further improve the superelasticity of the cold-rolled alloy. After 2 ~ 3 times abnormal grain growth heat treatment, the grains of the alloy could grow up from several hundred micrometers to more than one centimeter in diameter; they still had strong <011> texture along the rolling direction, which enabled the superelastic strain of as high as about 7%.

Keywords: columnar grain, Cu–Al–Mn, shape memory alloy, α phase, rolling, grain growth

1. Introduction

Cu-based shape memory alloys (SMAs) are promising in large-scale industrial applications due to their lower cost compared to TiNi-based SMAs, good shape memory properties, and high electrical and thermal conductivities [1-3]. However, the application of ordinary polycrystalline Cu-based SMAs was limited by poor ductility and poor shape memory properties due to serious intergranular cracking