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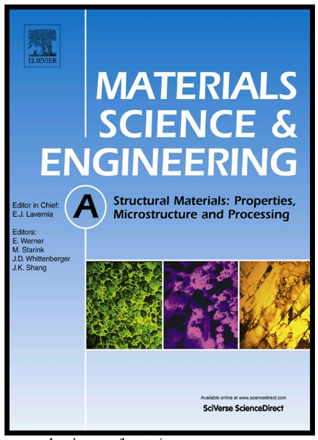

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Continuous measurement of m-parameter for analyzing plastic instability in a superplastic ultra-fine grained magnesium alloy

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Abstract

In this paper, the superplastic properties of ultra-fine grained AZ31 Mg alloy prepared by ECAP are investigated. Ultra-fine grained materials (UFG) often exhibit superplastic behavior, but UFG microstructure is not stable at increased temperatures. Due to recovery and grain growth the m-parameter of strain rate sensitivity may decrease during the tensile test. Methodology of continuous measurement of m-parameter during the tensile test is presented. Tensile tests were conducted at relatively low temperatures of 150°C - 250°C. The m-parameter decreased with increasing true strain for all studied conditions from approx. 0.5 to 0.3. The decrease was most pronounced for the highest temperature (250°C) and was attributed to recovery and recrystallization. Three different criteria of plastic instability were evaluated. Hart's criterion significantly underestimated the stability of plastic deformation, whereas other criteria based on geometrical model of grain boundary sliding were more appropriate for the description of elongation up to fracture.

Keywords: Superplasticity, Magnesium alloys, Equal channel angular pressing, Grain refinement, Recrystallization, Mechanical characterization.

1. Introduction

There are two common definitions of superplastic behavior. The first one relates the superplasticity to the minimum elongation to fracture (elongation > 400%, true strain > 160%) [1] while the other one to the dimensionless strain rate sensitivity *m*-parameter ($0.3 < m < 0.8$) [2, 3, 4]. This duality in definitions brings no ambiguity as both conditions are usually fulfilled at the same time. The reason is that strain rate sensitivity effectively suppresses necking and extends the region of plastic stability. The localization of plastic deformation leads in fact to the increase of local strain rate and consequent increase of stress, which avoids further localization