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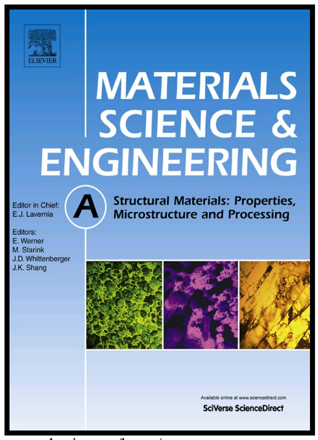

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Exceptional mechanical properties of ultra-fine grain Mg-4Y-3RE alloy processed by ECAP

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Abstract

Precipitation hardenable WE43 magnesium alloy containing yttrium and rare earth elements was processed by ECAP. Microstructure, phase composition, mechanical properties and texture of the processed material was investigated by several complementary techniques. Substantial precipitation during ECAP led to exceptional grain refinement with the resulting average grain size of ~340 nm. The processed material exhibited previously unreported weak texture without a typical component usually observed in magnesium alloys processed similarly. The observed texture resulted from a massive particle-induced recrystallization during the processing through ECAP. The ultra-fine grain microstructure, the high density of Mg_5RE particles and the specific texture resulted in the significant strengthening of the ECAPed material. The yield compression strength of ~427 MPa was by 340 % higher than that of the initial as-cast condition and by 210 % higher than that of the peek-age hardened one.

1 Introduction

Equal channel angular pressing (ECAP) is currently a widely used severe plastic deformation (SPD) processing technique to prepare materials with an ultra-fine grain (UFG) microstructure. Substantial grain refinement has been achieved in many different materials including magnesium alloys resulting in enhancement of different material properties [1]. ECAP became very popular particularly because of its effectiveness, scalability and possibility to obtain much larger samples compared to many other SPD techniques [1,2]. In magnesium alloys, the achieved average grain size after ECAP is usually >1 µm, see e.g. [3–13]. This limit is very hard to overcome because magnesium alloys need to be processed at elevated temperatures. Otherwise, subsequent pressing fails due to fracture and/or segmentation of the material [1]. The temperature increase enhances the deformability and dynamic recrystallization but reduces hardening as the driving force for recrystallization and refinement. Additionally, a grain growth in the feed-out channel may suppress the effectiveness of the grain refinement even further. Therefore, it is crucial to optimise the processing parameters for each material independently and to optimise the processing parameters of each subsequent pass, in order to limit dynamic recovery and grain growth. As a

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