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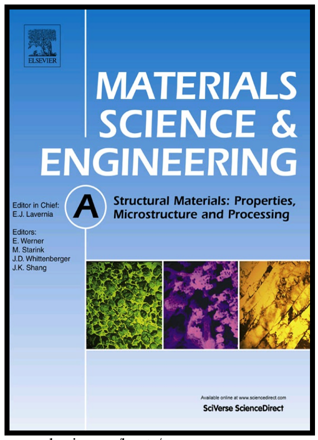

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Effect of route on tensile anisotropy in equal channel angular pressing

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Abstract:

Due to limitations in the billet dimension, the tensile anisotropy of billets processed by equal channel angular pressing (ECAP) are rarely reported. In this work, AZ91 magnesium alloy billets with a diameter of 60 mm were processed by 4 ECAP passes via route A, Ba, Bc and C. The tensile test was carried out to study anisotropy and the tensile samples were machined along 3 orthogonal directions: extrusion direction (ED), transverse direction (TD) and normal direction (ND). The crystal preferred orientation was measured via X-ray diffraction (XRD). The results showed that significant tensile anisotropy occurred for different samples. The yield strength in the TD direction was highest regardless of the sample type. The 4Bc sample had a yield strength and fracture elongation that was similar in the ED and ND directions, which attributed to the 50.5° intersection angle between the (0001) basal plane and the observation plane. The texture for 4A and 4C samples could be both expressed as $(0001)[\bar{4}\bar{1}50]$, while their pole densities were different. For the 4Ba samples, varieties of textures were formed whose pole densities were almost the same—this is responsible for the astonishing 8.9% fracture elongation in the ED direction. The basal texture dominated the tensile deformation mechanism at room temperature of the AZ91 magnesium alloy. The microstructure was greatly refined to 5 μm by 4 passes ECAP from the above value of 100 μm; the β phase was not homogenously distributed for 4Ba, 4Bc and 4C samples.

Keywords: Anisotropy; Equal channel angular pressing; Texture; AZ91; Schmid factor

1. Introduction

Equal channel angular pressing (ECAP), one of the severe plastic deformation (SPD) techniques, has been used to improve the mechanical performance of magnesium alloys for decades. Significant improvements have been achieved both in the strength and ductility [1]. The most common characterization was mechanical performance testing, which was done almost exclusively in a single direction, such as the extrusion direction (ED)[2] or the transverse direction (TD) [3, 4]. Mechanical performance in the other directions was rarely discussed - mostly because the dimension of the billet processed by ECAP in laboratory limited this. ECAP was mostly carried out on a billet with the side length/diameter of about 20 mm [5, 6], 10 mm [7-11] or less [12-14]. Therefore, it was difficult to machine tensile samples in 3 orthogonal directions simultaneously.

However, compression testing in the orthogonal directions can be easily executed for magnesium alloy billets processed by ECAP [5, 7, 15-17]. The deformation mechanism of compression is different from that of tensile because of the asymmetry in compression and tension, which depends on the direction of straining[18, 19]. Until recently, there have been few reports about the tensile anisotropy of magnesium alloy. Some researchers studied 50 mm diameter billets or above with ECAP, but the tensile