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Full Length Article

The effect of extrusion conditions on the properties and textures of AZ31B alloy

Qiang Liu [a], Xiao Zhou [a], Haitao Zhou [a,*], Xiaohui Fan [a], Keming Liu [b]

[a] Key Laboratory of Nonferrous Metal Materials Science and Engineering of Ministry of Education, School of Materials Science and Engineering, Central South University, Changsha 410083, China

[b] Jiangxi Key Laboratory of Advanced Copper and Tungsten Materials, Jiangxi Provincial Academy of Science, Nanchang 330029, China

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Abstract

The effect of extrusion conditions on the tensile properties and texture of AZ31B alloy has been investigated by means of optical microscopy (OM), scanning electron microscopy (SEM), electron backscattered diffraction (EBSD) and tensile tests. It is found that the ultimate tensile strength (UTS), the yield strength (YS) and elongation (EN) of the extruded AZ31B alloy are more significantly influenced by extrusion velocities in contrast with temperature. Although the extrusion conditions are different, the $\{11\bar{2}0\}\ \langle 01\bar{1}0\rangle$ texture is the chief texture in the AZ31B after extrusion. Moreover, the extrusion textures become scattered with increasing the temperatures at the same extrusion velocity. As the extrusion velocity is raised at the same temperature, the orientation density of textures increases and the separated textures become relatively concentrated. This leads to the changes of tensile properties at different extrusion conditions.

Keywords: AZ31B magnesium alloy; Hot extrusion; Textures; Properties; Temperature

1. Introduction

Magnesium alloys are the lightest metallic materials for industrial applications with increasing needs due to their low density, high specific strength, good damping characteristics and stable machinability [1–3]. For instance, they are widely used in the fields of aerospace, military, automotive and electronic industry [4–6]. However, there are some disadvantages, such as poor formability [7,8] and bad corrosion resistance so that their application for structural parts are limited. In order to improve their formability, they need to be activate some slide systems and decrease some critical resolved shear stresses (CRSS) of different slip and twining systems in hcp magnesium [9,10]. As we know, the CRSS of the basal slip mode $\{0001\}$ $\langle 01\bar{1}12\rangle$ is much smaller than those of the non basal slip and twining modes. Thus, a fulfillment of the von Misses condition requires the activation of at least one hard slip mode with c-component Burgers vectors (i. e. <c+a>) pyramidal slip or $\{0\bar{1}\bar{1}2\}\ \langle 0\bar{1}\bar{1}1\rangle$ twining [11], which finally results in the occurrence of textures of hcp metals [12].

For magnesium and its alloys a basal texture is commonly observed [13–15], but other textures depend on the prismatic and pyramidal slip modes with <a > Burgers vector as well as the pyramidal slip mode with <c + a > Burgers vector and also the twining system $\{0\bar{1}\bar{1}2\}\ \langle 0\bar{1}\bar{1}1\rangle$ [16]. However, these slip modes are usually activated at high temperature (higher than the recrystallization temperature) accompanied by dynamic recrystallization (DRX) [17–20], so the appearance of texture becomes possible under hot deformation. For instance, increasing deformation temperature, especially over 523 K, leads to the decrease of CRSS of the basal, prismatic and pyramidal slips as well as the pyramidal slip. Due to the activation of such deformation modes at high temperature, the developments of textures become complex [12,21], especially that the type of texture strongly depends on deformation conditions. Therefore, texture control by hot working is important for the practical application of magnesium alloys.

During the past few years, many researchers focus on the effect of extrusion on the properties and textures in magnesium alloys. For instance, Shahzad and Wagner [22] showed that a

* Corresponding author. Key Laboratory of Nonferrous Metal Materials Science and Engineering of Ministry of Education, School of Materials Science and Engineering, Central South University, Changsha 410083, China. Fax: +86 731 88876692.

E-mail address: ht_zhou@sina.com.cn (H. Zhou).

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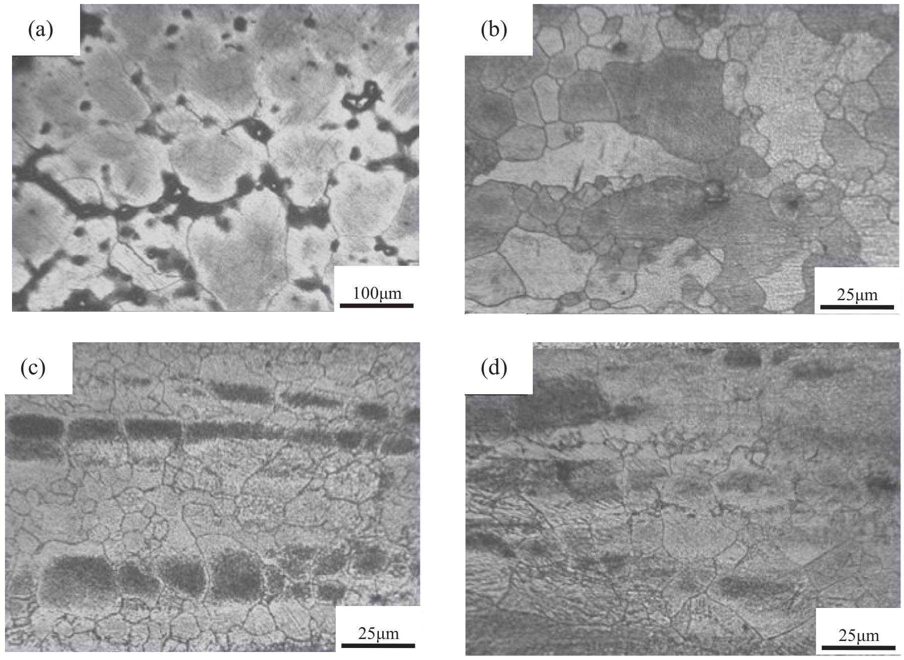

Fig. 1. The optical microstructures of AZ31B alloy: (a) as-cast; (b) extruded at 703 K, 2.2 m/min; (c) extruded at 673 K, 2.2 m/min; (d) extruded at 643 K, 2.2 m/min.

higher extrusion ratio gave rise to a higher degree of post-extrusion secondary recrystallization and consequently a relatively weaker texture in AZ80 ally, and the basal texture after extrusion gave higher yield strength in the longitudinal direction. Bohlen et al. [23] indicated that the weaker texture led to increased ductility, lower yield and ultimate stresses, but a decrease in the asymmetric yield behavior of the extruded bars in magnesium and its alloys. Jiang et al. [24] developed dilute Mg-Zn-Ca-Mn alloy with a high performance via extrusion, and suggested that significantly weakened basal texture (maximum intensity of 3.2) with rare-earth texture component was achieved in a high compression/tension yield ratio of ~0.8

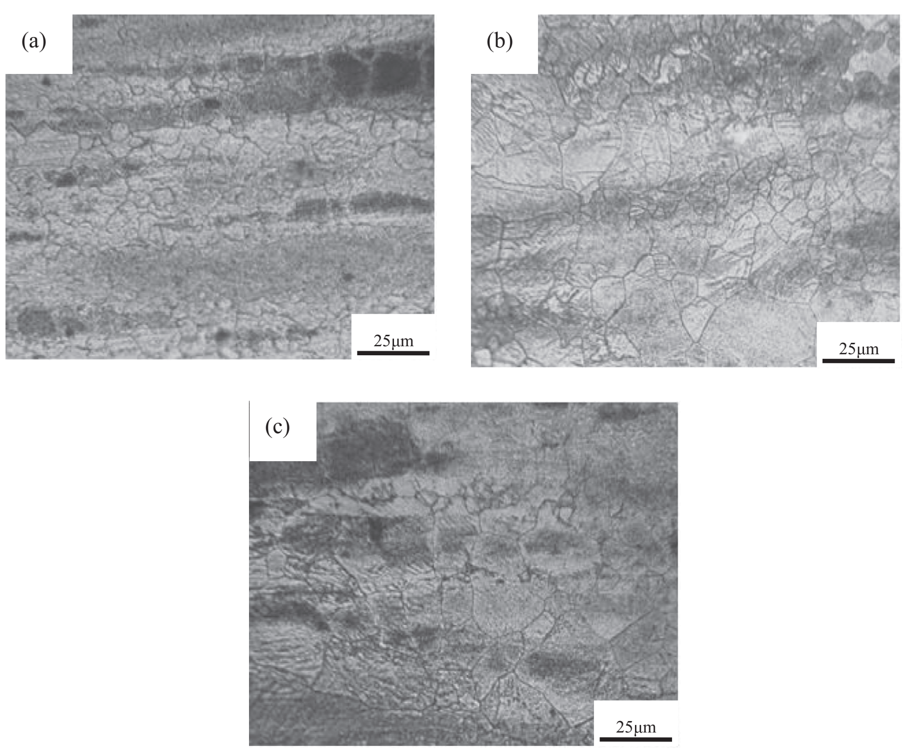

Fig. 2. The optical microstructures of AZ31B alloy extruded at 643 K with different extrusion velocities: (a) 0.8 m/min; (b) 1.4 m/min; (c) 2.2 m/min.

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