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Effect of extrusion ratio on mechanical and corrosion properties of AZ31B alloys prepared by a solid recycling process

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ABSTRACT

Some AZ31B magnesium alloy bars were prepared by a solid recycling process with different extrusion ratios. A reference specimen was processed by extruding an as-received AZ31 ingot. The microstructures, mechanical and corrosion properties of AZ31B magnesium recycled specimens were investigated. With increasing extrusion ratio, the yield strength, tensile strength and yield ratio increases. The reliability of the recycled alloy is poorer than the reference specimen. The corrosion rates of recycled AZ31B magnesium specimens increase immersed in both alkaline and neutral 4% NaCl solution with a decrease extrusion ratio. The corrosion resistance of recycled AZ31B magnesium specimens is improved with increasing pH of immersed solution. The recycled specimens show superior corrosion resistance than reference specimen.

1. Introduction

Magnesium alloys have been widely used in structural components in vehicle and electric appliance because of their low density and high strength [1,2]. At the process of machining magnesium alloy parts, many magnesium alloy chips are produced. In order to promote the utilization of the magnesium alloys, it is necessary to develop useful recycling processes. Presently, remelting of machined chips is a common recycling process. Nevertheless, this method is costly because magnesium chips are prone to oxidation. A solid recycling process is proposed as an alternative method of recycling magnesium alloys [3]. In the process, chips and scraps are recycled by hot extrusion, and recycled magnesium alloy shows excellent mechanical properties. The recycled AZ80, Mg–Al–Ca, ZK60, and Mg–Nd–Zn–Zr show ultimate tensile strength of 285, 348, 402 and 250 MPa, and elongation of 6%, 9%, 6.8% and 17%, respectively [4–7].

Study on the solid recycling process is a hot topic for its potential application. Chino et al. [8] studied the anisotropy in fatigue properties of AZ31 alloy recycled by solid-state processing, and found that the fatigue resistance of 90° to the rolling direction was significantly poorer than that of 0°. Wu et al. [9] fabricated materials with different size chips of AZ31B, and reported recycled specimens with larger total surface area of chips exhibit higher ultimate tensile strength. Wang et al. [10] recycled AZ91D alloy in chip form bearing different environmental corrosive conditions in order to assess the feasibility of recycling in solid-state. This recycled material showed no inferior mechanical properties than its un-chipped counterpart. Peng et al. [11] established the nonlinear relation of the temperature, the press and deformation velocity according to a thermal simulation and mathematic regression analysis of Mg–10Gd–2Y–0.5Zr alloy.

Extrusion ratio is an important parameter for industrial production of metal bar. However, reports on influence of extrusion ratio on the microstructure and mechanical properties of AZ31B magnesium prepared by solid recycling process are scarce. The main purpose of this paper is to investigate the microstructures, mechanical and corrosion properties of recycled AZ31B magnesium specimens extruded by different extrusion ratios.

2. The experimental procedures

2.1. Preparing of extrude bar

Machined chips with the average dimensions of 10 mm × 2 mm × 0.4 mm of AZ31 (Mg-3 wt.%Al-1 wt.%Zn-0.5 wt.%Mn) were prepared by machining a cast ingot (Fig. 1). In the machining process, no cooling fluid was used and machined chips were kept clean. The chips were filled into a cylindrical container with a diameter of 40 mm and pressed into billets with a pressure of 350 MPa at room temperature (Fig. 2). The average density of the billets is about 1.68 g/cm^3. Comparing with the density of the fully condensed ingot of 1.83 g/cm^3, relative density is 91.8%. Then the billets were hot extruded into rods in the following extrusion conditions: extrusion temperature 723 K, extrusion ratios from 11 to 44.4 and the

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