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Full Length Article

Determining the microstructure and properties of magnesium aluminum composite panels by hot rolling and annealing

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Abstract

The researchers made magnesium aluminum composite panels by asymmetric metal packaging and studied rolling temperature, holding time, and high temperature heat treatment, such as short time and low temperatures over long periods of time parameters under the new preparation method. We tested the new magnesium aluminum composite panels' tensing properties and bending performance by using scanning electric mirror and EDS. It is concluded that the new magnesium aluminum composite panels' elongation is 24% under the tensile strength of 260 MPa. Regarding performance when compared with other methods, traditional magnesium aluminum composite panels' elongation is 10%, which shows its advanced nature. At the same time, bending performance test showed that the combination of the composite board has higher performance, offering the reference value for the preparation of magnesium–aluminum composite plate.

Keywords: Magnesium aluminum composite plates; Asymmetric coating; Performance; Microstructure; Intermediate compounds

1. Introduction

Compared with other metal materials, magnesium and magnesium alloys have many outstanding performance characteristics, which are widely used in automobile, electronics and aviation. However, corrosion and plasticity are the main problems in magnesium and magnesium alloys, which have immensely restricted the wide application of magnesium alloy in the field of engineering, making the excellent properties of magnesium alloy unusable. In contrast, aluminum alloy usually has very good corrosion resistance and plastic form, and its surface can be repaired. Therefore, we coated a layer of corrosion resistant aluminum alloy forming laminated composite material on magnesium alloy surface so we can take full comprehensive performance advantages of the two materials; we expected to further expand their application areas. In this study, we made a more practical method for engineering to prepare the high performance magnesium aluminum composite panel production. It was considered the actual situation of the production site and different from the traditional metal package method. We wanted to offer the reference value for the preparation of magnesium aluminum composite panels.

1.1. Experiment

In this study, the 5052 aluminum alloy sheet is chosen, the size of which is as follows: 80 mm, 40 mm, 0.5 mm and 60 mm, 20 mm, and 0.5 mm. The magnesium alloy plate is AZ31, the size of which is as follows: 60 mm, 20 mm, and 2 mm. Their chemical composition is shown in Table 1. The main equipment include scanning electron microscopy (MIRA3-SEM), DK7735 taper EDM CNC cutting machine, box type resistance furnace, electronic universal testing machine, the BKDØ130 experimental mill, thermocouple heating device, and so on.

In this experiment, the raw materials were cut into the desired size by making an electric spark wire cutting machine and then the materials went through burnishing, ethanol washing, water washing, drying and other steps. The larger aluminum panel coated the magnesium panel and the smaller aluminum panel, which was the method to package the material, as shown in Fig. 1. The raw materials are heated to 350 °C, 400 °C and 450 °C; the heating preservation time is 20 min on the inside of the box type electric resistance furnace. The experiment used a method that applied the single rolling of

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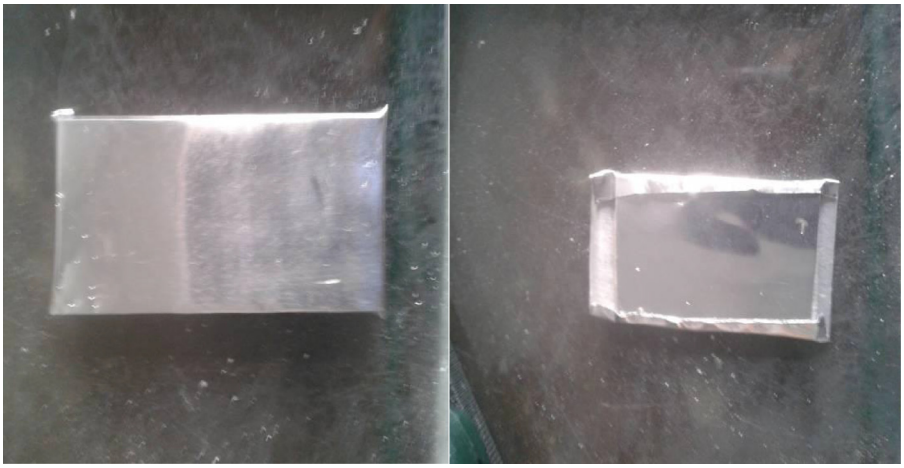


(a) front **(b) back**

Fig. 1. The figure of the asymmetric metal package method.

Table 1
The chemical composition of 5052 aluminum alloy and AZ31magnesium alloy.

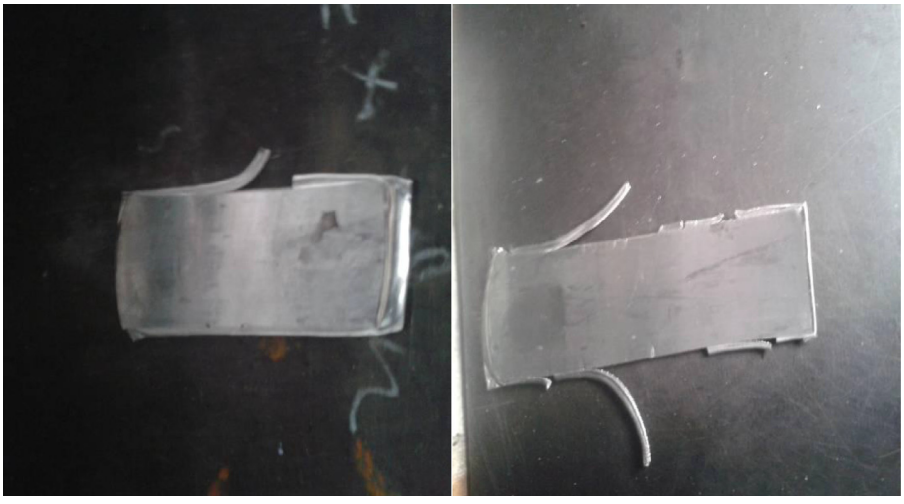
Metal	Mg	Cr	Mn	Zn	Al	Si
5052	2.2–2.8	0.15~0.35	0.1	0.1	Surplus	0.25
Metal	Mg	Ni	Mn	Zn	Al	Si
AZ31	Surplus	0.005	0.5	0.9	3.01	0.04

reduction setting to 30%, 35%, and 40% in the BKD Ø130 experimental mill. Two heat treatment methods were used in the experiment: one includes is 200 °C and the time is 60 min, and the other has a temperature of 300 °C and the time is 20 min. After the experiment, the test sample was cut to the standard size of the tensile test specimen along the rolling direction by DK7735 taper EDM CNC cutting machine for tensile test. JSM6700-F type scanning electron microscope was used to observe the thickness of the bonding layer and the morphology, and then the experiment used the bending test for performance.

2. Results and analysis

2.1. The macroscopic analysis of the asymmetric metal package method and the rolling sample

The traditional metal packaging is that magnesium plate packed by aluminum sheet, which is folded simply. Oxidation of metal surface won't be serious when it is heated in box-type resistance furnace in laboratory, but it will be so serious when it is heated in a gas furnace in an engineering production that influences the compound effect. When rolling, it will make the composition of rolling deflective due closed traditional inclusions. Coupled with serious oxidation, it will also severely influence the compound effect. The dissymmetrical metal package, as shown in Fig. 1, can not only decrease the oxidation of metal surface when it is heated to make the fresh surface combine better when it is rolled, but also assure that it won't slip relatively when it is rolled. Fig. 2 shows the rolling reduction of 30% and 35% after rolling under 400 °C. The image showed



(a) 30% reduction **(b) 35% reduction**

Fig. 2. Sample after rolling at 400 °C.