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Short Communication

A study of the effect of antimony content on damping capacity of ZA84 magnesium alloy

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ABSTRACT

The effects of antimony content on damping capacity of as cast Mg–8Zn–4A1–0.3Mn magnesium alloy were investigated by using optical microscopy and dynamic mechanical analyzer, etc. The results indicated that the damping capacity of Mg–8Zn–4A1–0.3Mn magnesium alloy was reduced at the low temperatures (<80 °C) after adding antimony, but its damping capacity was improved at the higher temperatures (>80 °C). There exists a damping peak in both modified and unmodified alloys with different temperature, adding antimony postpones the emergence temperature of damping peak. The damping capacities of the modified alloys were decreased gradually with the increase of antimony content. In the present work, the best damping capacity was obtained from the modified alloy containing 0.1 wt.% antimony at the high temperatures.

1. Introduction

In choosing a particular structural material for a given application, a whole host of other physical properties always must be considered, such as its strength and intrinsic damping capacity. However, in metals these properties are often incompatible due to the dependence of the microscopic mechanisms involved in strengthening and damping [1]. Usually, high mechanical property is related to those materials with poor damping capacity [2]. Therefore, it would be of interest to develop new materials that simultaneously exhibit good mechanical properties and high damping. The key problem is in preparing composites for coupling high damping capacity with a tolerable modulus and high strength [3,4].

Magnesium is the lightest structural materials with high specific strength and high specific elastic modulus. It is considered the most promising metal in the 2lst century [5,6]. Meanwhile, magnesium and magnesium alloys possess high damping capacity due to their good ability to absorb energy elastically. Therefore, magnesium alloys are also very attractive for application in various structures in automotive, aerospace industry, and so on [7–10], while, its poor mechanical properties, especially at the elevated temperature limit its more widespread applications. Various methods and techniques were used to substantially improve the mechanical property of magnesium alloy while the damping capacity was lowered at the same time [11]. The crux lies in resolving the contradiction between damping capacity and mechanical capacities, and to exploit magnesium based damping alloys having high damping and sufficient mechanical capacities [12].

ZA84 (Mg–8Zn–4A1–0.3Mn) is one kind of magnesium alloy with good mechanical properties at the room and elevated temperatures. Compared to other modifiers such as rare earth element, the melting point of antimony (Sb) is about 630 °C, very close to the melting point of magnesium (649 °C), and Sb is adopted simply by magnesium alloys, hence, some researchers have successfully applied Sb as a modifier in magnesium alloy AZ91. Results of preliminary study [13] also found the mechanical properties of ZA84 can be further improved by adding modifier Sb. Nevertheless, the damping capacities variation with or without Sb have not been investigated. Therefore, in the present work, the effects of Sb content on the damping capacity of ZA84 magnesium alloy were investigated. It is expected that the modification of Sb may have a significant influence on the mechanical properties and damping capacity, at a minimum, while enhancing the strength, the damping capacity should not be reduced evidently. If so, Sb modification ZA84 magnesium alloys would have good prospects for engineering applications.

2. Experimental

The nominal chemical compositions of the prepared alloys are shown in Table 1. The raw materials used in the experiment are Mg ingots (its purity ⩾99.95%), Zn ingots (its purity ⩾99.5%), Al ingots (its purity ⩾99.5%), Al–10%Mn intermediate alloys and Sb ingots (its purity ⩾99.99%). Alloys were melted in an electrical resistance furnace using a steel crucible under the protection of flux and then poured into steel mould.

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