Effect of Quench-Ageing on Microstructural Evolution and Damping Behaviour of Zn-27Al-1Cu Alloy

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Abstract

A ternary Zn-27Al-1Cu alloy was prepared by permanent mould casting. The microstructural evolution and damping behaviour of the Zn-27Al-1Cu alloy were investigated in different periods of ageing after subjected to solution treatment followed by water quenching. As a result of this investigation, it was determined that the microstructure of as-cast alloy consisted of aluminium-rich α dendrites surrounded by zinc-rich η and eutectoid β phase and copper-rich ε particles. The quench-ageing treatment removed the dendritic structure of the as-cast alloy and transformed into a uniform microstructure consisting of large grains (β-matrix) combined with zinc and copper-rich precipitates. Microstructural changes after quench-ageing were accompanied with the variance of damping behaviour. It was found that the damping capacity by means of impact toughness increased in early stage of ageing and then it decreased sharply with increasing ageing time and finally it increased slightly and reached constant values in the prolonged stage of ageing. The highest toughness was obtained from the alloy aged for 0.5 h. The change in damping behaviour with ageing time can be explained in terms of the microstructural variations and precipitation hardening mechanism.

Keywords: Zinc-aluminium alloys; Ageing; Damping behaviour

1. Introduction

Zinc-aluminium alloys, widely known as bearing materials, have been used for various engineering and industrial applications [1]. The main reasons of widely usage of the alloys are low-cost, good casting properties, long service life, high damping capacity, good surface quality and excellent wear resistance [1, 2]. However, mechanical properties such as tensile strength, impact toughness and ductility behaviour of the binary zinc-aluminium alloys are not adequate for some engineering application especially in the as-cast state [3]. In order to come through these inadequacies and improve the mechanical behaviour of the alloys, extensive research has been performed in recent years [4]. It has been known that the most widely effective method for increasing the strength of Zn-Al alloys is the addition of alloying elements and heat treatment [5]. However, very little is known about the effect of heat treatment parameters on the mechanical properties especially the damping behaviour of the quench-aged Zn-Al-Cu alloys in the literature. Whereas, high mechanical properties are very important to enhance the usage of these alloys having many advantages compared to other non-ferrous metals as explained above. Thus, the main purpose of this study is to investigate the effect of ageing treatment on the microstructural and damping capacity of the as-cast Zn-27Al-1Cu alloy.

2. Conclusion

The microstructure of the ternary Zn-27Al-1Cu alloy in as-cast condition consists of Al-rich α dendrites, decomposed β phase around the α phase and also η and ε phases in the interdendritic regions. Quench-ageing treatment mostly eliminates the dendritic microstructure. Instead, a uniform microstructure consisting of large α grains combined with zinc and copper-rich precipitates. Quench-ageing treatment was effective on mechanical properties. In early stage of the ageing process, all mechanical properties of the alloy improve. The best impact toughness was obtained from the alloy aged for 0.5 h, while the alloy aged for 1 h exhibited the shortest one among all conditions. The change in damping behaviour with ageing time can be explained in terms of the microstructural variations and precipitation hardening mechanism.

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