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Technical Report

An investigation into the effects of graphite particles on the damping behavior of ZA-27 alloy composite material

B.M. Girish [a], K.R. Prakash [b,*], B.M. Satish [b], P.K. Jain [c], Phani Prabhakar [c]

[a] Department of Mechanical Engineering, MVJ College of Engineering, Bangalore 560 067, Karnataka, India
[b] Department of Mechanical Engineering, East Point College of Engineering and Technology, Bangalore 560 049, Karnataka, India
[c] International Advanced Research Centre for Powder Metallurgy and New Materials, Hyderabad, India

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ABSTRACT

The objective of present work is to investigate the effect of macroscopic graphite particles on damping behavior of ZA-27 alloy composites. Compo casting technique was used to prepare the composites, in which the graphite particles were used to reinforce ZA-27 alloy, in varying fractions in order to arrive at optimum graphite reinforcement for bearing applications and establish a correlation of experimental readings. The experimental method used was the cantilever technique with Dynamic Mechanical Analyzer to evaluate damping properties. Standard strips of size 60 mm × 10 mm × 1 mm thick were tested by cantilever method of vibration tests at various temperatures from ambient to 300 °C. It was observed that the damping capacity of the material increased with increasing temperature and fractions of graphite particles.

1. Introduction

The present study focuses on MMCs (metal matrix composites) prepared with ZA-27 (zinc–aluminium 27) alloy as the matrix and graphite particles as the reinforcement. An exhaustive study on the mechanical and damping behavior of the composite with varying fractions of reinforcement was carried out to evaluate the material to be used in several structural and bearing applications [1]. ZA-27/graphite composite can be considered for applications where service temperatures are as high as 200 °C. This composite has excellent machining characteristics, which means fast and efficient machining along with a long life for wear applications.

The performance of the material in structural applications such as aerospace, submarine, and machinery in general, can be affected severely by vibration and noise. There are several approaches to control noise and vibration, one of which is to manufacture structural and moving components from high-damping alloys [2,3]. In choosing a particular high-damping alloy for a given application, its strength, corrosion resistance, and a whole host of other physical properties must be considered, as well as its intrinsic damping capacity. Usually, high damping capacity is related to those materials with poor mechanical properties, therefore the key problem is in preparing composites for coupling high damping capacity with a tolerable modulus and high strength [4,5]. The ZA-27 alloys have high strength, hardness, and wear resistance, as well as other favorable physical properties. The properties make it an attractive alternative to aluminium, brass, bronze, or iron for the designer of structures and machine parts that can be cast. Therefore, it has obtained more and more applications in industry. Recently, much interest has been attracted to investigate the damping capacities of ZA-27 alloy, since the alloy has excellent mechanical properties and high damping capacities. Various methods and techniques were used to substantially improve the damping capacities of Zn–Al (zinc–aluminum) alloys without lowering significantly the mechanical properties of materials [6]. Studies show that the damping capacities of Zn–Al alloys could be improved by proper heat treatment. The hardness, ductility, strength and dimensional shrinkage of the supersaturated ZA-27 alloy during the aging were studied extensively, but the damping capacity variation during the process is less studied. Considering the above ZA-27/graphite composite can be an alternative to ZA-27 alloy with superior properties and reduced weight to make it priority material in structural applications such as aerospace, submarine, and machinery.

2. Experimental details

2.1. Preparation of the composite

In the present investigation, ZA-27 with the chemical composition as per ASTM B669-82 ingot specification (Al-25%, Cu-2%, Mg-0.01, Zn-% Remainder) was used as the matrix material. The ZA-27/graphite composites were prepared using the liquid metallurgy technique. The alloy is prepared using Zn (99.99%), commercially pure Mg (99.85%) and Al (99.6%). The size of the graphite particles selected was 100–150 μm. The graphite contents

* Corresponding author. Tel.: +91 8212582800; fax: +91 8212582800.
E-mail address: prakash_kupparavalli@yahoo.com (K.R. Prakash).

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