

Vibration and Damping Behavior of Si₃N₄ Reinforced Magnesium Alloy Composite for Structural Applications

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ABSTRACT

For a variety of application, materials are demanded with high damping that can lower fundamental natural frequencies, and composites offer widespread options towards designing space structure with lightweight which are controlled effectively. Damping fixtures were made with lightweight composites, for the purpose of transporting aerospace components from one place to another. This present work investigates the damping characteristics of lightweight magnesium-based composite (AZ31+x%Si₃N₄), subjected to vibration. The composite cantilever beam is excited using an impact hammer and the vibrations generated are recorded using a data acquisition system. The damping properties are related to the density and microstructure of the fabricated composites. Results show that the damping factor changes with higher reinforcement of Si₃N₄ ceramic particulates and the microstructure obtained during casting have an influence on the damping performance.

Keywords: magnesium composite, damping factor, microstructure, density, vibration

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1. INTRODUCTION

The method of transportation and logistics cycle of any consists of a series of risks such as integrity of load including vibrations. By measuring the parameters, vibrations can be characterized which allows engineers and researchers to simulate the real-time damages triggered by movement over the design of the package and to develop optimal packing that can protect the component against the threat of vibration [1]. A predominant method applied for detecting, monitoring, and analyzing the condition of a structure in real-time condition or over a period of time is vibration analysis performed through rapid data collection and data interpretation. Vibrations in structural components are hazardous for heavy machinery and equipment, and also for facilities, employees, and business consequential [2].

In the present scenario of modern transportation, noises and chatter produced is a health hazard for human beings [3], apart from that, uncontrolled vibration will lead to fatigue failure of machinery [4]. To avoid the adverse effect of vibration, materials are selected based on good damping properties, so as to absorb vibrations. For this, magnesium and their composites were a good choice, as they are light in weight with required mechanical properties and better damping characteristics. Presently in aerospace applications, fixtures made up of magnesium alloys are used for holding the aviation components during transit, in order to absorb the generated vibrations. Meanwhile, to strengthen the magnesium alloys, reinforcements are added to the base alloy to improve their

properties to the required condition without deteriorating their damping qualities.

Hoksbergen et al. [5] compared the vibration and damping characteristics of carbon fiber reinforced plastic (CFRP) with magnesium plates and identified that CFRP damping is higher than magnesium plates. As compared with magnesium plates the natural frequency of thin CFRP plates is almost the same. But the natural frequency of thicker CFRP sheets is lower than that of the magnesium sheets. Shunmugasamy et al. [6] examined the damping properties of various lightweight materials including magnesium and found that, with nanocomposites, damping capabilities tend to change which attributed to an increase in dislocation density, the thermal mismatch between filler and matrix, and grain boundary slide. Chung [7] identified that improvement in damping characteristics is mostly attributed to the microstructural design of metals, interface design for polymers, and the use of admixture for composite. Due to their viscoelasticity, metals and polymers tend to be better for damping than composite.

Zhang [8] concluded that pure magnesium matrix composites exhibit better tensile strength than pure magnesium and damping capacity is significantly reduced with an increase of reinforcement due to the movement of composite dislocations. Luo et al. [9] conducted damping loss factor testing and sound transmission experiments on AZ31B magnesium alloy with micro-arc oxidation coating and electrophoretic deposition process, an improvement in the frequency range of the damping loss factor from 0–850 Hz was observed and improvement in bending stress improves losses in sound transmission. Parande et al. [10] synthesized

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