Effect of Loading Rate on the Microstructure and Mechanical Properties of Copper and Silicon Oxide (Cu+SiO2) Composite Material

B. Srilekha

M. Tech (AMS), Roll No.:12011D3318, Department of Mechanical Engineering, JNTUH College of Engineering, Science & Technology, Hyderabad

Under the Guidance of Dr. A. Chennakesava Reddy, Senior Professor, JNT University Hyderabad

ABSTRACT

Composite materials are extensively employed in various engineering applications due to their tailored properties and enhanced performance characteristics. The present study investigates the influence of loading rate on the microstructure and mechanical properties of a composite material comprising copper (Cu) matrix reinforced with silicon dioxide (Si02) particles.

The composite specimens were prepared via powder metallurgy techniques, with varying weight percentages of SiO2 Nano particles dispersed within the Cu matrix. Mechanical tests, includingtensile, compressive, ands impact tests, were conducted at different loading rates to assess the material's response under dynamic loading conditions. Additionally, micro structural analyses were performed using scanning electron microscopy (SEM) to examine the distribution of Si02 particles within the Cu matrix and their effect on the material's deformation behaviour.

The results reveal a significant dependency of the mechanical properties on the loading rate, with higher loading rates leading to increased strength and stiffness due to strain rate effects. Moreover, micro structural analyses indicate that at lower loading rates, the Si02 particles facilitate dislocation movement and promote plastic deformation mechanisms, resulting in improved ductility. Conversely, at higher loading rates, a transition to brittle fracture occurs due to limited dislocation mobility and increased propensity for interfacial de-bonding between the Cu matrix and Si02 particles.

This study provides valuable insights into the dynamic behaviour of Cu+Si02 composite materials, highlighting the importance of loading rate considerations in designing composite structures for applications subjected to varying loading conditions. The findings contribute to the optimization of composite material formulations and processing parameters to achieve desired mechanical performance under dynamic loading environments.

CONCLUSION

The effect of loading rate on the microstructure and mechanical properties of copper and silicon oxide (Cu+Si02) composite material is a crucial aspect to consider in various engineering applications. Here are some potential conclusions based on the investigation:

1. The loading rate significantly influences the microstructure of the composite material.

2. At higher loading rates, there may be observable changes in the distribution and arrangement of copper and silicon oxide particles within the matrix. This could be due to various deformation mechanisms such as dislocation movement, grain boundary sliding, and fracture processes.

3. With increase of % Si02 and decrease of % Cu in composite it leads to decrease in fracture.

4. At higher loading rates, the composite may experience increased strain hardening, resulting in a finer grain size. This can lead to higher strength but lower ductility.

5. From microstructure investigations, adding Si02 to the composite caused grain refinement.

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