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Low velocity impact failure micromechanisms of 6061 aluminum reinforced with submicron Al_2O_3 metal matrix composites1

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1. Introduction

A PRMMC consists of a uniform distribution of strengthening ceramic particles embedded within a metal matrix. In general, these materials exhibit higher strength and stiffness, in addition to isotropic behavior at a lower density, when compared to the un-reinforced matrix material(McDaneals, 1985; Ibrahim *et al*., 1991; Paul and Gilman, 1991; Wang and Zhang, 1991; Mummery and Derby, 1991). PRMMC benefits from the ceramic' s ability to withstand high velocity impacts, and the high toughness of the metal matrix, which helps in preventing total shattering. This contribution leads to an excellent balance between cost and mechanical properties, which are appealing for many applications. From the mechanical behavior standpoint, the main drawback of these materials is their low ductility, which is caused by the nucleation, growth, and coalescence of voids created by the ceramic reinforcement.

The main contribution to the strengthening of PRMMC is particle addition, which affects most of the mechanical properties of PRMMC. Several particle parameters, which are critical in determining the mechanical properties of PRMMC, include volume fraction (v_f), size, shape, and distribution of reinforced particles within the metal matrix. The most influential among these parameters is (v_f)(Luster *et al*., 1993). However, only few researchers investigated PRMMC with reinforced particles less than 1μm. Generally, smaller particles are known to be less susceptible to fracture than long and elongated particles(Srivatsan, 1996); hence, sub-micron size particle additions should results in improved mechanical properties.

The impact failure micromechanisms of the 6061 aluminum alloy-based PRMMC composites reinforced with 10%, 20%, 30% vol. submicron Al_2O_3 particles are studied and presented in this paper.

2. Experimental

2. 1. Materials

The materials used in this study were composites based on a 6061 Aluminum alloy metal matrix containing 10%, 20%, and 30% vol. fraction of Al_2O_3 spherical particles with an average size of 0.7μm, in addition to unreinforced 6061Al alloy. The composite was prepared by powder metallurgy at Fraunhofer Institute Fetigungstenik Materialforschung.

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