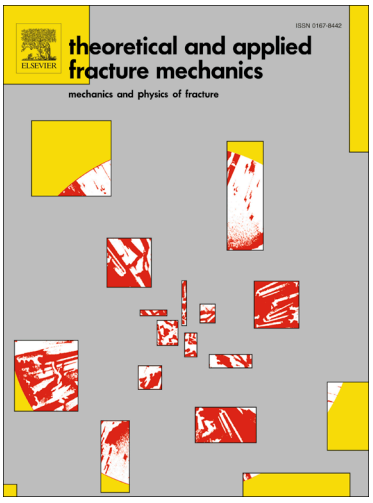

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Fabrication and Evaluation of Silica Aerogel-Epoxy Nanocomposites: Fracture and Toughening Mechanisms

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Abstract

Silica aerogel is a promising candidate for improving the mechanical properties of epoxy-based nanocomposites due to the unique properties such as the 3-dimensional nanoporous structure and high surface area. In this study rheological, mechanical and thermal properties of the silica aerogel-epoxy nanocomposites were investigated. The rheological results demonstrated an increase in viscosity of the nanocomposite suspension compared to the neat resin. The results of dynamic mechanical along with the thermal analysis showed that the addition of 6 wt% of silica aerogel causes the storage modulus and glass transition point (Tg) to be increased by 11% and 5 °C, respectively. Also, significant improvements in the elastic modulus (35%), tensile strength (62%) and toughness (126%) were achieved with the optimal volume fraction of silica aerogel (6 wt%). Two main fracture mechanisms were involved in the fracture behavior of the silica aerogel-epoxy nanocomposite: (a) crack pining and deflection, and (b) plastic deformation (debonding).

Keywords: Silica aerogel, Nanocomposite, Mechanical properties, Fracture Mechanism, AFM-IR.

1. Introduction

Nowadays, inorganic nanoparticles-reinforced polymer nanocomposites have been widely used in engineering applications due to the possibility of improving the mechanical, thermal, electrical and self-healing properties [1-4]. Nanoclays, silica nanoparticles, and carbon nanotubes (CNTs) are commonly utilized as reinforcing agents for a variety of polymer systems [5-8]. However, several processing challenges eliminate the potential benefit of employing nanostructured particles. These challenges include: (1) aggregation and (2) the poor interfacial interaction between polymer and reinforcement [9-12]. In order to overcome to these two challenges, surface functionalization of