ADVANCES IN COMPOSITE MATERIALS

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Fatigue Fracture Mechanism of PVC/CaCO₃ nanocomposites

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Abstract: The effects of nano-CaCO₃ particles on the fatigue properties of PVC have been investigated. PVC nanocomposites were fabricated with different content of CaCO₃ ranging from 3 – 20 ppfr. It was found that the fatigue resistance of the PVC nanocomposites is similar to that of unmodified PVC with no significant deterioration in crack growth rates observed. Fracture mechanism analysis on PVC nanocomposites was studied to understand the interaction between PVC and the nanosized particles during fatigue loadings. Crazing and particles debonding are the main fracture mechanisms. In addition, ligament yielding of the PVC matrix also occurred and was associated with the particle content and stress amplitude.

Introduction

The addition of nanoparticles into neat polymers is observed to improve not only their mechanical properties i.e. impact strength, but also result in differences in the fracture micromechanisms. In general, particle debonding/cavitation are the dominant toughening mechanisms in the nanocomposite specimens. Evidence for this mechanism was seen to occur in PVC-modified with calcium carbonate [1-2]) and in PP modified with alumina [3] and calcium carbonate [4].

It is noted that the cavitation of particles is an effective mechanism for toughening since its occurrence leads to the deformation of the matrix around the nanocomposites [5]. As a result, large amount of energy is absorbed [2]. In addition, according to Xie et al., [1] a strong interfacial interaction between nanoparticles and the polymer matrix would further increase the absorbed energy for crack initiation and fracture propagation which would then result in toughening during impact. A study by Zhao and Li [3] in polypropylene-filled alumina at the crack tip also found that the particle debonding led to the formation of numerous crazes and microcracks around the subcritical crack tip.

Although research in nanocomposites has received considerable attention, very limited works have been carried out on determining the fracture mechanisms of this composite, predominantly in fatigue tests. A study by Zhou et al., [6] of fatigue response of epoxy reinforced with aluminium oxide particles, showed a marked improvement in fatigue