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Damping behaviour and self-healing performance evaluation of microcapsules reinforced epoxy composites by impulse excitation technique

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Abstract

Micro cracks developed in the composite structures can be repaired autonomously by incorporating microcapsules-based self-healing approach into the composites. In the current study, in order to employ self-healing composites in different structural applications, damping behaviour and self-healing performance of the composites were evaluated. CY230 epoxy and HY951 hardener were chosen as two different self-healing agents and encapsulated in polymethylmethacrylate (PMMA) shell material. Dual microcapsules reinforced carbon fibre epoxy composites were fabricated by employing 15wt% of microcapsules at 1:1 weight ratio and 0.5:0.5 weight fractions of matrix reinforcement. Influence of microcapsules addition and induced damages on the damping behaviour and self-healing performance of the pure epoxy and pure carbon fibre reinforced polymer (CFRP) composites were investigated by impulse excitation technique (IET). It was noticed that with the addition of respective optimized 7.5 wt%, 15 wt% microcapsules to pure epoxy and pure CFRP, damping factor of both the composites increased whereas elastic modulus decreased. Compared to capsules reinforced virgin composites, damping factor of damaged composites was higher in both types of composites. Self-healing efficiency of capsules reinforced pure epoxy and carbon fibre epoxy composites were calculated based on the recovery in stiffness of the composites and noticed respective healing efficiencies of 72.05% and 53.72% at optimized healing conditions and microcapsules concentration.

Keywords

self-healing, microcapsules, impulse excitation technique, damping, stiffness

Introduction

Thermosetting polymers and fibre reinforced composites are getting enormous interest from the research fraternity due to their numerous structural advantages such as high strength to weight ratio, good damping capabilities and customizable properties. Epoxy is one of the most used thermosetting polymers in various structural applications due to its good mechanical strength and less shrinkage during curing. However, due to inherent brittle nature, epoxy thermosets were highly susceptible to micro cracks. Fibre reinforced polymer composites also experience certain failures such as matrix cracking, delamination and impact damages during service conditions. In general, polymeric structures experience damages due to external mechanical loads, thermal loads and any other environmental factors and thus induce micro cracks deep within the structure. In such cases, if developed microcracks not repaired in time will extend to macro crack and finally lead to premature failure of the component and may cause severe property loss or even human death. Unfortunately, some of these microcracks were invisible, difficult to identify and repair manually. Hence to address the damage at microlevel itself, few researchers[1–5] suggested self-healing materials, which have the ability to self-sense and self-heal the damage automatically and recover the material's original properties such as strength, stiffness and fracture toughness.

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