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Elastic Behaviour of Graphene Nanoplatelets Reinforced Epoxy Resin Composites

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Abstract : Graphene has recently attracted an increasing attention in nanocomposites applications because it has 200 times greater strength than steel, making it the strongest material ever tested. Graphene, as the fundamental two-dimensional (2D) carbon structure with exceptionally high crystal and electronic quality, has emerged as a rapidly rising star in the field of material science. Graphene, as defined, as a 2D crystal, is composed of monolayers of carbon atoms arranged in a honeycombed network with six-membered rings, which is the interest of both theoretical and experimental researchers worldwide. The name comes from graphite and alkene. Graphite itself consists of many graphite-sheets stacked together by weak van der Waals forces. This is attributed to the monolayer of carbon atoms densely packed into honeycomb structure. Due to superior inherent properties of graphene nanoplatelets (GnP) over other nanofillers, GnP particles were added in epoxy resin with the variation of weight percentage. It is indicated that the DMA results of storage modulus, loss modulus and tan δ, defined as the ratio of elastic modulus and imaginary (loss) modulus versus temperature were affected with addition of GnP in the epoxy resin. In epoxy resin, damping (tan δ) is usually caused by movement of the molecular chain. The tan δ of the graphene nanoplatelets/epoxy resin composite is much lower than that of epoxy resin alone. This finding suggests that addition of graphene nanoplatelets effectively impedes movement of the molecular chain. The decrease in storage modulus can be interpreted by an increasing susceptibility to agglomeration, leading to less energy dissipation in the system under viscoelastic deformation. The results indicates the tan δ increased with the increase of temperature, which confirms that tan δ is associated with magnetic field strength. Also, the results show that the nanohardness increases with increase of elastic modulus marginally. GnP filled epoxy resin gives higher value than the epoxy resin, because GnP improves the mechanical properties of epoxy resin. Debonding of GnP is clearly observed in the micrograph having agglomeration of fillers and inhomogeneous distribution. Therefore, DMA and nanohardness studies indiacte that the elastic modulus of epoxy resin is increased with the addition of GnP fillers.

Keywords : agglomeration, elastic modulus, epoxy resin, graphene nanoplatelet, loss modulus, nanohardness, storage modulus
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