Optimised Nitrogen Doping of Pristine Graphene for Enhanced Dispersion in Epoxy Matrix

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Abstract

The integration of graphene into epoxy resin composites yields significant improvements in mechanical, thermal, barrier, and conductive properties, rendering them highly attractive for innovative scientific and industrial applications. Uniform dispersion and strong interfacial adhesion are crucial requirements for applying graphene in epoxy resin composites. The process of nitrogen doping on pristine graphene is a promising technique to improve its dispersion and interfacial compatibility within epoxy matrices. This method also overcomes the processing difficulties of graphene during mixing with epoxy, which is a considerable factor, as it tends to agglomerate due to the van der Waals force of attraction between two consecutive graphene particles. This study investigates the effect of functionalising pristine graphene by using urea under controlled reaction conditions, with a specific focus on incorporating nitrogen to form an amine group, which enhances exfoliation and interfacial interaction with epoxy resin. The amine group ensures bonding of pristine graphene with the epoxy and hardener during the nanocomposite curing process. FTIR, Raman, SEM, and EDS were used to validate the presence of nitrogen and the degree of functionalisation. The functionalised graphene showed excellent dispersion in the epoxy matrix, due to its lower surface energy and enhanced chemical affinity, leading to nanocomposites with significantly better mechanical properties compared to neat epoxy composites.

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