Editorial corner – a personal view

Graphene and its derivatives: Novel materials for forming functional polymer nanocomposites

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Expanded graphite (EG) and graphite nanoplatelets (GNPs) have been widely used as nanofillers to enhance electrical conductivity and mechanical properties of polymers. EGs with a thickness of ~50 to 400 nm were synthesized from graphite intercalation compounds followed by rapid heating. However, the graphene sheets of EGs are partially separated. EGs can be exfoliated to GNPs with a thickness of less than 10 nm under sonication in solvents. The EG/polymer and GNP/polymer nanocomposites show potential applications as the structural components of fuel cells, electromagnetic interference shielding materials, conducting materials for chemical sensors, etc. The physical and mechanical performances of polymers can be further improved by adding very low loading level of graphene of large aspect ratios.

Graphene, a single atomic layer of carbon atoms that are covalently bonded in a honeycomb crystal lattice, is widely known as a basic building block for carbonaceous materials. The remarkable achievement of graphene monolayer through mechanical exfoliation of graphite by Geim and Novoselov in 2004 has sparked tremendous research interest relating to its properties and applications. Because of its extraordinary electrical, mechanical, optical and thermal characteristics, graphene is an ideal filler material for the polymers to form functional nanocomposites. However, the yield of mechanically exfoliated graphene is very low, and can only be used for general property characterization. The

successful synthesis of graphene oxide (GO) via chemical oxidation of graphite opens up new opportunities for fabricating high performance-polymer nanocomposites with excellent biological, mechanical and physical properties. GO is an electrical insulator since it contains oxygenated functional groups. To resume its electrical conductivity, chemical reducing agent addition or thermal treatment is needed to remove such functional groups. Enhanced electrical conductivity can be achieved in thermoplastics by adding ultra-low reduced graphene oxide of ~0.07–0.1 vol%. Thermally reduced graphene oxides with wrinkled morphology, high aspect ratio, and extraordinary high strength are more effective than carbon nanotubes to reinforce and toughen epoxy and glassy polymers. Finally, graphene and its derivatives have been reported to exhibit good biocompatibility with human cells. Carbon nanotubes generally contain metal catalysts that may induce cytotoxicity and inflammation. Metal catalysts are not needed for the synthesis of graphene, thereby avoiding cytotoxicity and inflammation issues.

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