Editorial corner – a personal view

Graphene and graphene/polymer nanocomposites

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Since the single graphene layers were isolated from the graphite by Geim and Novoselov group in 2004, graphene triggered a gold rush for exploiting its possible applications. A search with graphene as a key word using the SciFinder shows even a tremendous increase of publication from 3900 (2010) to 9500 (2011) as they were awarded the novel prize in physics in 2010.

Graphene is a one-atom thick, two-dimensional sheet composed of sp^2 hybridized carbon atoms arranged in a honeycomb structure. It has combined benefits of layered silicates and carbon nanotubes, and is considered as the most promising reinforcing and functional filler of polymers.

Large area graphene is typically produced by bottom-up method such as chemical vapor deposition while flake type by top-down method consisting of oxidation of graphite, exfoliation of graphite oxide (GO) by sonication in liquid media, and reduction. Rapid thermal expansion of GO in inert atmosphere gives thermal exfoliation and reduction simultaneously and is suited for economical, large scale production without using any dispersion media.

The oxygen groups on the surface remaining upon reduction of GO enable dispersion in solvent and water and provide sites for chemical functionalization which allows covalent bonding with reactive polymer function (Advanced Materials, DOI: [10.1002/adma.201102036](https://doi.org/10.1002/adma.201102036)). For example, polyurethanes (PUs) are readily blended with graphene, and hydroxyl functions of graphene react with isocyanate termini of PU to form graphene/PU chemical hybrids.

It is vital to control the type and amount of reactive sites on the graphene surface and edges. Markets for graphene are opened for i) energy saving electrodes as secondary cells for smartphone, notebook, electric car and solar cell, ii) transparent electrodes for flat panel (LCD, OLED) and touch screen, and iii) semiconductors. If graphene thin layer is properly deposited on glass or polymer surfaces, flexible displays, thin film transistors, and photovoltaic and LCD devices will be made possible (Macromolecules, DOI: [10.1021/ma100572e](https://doi.org/10.1021/ma100572e)). Graphene can be used as functional reinforcement for polymer to include packaging, gasketing, automotive, aircraft, ink, painting, sensor etc. When graphene is doped to PU, electrically and infrared light triggered shape memory material is synthesized where graphene provides crosslinks, strain energy storage and light absorption. However, low cost and large production of graphene will only expedite its applications. Otherwise, 'It is a dream. The prospect is so far beyond the horizon that we cannot even assess it properly', as Geim says.

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