Editorial corner – a personal view

Chemical modification of graphene for functional polymer nanocomposites

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Graphene is a single layer of sp^2 -bonded carbon atoms forming a two-dimensional honeycomb structure. It could be considered as a basic structural element of all other graphitic carbons. Many physical properties of graphene have been characterized experimentally and some of them are higher than those of any other known materials. For example, it exhibits a Young's modulus of 1TPa and ultimate strength of 130 GP. The very high thermal conductivity of above $5000 \text{ W}\cdot\text{m}\cdot\text{K}^{-1}$ corresponds to the upper bound of the highest values for SWCNTs [DOI: [10.1021/nl0731872](https://doi.org/10.1021/nl0731872)]. Additionally, it has high electrical conductivity of around $6000 \text{ S}\cdot\text{m}^{-1}$. Especially, graphene is completely impermeable to any gas [DOI: [10.1021/nl801457b](https://doi.org/10.1021/nl801457b)]. It has very large surface area and tunable surface properties. Based on these valuable characteristics, in the last decade, graphene has been viewed as promising material for many applications including polymer nanocomposites (PNCs).

However, due to the inertness, graphene is not compatible with most of polymers. Thus, it must be appropriately modified to provide it with suitable functional groups which are able to have good dispersion and strong interactions or even forming covalent bonds with the chemical moieties in polymers. Using graphene oxide (GO), an oxidized form of graphene, and its various derivatives have widely been considered as the most promising approach for the preparation of graphene. GO contains several oxygen functionalities such as hydroxyl and carboxyl groups and it is readily compatible with a nanocellulose (NFC) in form of suspension. Taking

this advantage, we combined them together to form a mechanically strong and conductive composite film [DOI: [10.1039/C1JM12134K](https://doi.org/10.1039/C1JM12134K)]. NFC/graphene porous structure has been used effectively as host matrix for sulphur impregnation in lithium sulphur batteries [DOI: [10.1016/j.jpowsour.2013.12.081](https://doi.org/10.1016/j.jpowsour.2013.12.081)]. In a study on polyimide graphene composite film [DOI: [10.1016/j.polymer.2011.09.033](https://doi.org/10.1016/j.polymer.2011.09.033)], GO has been treated with ethylisocyanate and the resulted modified GO was seen as good reinforcement in polyimide (PI). Electrical conductivity of the PI/graphene composite film is above the antistatic criterion. Polymer and graphene can also be combined in PNCs *via grafting-to or grafting-from* approaches [DOI: [10.1002/marc.201100527](https://doi.org/10.1002/marc.201100527)]. By *grafting-to/grafting-from* approaches, covalent binding between polymers graphene sheets is formed, leading to a single compound of PNCs where graphene forms an integral part of the polymer chains. However, by these methods, the covalent bonding can enhance some properties while it may be negative for some others, for example, electrical conductivity. Thus, quantitative estimation on the kind of chemical functionalization and degree of the functionalization on the single layer properties such as mechanical and electrical properties would be highly valuable [DOI: [10.1021/ma401606d](https://doi.org/10.1021/ma401606d)].

In general, chemical modification of graphene is an effective way to widen the utilization of graphene in PNCs for different purposes. GO has been used as starting material to modify the structure of graphene as it contains several active groups which are hydroxyl, carboxyl and epoxide functionalities.

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