Functionalization of Graphene and Carbon Nanotubes through Polymerization in Micelles: a Bridge between the Covalent and Non-covalent Methods

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Carbon-based nanomaterials (SWNTs and graphene) constitute a relatively new class of materials exhibiting exceptional mechanical and electronic properties; they are promising candidates for the realization of composites, electronic devices and sensors, for energy conversion and biomedical applications. The fabrication of tailor-made functional hybrids that combine the properties of their building blocks is a central issue of nanosciences. In this context, the development of efficient techniques for the functionalization of carbon-based nanomaterials preserving their exceptional quality, while robustly enriching their functionalities is a key requirement.

It is well established that the covalent grafting of molecules on carbon nanotubes and graphene give rise to robust conjugates since the addends are linked through covalent bonds. However, the transformation of carbon atoms hybridized sp^2 into sp^3 in the conjugated carbon framework induces a sizeable loss of their electronic properties.[1] On the contrary, the non-covalent functionalization permits to better preserve the electronic properties of the nano-objects.[2] So, for a number of applications, the non-covalent functionalization should be preferred. Nevertheless, this approach suffers from a major drawback which is the lack of stability of the resulting assemblies. Indeed, molecules adsorbed on graphene or on the nanotube sidewalls can desorb, more or less easily (depending on the size and/or conformation of the grafted molecules/polymers), when for example the solvent changes, the temperature increases or when the material is filtered and purified.

In this communication, we describe a method of functionalization of nanocarbons which combines most advantages of both covalent and non-covalent methods without their principal drawbacks. Our method is based on the controlled polymerization of hydrophobic molecules on nanotubes/graphene dispersed in micelles (Figure 1). This approach permits to obtain hybrid mateials exhibiting high stability while preserving the π-conjugated system responsible for their outstanding optical and electrical properties. The hybrids can be purified, manipulated and dispersed in various solvents without loss of their functionality. Extensive characterizations based on absorption, photoluminescence spectroscopy and microscopic measurements demonstrate the strength of this method for designing new functional materials while keeping the original properties of SWNTs.[3].

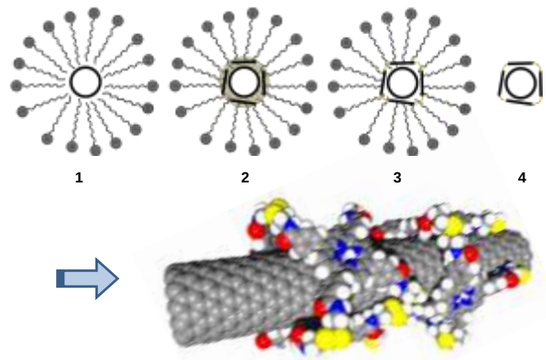

Figure 1. Schematic representation of SWNT functionalization through polymerization in micelles.

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