The Nano-Carbon Landscape: Form Doped Graphene and Molecular Sensors to Nanotubes and their Biological Applications

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This talk will discuss the synthesis of large-area, high-quality monolayers of nitrogen-, silicon- and boron-doped graphene sheets on Cu foils using ambient-pressure chemical vapor deposition (AP-CVD). Scanning tunneling microscopy (STM) and spectroscopy (STS) reveal that the defects in the doped graphene samples arrange in different geometrical configurations exhibiting different electronic and magnetic properties. Interestingly, these doped layers could be used as efficient molecular sensors and electronic devices. In addition, the synthesis of hybrid carbon materials consisting of sandwich layers of graphene layers and carbon nanotubes by a self-assembly route will be discussed. These films are energetically stable and could well find important applications as field emission sources, catalytic supports, gas adsorption materials and super capacitors.

We will describe the synthesis of carbon nanotubes and nanotube networks using different dopants during chemical vapor deposition. In particular, the effects of sulfur, boron and nitrogen will be discussed. For example, sulfur induces the formation of pentagons and heptagons, whereas boron aids the growth of heptagonal carbon rings, and nitrogen promotes the formation of pentagonal cusps. It will be demonstrated that it is indeed possible to assemble/grow carbon nanotube networks if a careful control of dopants is achieved during chemical vapor deposition (CVD) growth. High resolution electron energy loss spectroscopy (HR-EELS) studies on these nanotube materials will be presented, and the locations of boron, sulfur and nitrogen within nanotubes will also be shown. First principles theoretical calculations on nanotubes containing pentagon, hexagons and heptagons in the presence of these dopants will be discussed. Recent experiments on the synthesis of large area super-tough smart carbon textiles, capacitors, catalysts and more. We will also discuss the citotoxicity and applications as molecular sensors and virus traps of these doped nanocarbons. Finally, different routes to synthesize 3D architectures of covalently interconnected carbon nanotubes will also be discussed. These include the use of Si an atomic welder and a multi-stage CVD growth on crisscross nanotubes decorated with Fe nanoparticles. Physico-chemical properties of these novel architectures will also be introduced.

References

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