The Versatility of Carbon: Custom-Made Nanostructures

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In spite of being one of the simplest elements in the Periodic Table, carbon can form an enormous variety of stable structures. In fact, there is a whole branch of Chemistry dedicated to its compounds. On the other hand, there is also a branch of Science dedicated to the multiple forms of the element as a material. Diamond (sp^3 hybridization) and graphite (sp^2 hybridization) were the two ordered carbon allotropes known since ancient times. The discovery of the fullerenes in 1985, followed by that of carbon nanotubes in the early 1990s', marks the birth of the new era of carbon nanomaterials. These include both *nanosized* carbons (carbon nanofibers, fullerenes, single walled and multiwalled carbon nanotubes, graphene-based materials, carbon nanocones, nanohorns and nano-onions, and nanodiamonds), as well as *nanostructured* carbons (carbon gels and templated carbons), where the structure and texture are controlled at the nanometer scale, leading to carbon materials with hierarchical porosity. These carbon materials present reactive sites at the edges of the graphene layers and at structural defects, which are able to react with different compounds forming various types of surface functional groups. Doping is also possible, replacing carbon atoms in the graphite lattice by heteroatoms, such as nitrogen or boron. Thus, in addition to controlling the texture and structure of these materials, we are also able to tune their surface chemical properties, allowing the design of *custom-made* carbons for specific applications. We will review the methodologies used for the synthesis of these carbon nanomaterials and discuss selected applications.

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