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EDITORIAL

Carbon-based nanoscience and nanotechnology: where are we, where are we heading?

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'Without carbon, life cannot exist', the saying goes, and not only life. For technological development, carbon was the ultimate material of the 19th century. It allowed the beginnings of the industrial revolution, enabling the rise of the steel and chemical industries, it made the railways run, and it played a major role in the development of naval transportation. Silicon, another very interesting material which makes up a quarter of the earth's crust, became the material of the 20th century in its turn. It gave us the development of high performance electronics and photovoltaics with large fields of applications and played a pivotal role in the evolution of computer technology. The increased device performance of information and data processing systems is changing our lives on a daily basis, producing scientific innovations for a new industrial era. However, success breeds its own problems, and there is ever more data to be handled—which requires a nanoscience approach. This cluster aims to address various aspects, prospects and challenges in this area of great interest for all our futures.

Carbon exists in various allotropic forms that are intensively investigated for their unusual and fascinating properties, from both fundamental and applied points of view. Among them, the sp^2 (fullerenes, nanotubes and graphene) and sp^3 (diamond) bonding configurations are of special interest since they have outstanding and, in some cases, unsurpassed properties compared to other materials. These properties include very high mechanical resistance, very high hardness, high resistance to radiation damage, high thermal conductivity, biocompatibility and superconductivity. Graphene, for example, possesses very uncommon electronic structure and a high carrier mobility, with charge carriers of zero mass moving at constant velocity, just like photons. All these characteristics have put carbon and carbon-related nanomaterials in the spotlight of science and technology research. The main challenges for future understanding include i) material growth, ii) fundamental properties, and iii) developing advanced applications.

The reviews in this Cluster Issue of *Journal of Physics D: Applied Physics* cover carbon nanoparticles and nanotubes, graphene, nano-diamond and films. They address the most current aspects and issues related to their fundamental and outstanding properties, and describe various classes of high-tech applications based on these promising materials. Future prospects, difficulties and challenges are addressed. Important issues include growth, morphology, atomic and electronic structure, transport properties, superconductivity, doping, nanochemistry using hydrogen, chemical and bio-sensors, and bio-imaging, allowing readers to evaluate this very interesting topic and draw perspectives for the future.

