carbon nanotubes
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carbon nanotubes
FROM BENCH CHEMISTRY TO PROMISING BIOMEDICAL APPLICATIONS

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*Cécilia Ménard-Moyon and Giorgia Pastorin*

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Contributors

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In 2006 she worked as a post-doc in the group of Richard J. K. Taylor on the total synthesis of a natural product (‘upenamide) and on the development of novel methods of synthesis of heterocycles. She then joined, for 18 months, the R&D department of Nanocyl in Belgium, one of the main European producers of carbon nanotubes, and worked on the synthesis, dispersion and functionalisation of carbon nanotubes.
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Tapas Ranjan Nayak received his MTech in biochemical engineering and biotechnology in 2006 from the Indian Institute of Technology, Khargapur (India). He is currently continuing with his PhD at the National University of Singapore (Singapore). His research interests focus on toxicological studies and biomedical applications involving various nanomaterials such as carbon nanotubes, zinc oxide nanofibres and graphene.

He is the main author of Chapter 8 on the toxicity of carbon nanotubes.
Preface

Nanotechnology is a fast-emerging, sophisticated discipline that involves the study and manipulation of matter at atomic dimensions. It holds great promise to revolutionise and impact scientific research and industry, with opportunities for discovering new and exciting phenomena. This is largely due to nanotechnology being so different and counter-intuitive from previous technologies, resulting in past experience providing very little guidance about how to proceed. The fact that nanotechnology is the technology of the 21st century does not represent an exaggerated view of an ephemeral phenomenon, but instead echoes a real and immediate need for an extensive, “in-depth” investigation of what the synergy between Mother Nature and human ingenuity has to offer. Scientists, as is usual to their nature, have risen to the challenge with great gusto. This has led, among other things, to the realisation of advanced and extremely precise instruments that capitalise on the fact that material in the nanoscale dimensions allows integrated and compact systems to be fabricated. Nanotechnology includes not only great challenges such as the use of nanomaterials in novel scientific applications but also the understanding and manipulation of biological specimen at its fundamental levels. Carbon-based materials, among which carbon nanotubes (CNTs) represent a fascinating example, have shown extraordinary effects. CNTs represent interesting materials not only because they have high mechanical stability and nanoscale dimensions, but also because, depending on how the constitutive graphene sheets are rolled up, they share electronic properties of both metals and semiconductors. In addition, differently from spherical nanoparticles, they present a large inner volume that could be filled with several biomolecules ranging from small derivatives to proteins. This offers the advantage to load the inside of CNTs with a drug, while imparting chemical properties through the functionalisation of the external walls and thus rendering these tubes water-soluble and biocompatible.

However, there also exist cautious, almost mistrustful, but justified, opinions on nanotechnology and its consequences. A good reason is the effect on personal health or environmental pollution, because nanoparticles might escape the normal phagocytic defences in the body or might fluctuate and accumulate in the atmosphere. The reason behind such scepticism is that there is the general consciousness that the laws of physics and chemistry are pretty different when particles get down to the nanoscale. As a consequence, even substances that are normally innocuous can trigger intense chemical reactions and biological anomalies as nanospecies.
This has led to the stimulation of attitudes for and against this new science. This book addresses both these aspects by offering a general overview of the main factors that render CNTs unique for further promising applications, as well as the potentially risky aspects associated with these still-unknown carbon-based nanomaterials. It is particularly suitable for young scientists who have been involved in nanotechnology recently, or those who are simply curious about one of the most debated topics of their generation. The main authors of the present volume have been specifically picked from the pool of expert researchers and professors involved in nanotechnologies, but who are younger than 50, with the intention of providing dynamic visions and fresh perspectives of the actual "state of the art" of CNTs. To reiterate, the common undeniable opinion is that, although it is too early to say whether these "nano-structures" will wean the world from its current limitations, or monumentally backfire to cause harm, a superficial understanding might provide good ideas, but a deep knowledge favours great discoveries, even at the nanoscale.

Giorgia Pastorin