Preface

In the last two decades, carbon nanotubes (CNTs) have attracted tremendous attention. A CNT can be considered a seamless cylinder formed by rolling up graphene sheets, which are composed of hexagonal sp^2 carbon networks. A single-walled CNT (SWCNT) has only one graphene layer. A multi-walled CNT (MWCNT) consists of a series of concentric graphene layers with an interlayer distance similar to graphite. The unique structure of CNTs endows them with extraordinary properties, for example, superior conductivity of both electricity and heat, outstanding mechanical properties, and excellent chemical and thermal stability. In particular, SWCNTs can behave as semiconductors with a tunable direct band gap determined by their structure. These properties make CNTs an important material both for scientific research and applications.

Although tubular carbon nanostructures were observed earlier [1,2], it is the report by Iijima [3] in 1991 that launched the huge interest in CNTs. They observed MWCNTs under a high resolution transmission electron microscope. In 1993, Iijima et al. [4] and Bethune et al. [5] reported the observation and preparation of SWCNTs, respectively. Since then, CNTs have been studied intensively. Chinese scientists entered this field shortly after its beginning and have contributed much. Therefore, we have published this special topic on CNTs to celebrate the twentieth anniversary of CNT research.

This special topic contains eight review articles. The topics cover different areas of CNT study, including their preparation, properties, and application [6–13]. The authors have mainly summarized the progress achieved in the respective research groups. CNTs have been prepared using different strategies and obtained in various forms to meet the requirements of different applications. Mass production of bulk-form CNTs with tunable diameter and length has been realized [8]. This is a significant progress in the nanoscale process engineering of CNTs. When using anodic aluminum oxide membranes as templates, the length, diameter and wall thickness of CNTs can be controlled [11]. The preparation of different forms of SWCNTs is also discussed. Well-aligned ultralong SWCNTs ready for building nanodevices have been directly grown on substrates by chemical vapor deposition (CVD) [13]. Free-standing SWCNT networks have been fabricated either directly by CVD or arc discharge as well as by post-growth treatment [12]. A new condensed form of SWCNTs, SWCNT crystals, has been prepared using a series of diamond wire drawing dies [10]. The structure and properties of CNTs have been studied, as well as their various applications. Sc and Y contacts can be used to obtain high performance ballistic n-type field-effect transistors [6]. This resulted in a new doping-free strategy to fabricate CNT-based CMOS devices and integrated circuits. CNTs are also ideal materials for building optoelectronic devices such as light emitters, photodetectors, and photovoltaic devices [7]. SWCNTs can generate electricity when water molecules flow inside their channels, and can even harvest the surface energy of ethanol [10]. CNT-based nanocomposites are superior materials for supercapacitors [12]. SWCNT networks can also serve as transparent conductive electrodes and reinforcement materials in composites [12]. Recently, new opportunities for CNTs have appeared in the fields of biology and medicine. CNTs may bring about some novel technologies for disease diagnosis and therapy [9]. The reviews presented in this special issue are valuable references for the future research in CNTs and related fields.

This special topic only represents part of the progress made by Chinese research groups. I believe that there are still some excellent works which have not been included in this special topic. After two decades of effort, we have discovered much about CNTs. However, emerging challenges still need us to explore. I hope that in this area, full of challenges and opportunities, we will make more important progress.

- 1 Radushkevich L V, Lukyanovich V M. Obrazujucesja pri termiceskom razlozenii okisi ugleroda na zeleznom kontakte. *Zurn Fistic Chim*, 1952, 26: 88–95
- 2 Oberlin A, Endo M, Koyama T. Filamentous growth of carbon through benzene decomposition. *J Cryst Growth*, 1976, 32: 335–349
- 3 Iijima S. Helical microtubules of graphitic carbon. *Nature*, 1991, 354: 56–58
- 4 Iijima S, Ichihashi T. Single-shell carbon nanotubes of 1-nm diameter. *Nature*, 1993, 363: 603–605
- 5 Bethune D S, Kiang C H, Devries M S, et al. Cobalt-catalyzed growth of carbon nanotubes with single-atomic-layer walls. *Nature*, 1993, 363: 605–607

- 6 Zhang Z Y, Wang S, Peng L M. High-performance doping-free carbon-nanotube-based CMOS devices and integrated circuits. *Chin Sci Bull*, 2012, 57: 135–148
- 7 Wang S, Zhang Z Y, Peng L M. Doping-free carbon nanotube optoelectronic devices. *Chin Sci Bull*, 2012, 57: 149–156
- 8 Huang J Q, Zhang Q, Zhao M Q, et al. A review of the large-scale production of carbon nanotubes: The practice of nanoscale process engineering. *Chin Sci Bull*, 2012, 57: 157–166
- 9 Wang X J, Liu Z. Carbon nanotubes in biology and medicine: An overview. *Chin Sci Bull*, 2012, 57: 167–180
- 10 Chen M J, Yu F, Hu L J, et al. Recent progresses on the new condensed forms of single-walled carbon nanotubes and energy-harvesting devices. *Chin Sci Bull*, 2012, 57: 181–186
- 11 Hou P X, Liu C, Shi C, et al. Carbon nanotubes prepared by anodic aluminum oxide template method. *Chin Sci Bull*, 2012, 57: 187–204
- 12 Zhou W Y, Ma W J, Niu Z Q, et al. Freestanding single-walled carbon nanotube bundle networks: Fabrication, properties and composites. *Chin Sci Bull*, 2012, 57: 205–224
- 13 Peng F, Liu Y, Cui R L, et al. Direct growth of single-walled carbon nanotubes on substrates. *Chin Sci Bull*, 2012, 57: 225–233

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