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Self-Assembled Nanomaterials I

Nanofibers

Volume Editor: Toshimi Shimizu

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Preface

Nanotechnology is the creation of useful materials, devices, and systems through the control of matter on the nanometer-length scale. This takes place at the scale of atoms, molecules, and supramolecular structures. In the world of chemistry, the rational design of molecular structures and optimized control of self-assembly conditions have enabled us to control the resultant self-assembled morphologies having 1 to 100-nm dimensions with single-nanometer precision. This current research trend applying the bottom-up approach to molecules remarkably contrasts with the top-down approach in nanotechnology, in which electronic devices are miniaturizing to smaller than 30 nm. However, even engineers working with state-of-the-art computer technology state that maintaining the rate of improvement based on Moore's law will be the most difficult challenge in the next decade.

On the other hand, the excellent properties and intelligent functions of a variety of natural materials have inspired polymer and organic chemists to tailor their synthetic organic alternatives by extracting the essential structural elements. In particular, one-dimensional structures in nature with sophisticated hierarchy, such as myelinated axons in neurons, tendon, protein tubes of tubulin, and spider webs, provide intriguing examples of integrated functions and properties.

Against this background, supramolecular self-assembly of one-dimensional architectures like fibers and tubes from amphiphilic molecules, bio-related molecules, and properly designed self-assembling polymer molecules has attracted rapidly growing interest. The intrinsic properties of organic molecules such as the diversity of structures, facile implementation of functionality, and the aggregation property, provide infinite possibilities for the development of new and interesting advanced materials in the near future. The morphologically variable characteristics of supramolecular assemblies can also function as pre-organized templates to synthesize one-dimensional hybrid nanocomposites. The obtained one-dimensional organic–inorganic, organic–bio, or organic–metal hybrid materials are potentially applicable to sensor/actuator arrays, nanowires, and opto-electric devices.

The present volumes on Self-Assembled Nanofibers (Volume 219) and Nanotubes (Volume 220) provides an overview on those aspects within eight chapters. Different points of view are reflected, featuring interesting aspects related

to (a) the self-assembly of supramolecular nanofibers comprising of organic, polymeric, inorganic and biomolecules (N. Kimizuka, in Volume 219, Chapter 1), (b) controlled self-assembly of artificial peptides and peptidomimetics into nanofiber architectures (N. Higashi, T. Koga, in Volume 219, Chapter 2), (c) self-assembled nanostructures from amphiphilic rod molecules (B.-K. Cho, H.-J. Kim, Y.-W. Chung, B.-I. Lee, M. Lee, in Volume 219, Chapter 3), (d) the production of functional self-assembled nanofibers by electrospinning (A. Greiner, J. H. Wendorff, in Volume 219, Chapter 4), (e) the synthesis of tailored π–electronic organic nanotubes and nanocoils (T. Yamamoto, T. Fukushima, T. Aida, in Volume 220, Chapter 1), (f) preparation and fundamental aspects of nanotubes self-assembled from block copolymers (G. Liu, in Volume 220, Chapter 2), (g) β-1,3-glucan that can act as unique natural nanotubes and incorporate conjugated polymers or molecular assemblies (M. Numata, S. Shinkai, in Volume 220, Chapter 3), and (h) the fabrication of self-assembled polymer nanotubes involving the use of a nanoporous hard template (M. Steinhart, in Volume 220, Chapter 4). A variety of nanofibers and nanotubes with well-defined morphologies and dimensions are discussed in terms of self-assembly of molecular and polymer building blocks in bulk solution or confined geometry like nanopores.

Current materials and manufacturing technologies strongly require technological advances for reducing environmental load combined with energy and resource savings in production. In order to develop such technologies for the development of a sustainable society, research on materials production based on the self-assembly technique is of great interest. Hopefully, these volumes will be beneficial to readers involved with self-organization in the field of bottom-up nanotechnology as well as those concerned with industrial fiber processing.

Tsukuba, June 2008 Toshimi Shimizu

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