Preface

The definition or concept of the nanostructure has two levels of implication [1]. The first refers to nanostructures, including nanoparticles, nanoclusters, nanotubes, nanorods, nanowires and nanopores, which have at least one dimension in the size range of approximately 1 to 100 nm. The second refers to the unique properties of nanostructures. When their size is reduced to sub-micron or especially to nanometer scale, their properties are significantly altered. Obviously, the latter implication is more meaningful and suggests numerous potential applications [2]. Relevant studies have led to a broad spectrum of innovative developments in various areas, including physics, chemistry, medicine, energy, and sensing.

The controllable preparation and mass production of nanostructures are critically important for the advancements of nanoscience and nanotechnology. Despite the rapid development of chemical synthesis of nanostructures over the past two decades, in-depth examination and understanding of the formation mechanism of nanostructures at different dimensional levels based on different materials (e.g., carbon, metals, semiconductors, organic molecules, and inorganic-organic hybrid materials) are in great demand. Relevant studies are currently among the major priorities for the further development of nanoscience and nanotechnology. In China, many research groups are engaged in this area [3], and it is therefore an appropriate time to launch a special issue on the formation mechanism of nanostructures to promote the work of these groups and strengthen this important research direction.

This special topic consists of 14 invited papers, including 5 research articles and 9 reviews, which, together with a sister issue in Chinese (*Scientia Sinica Chimica*, vol. 42, issue 11, 2012, containing 2 research articles and 9 reviews) gathers the representative work of the most distinguished and/or active Chinese scientists in the nanoscience field, with special focus on the studies of growth mechanisms of nanostructures. These papers are basically divided into three areas: detailed analysis of the formation mechanisms, systematic investigation of the growth processes, and rational design and preparation of structurally well-defined nano-

materials. We hope that the systematic efforts presented in this issue will enable us to provide a more comprehensive understanding of the existing research results, and thus allow us to better target future nanomaterials research.

In the first part, the formation mechanisms of nanostructures with different dimensions are scrutinized to reveal the driving forces behind them. WAN LiJun and coworkers [4] discuss a “non-classical crystallization” mechanism in terms of its possibilities for morphology control of hierarchically-structured materials, where the crystallization route is through self-organization of nanosized building blocks rather than the attachment and detachment of monomers, as occurs in a classical case. HU Shi and WANG Xun [5] review the progress in ultrathin nanocrystals over the last decade along with several important factors for the growth mechanisms. Examples of cluster assembly from one-dimensional to three-dimensional nanostructures are used to demonstrate the usefulness of cluster assembly for the synthesis of new materials. XIONG YanSong and TANG ZhiYong [6] summarize the recent advances in controllable fabrication of inorganic nanocrystalline materials, including one-dimensional, two-dimensional and three-dimensional nanostructures, via the self-assembly method. The oriented aggregation mechanism is discussed in detail. WEI ZhiXiang and coworkers [7] present a review of the self-assembly of one-, two- and three-dimensional anisotropic nanostructures using conjugated polymers as building blocks. The mechanisms that guide the formation of various nanostructures are analyzed using the cooperative effect of π - π stacking interaction and other non-covalent interactions.

The second part focuses on thorough investigations of the process parameters, including heating, additives, and ultrasonication, to illustrate their roles in the formation of nanostructures. SUN YuGang and colleagues [8] monitor real-time variations of δ -phase MnO_2 nanoflowers in terms of their morphology and crystalline structures during thermal annealing by *in-situ* transmission electron microscopy. The δ - MnO_2 flowers, consisting of an assembly of nanosheets with thicknesses in the range of 2–10 nm, prefer to transfer into α - MnO_2 flowers through thermal annealing.

SUN ShiGang and coworkers [9] investigate the interactions of citrates with the platinum single crystal (100) plane in acid media by using cyclic voltammetry, and reveal that citrates could stabilize the surface domains of the two-dimensional long range order of Pt(100) surfaces. JIANG LiPing and coworkers [10] demonstrate the effects of ultrasonics on crystallization. Ultrasonic-assisted Ostwald ripening and oriented attachment processes are reviewed for possible crystal growth mechanisms for use in the fabrication of inorganic nanostructures [10]. XU Guo-Bao and coworkers [11] reveal appropriate thermodynamic and kinetic parameters for the nucleation and growth of noble metal nanocrystals and provide useful guidelines for the rational design and synthesis of high quality novel noble metal nanocrystals by a seed-mediated growth method.

The third part presents a series of nanostructures with well-defined structures and/or interesting properties to illustrate the continuing enrichment of the nanomaterials family. JIN RongChao and coworkers [12] report the controlled growth of $\text{Au}_{25}(\text{SR})_{18}$ and $\text{Au}_{38}(\text{SR})_{24}$ (where $\text{R} = \text{CH}_2\text{CH}_2\text{Ph}$) nanoclusters with high molecular purity via size-focusing from the same raw product that contains distributed nanoclusters. CAI JinGuang and QI LiMin [13] summarize recent advances in the synthesis of hierarchically structured TiO_2 mesocrystals and their applications, with particular emphasis on their formation mechanisms. LIU KeSong, JIANG Lei and coworkers [14] review the recent developments in bio-inspired special wetting surfaces that are fabricated via self-assembly, including low adhesion superhydrophobic surfaces, high adhesion superhydrophobic surfaces, superamphiphobic surfaces, and stimuli-responsive surfaces. XU DongSheng and colleagues [15] review their recent progress in the transfer of one-dimensional titanates into TiO_2 nanostructures through the hydrothermal method, including the transformation mechanism and applications. NIU Ping and HAO JingCheng [16] report layer-by-layer assembly of TiO_2 and $\text{H}_4\text{SiW}_{12}\text{O}_{40}$ multilayer films on silicon wafers and glass slides for photocatalytic degradation of methyl orange (MO). CHEN Da, LI Jing-Hong and coworkers [17] fabricated well-ordered TiO_2 nanotube arrays (TNAs) by electrochemical anodization in a mixed organic electrolyte consisting of ethylene glycol and glycerol. These well-ordered TNAs have excellent electronic properties and highly efficient photocatalytic properties when compared with commercially available TiO_2 P25 nanoparticles.

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TIAN ZhongQun (Xiamen University)

LI YaDong (Tsinghua University)

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TIAN ZhongQun received a B.S. degree in Chemistry from Xiamen University in 1982, and then went to the University of Southampton, UK in 1983. He worked on surface-enhanced Raman spectroscopic studies of various electrochemical systems under the supervision of Professor Martin Fleischmann (FRS). After obtaining his Ph.D. in 1987, he returned to Xiamen University and worked in the State Key Laboratory for Physical Chemistry of Solid Surfaces, where he was appointed as Professor (1992) and later as Director (2003–2009). His research interests have included surface-enhanced Raman spectroscopy, spectro-electrochemistry and nano-chemistry. He is a Member of the Chinese Academy of Sciences and is a Fellow of the Royal Society of Chemistry (2005–present), and was the Titular Member of the Division of Physical and Biophysical Chemistry, IUPAC (2004–2007). He serves on the advisory boards of several international journals including *J. Am. Chem. Soc.*, *Chem. Sci.*, *Chem. Comm.*, *J. Phys. Chem.*, and *J. Chem. Phys.*; and is an associate editor of *Chem. Soc. Rev.*, *J. Raman Spectroscopy* and *Sci. China Chem.*

LI YaDong was born in 1964. He received his B.S. degree from the Department of Chemistry at Anhui Normal University in 1986, and received his Ph.D. from the Department of Chemistry at the University of Science and Technology of China in 1998. His research interests are focused on the synthesis, assembly, structures and exploration of the applications of nanomaterials. He is a Member of the Chinese Academy of Sciences and serves on the advisory boards or an editor or associate editor of several journals, including *Inorg. Chem.*, *Chem. Mater.*, *J. Mater. Res.*, *Nano Research.*, *Sci. China Chem.*, and *Chinese Sci. Bull.*