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Low-Dimensional Nanomaterials and its Applications

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Introduction

Nanoscience and nanotechnology are a major research topic over a period of several decades. In the circumstance, nanomaterials, which have low-dimensional structures, contribute to developing those scientific fields. That is, prosperity of nanoscience has provided various examples demonstrating that the size and dimensionality have a momentous influence of materials properties [1]. Molecular properties on and/or in nanomaterials have been much different from the preceding aspects of structure and dynamics, that is, movement, phase transition, chemical transformation etc., [2]. Thus, those properties are difficult to predict the phenomenon with typical sense. Quantum mechanics and statistical mechanics become more important to understand those phenomena in those low-dimensional nanomaterials.

Various nanomaterials such as carbon nanotubes, graphene, zeolites, porous silica and alumina, metal organic frameworks, and metal nanoclusters are utilizing for nano-electronics, photonic devices, nano-machine, and sensors [2]. Carbon nanotubes could be one-dimensional nanomaterials and have extraordinary electrical conductivity and mechanical properties. Due to the high current density, low turn-on and operating voltages, and steady, long-lived behavior make carbon nanotube the best field emitters of any materials [3]. Graphene has two-dimensionality, which is available for several applications in mechanical engineering, electrical engineering and micro-electronics [4]. Therefore, interdisciplinary approaches among physics, chemistry, biology, material science and engineering could be possible using graphene. Carbon nanotubes have a significantly high surface area as well as good electrical conductivity. Carbon nanotubes and grapheme could be a good candidate for molecular electronics, electrodes in battery and capacitors, and electrode catalyst supports in fuel cells. Comprehensive development, including fundamental and applied science, safety evaluation and the establishment of control methods in future carbon nanotubes can meet the science, technology, economy and social acceptance. Nanofibers also have one-dimensional structure and have many possible technological and commercial applications. Nanofiber scaffolds are act as an artificial highly porous extracellular matrix in the tissue engineering to guide cell growth and tissue regeneration [5]. Lithium ion battery electrodes made with nanofiber demonstrate four times larger storage capacity of typical lithium ion batteries due to their outstanding electrical conductivities, large surface areas and chemical stability. Furthermore, nanofiber will be applicable in the textile industries such as sport apparel, sport shoes, special rainwear, outerwear garments. Nanowires also have one-dimensional structure, but are much higher aspect ratio than nanofibers. By employing bottom up nanowires

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are using to construct complex integrated circuits with functionalities common in conventional semiconductor technologies, such as p-n junction diodes, field-effect transistors, logic gates and light emitting diodes [6]. Metal nanoparticles have zero-dimensional geometry and unique catalytic activities. Optical properties of metal nanoparticles strongly depend upon the particle size and shape [7]. Various nano-composites such as metal-ceramics, carbon nanotube-polymer, and so on have been fabricated for fuel cells, sensors and coatings devices, reduction of solid wastes and improved manufacturing capability [8].

Various scientists have been fabricating unique low-dimensional nanomaterials from the recent several decades, and are developing those materials and evaluating the properties for various applications. We are confident that the special issue "Low-dimensional Nanomaterials and its Application" will be of great interest in broad fields of scientific community and hope that it will bring to their attention and be available for future researches.

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