A mesoporous composite template composed of self-assembled silica nanotube and multi-walled carbon nanotube

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Received 27 December 2006; received in revised form 15 July 2007; accepted 8 August 2007
Available online 23 August 2007

Abstract

The multi-walled carbon nanotubes (MWNTs) were successfully embedded in the hexagonally-arranged silica tubular structure by the self-organization of two surfactant systems providing a MWNT-incorporated silica nanocomposite template. The anionic surfactant (sodium dodecyl sulfate, SDS) adsorbed on the MWNT surfaces allowed the MWNTs to interact with the outer surface of the self-assembled non-ionic surfactant, poly(ethylene oxide)–poly(propylene oxide)–poly(ethylene oxide) (PEO–PPO–PEO) triblock copolymer. Due to the hydrophilic–hydrophilic interaction between the PEO blocks and the sulfate group of SDS, the MWNTs were most possibly surrounded by the outer wall of the SBA-15 hexagonal tubes aligning in the longitudinal and transverse directions to the silica tube direction. According to the interplanar distances, electron microscopy images, and N2 adsorption–desorption isotherms, the synthesized SBA-15/MWNT system exhibited the structural integrity of silica-tube arrangement and structural characteristics of MWNTs in terms of BET surface area and micropore volume. This work made it clear that the developed SBA-15/MWNT template could be used to synthesize various MWNT-incorporated 2-D replicas.

Keywords: Multi-walled carbon nanotube; Template; SBA-15; Mesoporous silica; Nanocomposite

1. Introduction

Ordered mesoporous materials from various nanoporous templates have been reported to have unique characteristics such as a uniform pore size, sustainable physicochemical stability, and large surface area [1]. Among the many nano-sized templates, SBA-15 is one of the most attractive materials on account of its strong and heavy wall thickness, which provides large surface area, high mechanical stiffness, and hydrothermal stability [2]. Accordingly, the SBA-15 templates and their replicas have been considered for many applications including catalysis, separation, low-k dielectrics and optical techniques [3]. Monometallic Pt, Au, and Ag nanowires have been synthesized using SBA-15 silica templates for applications in nanoelectronic circuits and nanorobotics [4]. Nanoporous carbon rod structures have also been synthesized by the template and applied as a catalytic substrate of platinum in the application of direct methanol fuel cells (DMFC) [5]. This replicated carbon structure is reported to give a well-connected conducting network as an excellent current collector and high-porosity open pores for the facile transport of reactants and products in fuel cell operation.

Since their discovery in 1991 [6], carbon nanotubes (CNTs) have been the focus of intense study on account of their unique properties and potential applications [7]. For example, when compared with other conducting...