185g Synthesis of Free-Standing, Crystalline Tin-Oxide Nanorods with Controlled Diameter Using Mesoporous Siica as Templates

Chang Hyun Ko, Hirn Ill Song, Sang Sup Han, Soon Haeng Cho, and Jong-Nam Kim

Tin-oxide has attracted much attention due to its wide range of applications such as transparent conducting coating, modification of electrode surface and sensors. Recently, many researchers have tried to synthesize nanostructure tin-oxide, such as aligned nanowires, ordered mesoporous powders in order to increase the specific surface area of tin-oxide because their properties, conductivity, sensitivity for gas detection and so on, are expected to be more promising than previously synthesized bulk phase tin-oxide. Chemical vapor deposition and solution phase synthesis with surfactants were the methods to produce single crystalline, well-organized tin-oxide nanowire arrays. But diameter of them was larger than 50 nm. Very recently, mesoporous materials have been introduced as efficient templates to synthesize nanostructure metal, carbon and metal oxide with their critical dimension between 3 ~ 10 nm. Based on previous results, we synthesized free-standing tin-oxide nanorods with uniform diameter from 3 to 10 nm using mesoporous silica with different pore diameters. After we impregnated tin chloride inside the pores of mesoporous silica, we calcined this sample around 823 K in oxygen atmosphere to convert tin chloride into tin-oxide. After calcinations, we selectively removed mesoporous silica template using HF. Then, we obtained free-standing tin-oxide nanorods. High-resolution transmission electron microscopy (HR-TEM) revealed that nanorods were not single-crystalline but poly-crystalline with grain-boundary and defects. Their diameters were the same as the corresponding mesopores in silica templates. Energy dispersive spectroscopy attached in HR-TEM also showed that silica was completely removed by HF. Considering geometry and surface areas, tin-oxide nanorods with controlled diameters are expected to be a promising candidate for various applications, especially sensors.