Vanadium Oxide Nanowire-Carbon Nanotube Composites: Preparation and Characterization

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Since the discovery of carbon nanotubes (CNT), 1-D nano-sized fibrous and tubular materials have attracted special attention due to their outstanding structural flexibility and special chemical and physical properties. Similar materials from inorganic compounds have been also synthesized recently, among them, vanadium oxide wires are of specially interest for catalytic application based on the intrinsic variable valency and redox properties.[1] Vanadium oxides and related compounds are frequently employed as the catalysts for partial oxidation or dehydrogenation of alkanes. Most of these reactions are very highly exothermal, which results in large amount of heat hoarding on the catalyst surfaces and thus declines the catalytic activity or selectivity because the active catalysts and/or the normally used supports are poorly conductive thermally.

Such a problem is possibly solved by using some materials with good thermal-conduction as the supports for active phase[2] or combining them with each other. These materials can act as a heat-pump to extract the heat from the catalyst surface and reactor. CNT have an excellent thermal conductivity, high surface area, and high thermal and chemical stability's. Furthermore, it has been well known that carbon material themselves, including nanofibres,[3] are also active and selective for some catalytic oxidation reactions. Therefore, combining vanadium oxides with CNTs is expected to produce a novel and interesting catalytic material and to improve the catalytic behavior, especially for the reaction selectivity. In this work, we report a novel approach for the preparation of vanadium oxide nanowires (VONW) and CNT composites.

The used CNT were produced by the detonation of a mixture of picric acid, paraffin, and cobalt acetate.[4] They are multi-walled and occupy about 80% of the as-synthesized samples. To synthesize the VONW-CNT composites, the CNT are pretreated by nitric

acid solution to partially remove the impurities (cobalt and amorphous carbon particles) and to modify oxygen-containing groups on the tube surface. A saturated solution of NH_4VO_3 (orange in color) was refluxed with desired amount of the pretreated CNT for 16 hrs, during which a lot of green solid materials are formed and suspended in the solution with the black CNT. After the refluxing, the suspension was filtrated, washed with deionized water, and dried at 110 ^oC in air.

The formed materials typically consist of VONW and CNT (Fig. 1a), which are separated from each other (very few cases show oxides on the carbon tube surface. The VONW are normally self-organized into bundles, unlike the CNT. The oxide wires are slightly thicker and obviously shorter than CNT. EELS analyses show the wires consisting of vanadium and oxygen mainly and very little nitrogen. High-resolution TEM (Fig. 1b) show the wires are well structured. CNT seems act as templates for the formation of the vanadium oxide wires because only very large irregular particles are formed without CNT. In this presentation, the data from SEM, EDX, XPS, and XRD analyses are also available.

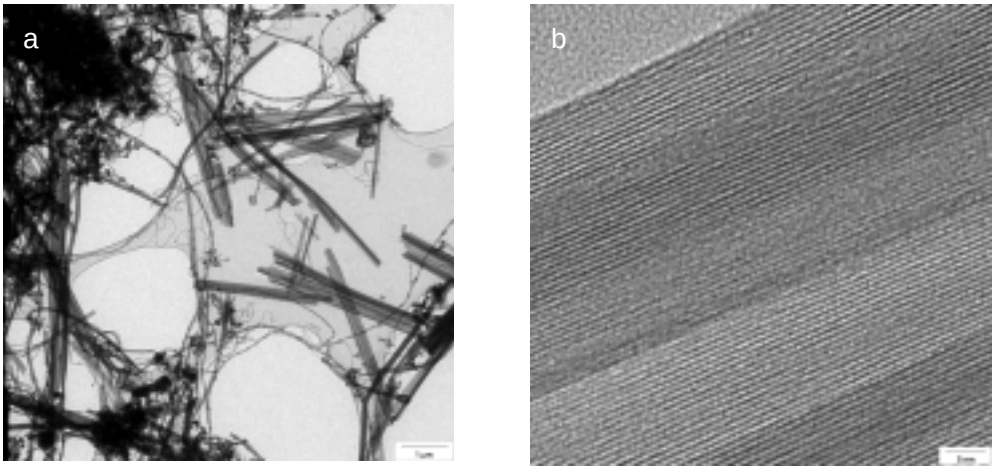

Fig. 1. (a) TEM image of the VONW-CNT composites. (b) High-resolution TEM image of a typical VONW bundle.

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