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Platinum Nanorods in Carbon Nanotubes

Nanosized carbon tubes filled with metal are predicted to have many industrial applications, as catalysts, nanowires for conducting electricity and as composite materials. The preparation and structure of the carbon nanotubes and the encapsulated metal determine the form that the active metal will take. Indeed, metal may be deposited upon the nanotubes as well as inside them. One method commonly used to prepare carbon nanotubes is arc-discharge evaporation, with metal subsequently inserted into the nanotubes.

Now, researchers at Tohoku University, Japan, have prepared uniform platinum-filled carbon nanotubes, with metal deposited only within channels, by a template method using the electro-oxidation of aluminium plate (T. Kyotani, L.-F. Tsai and A. Tomita, *Chem. Commun.*, 1997, (7), 701–702). The resulting aluminium oxide film template was an array of parallel, straight channels of nanometre-scale diameter. Carbon was deposited on the channel walls by thermal decomposition of propene. Platinum was loaded on this carbon film by impregnating with an ethanol solution of hexachloroplatinic acid at room temperature. The chloroplatinic acid was then reduced to platinum in the channels by either heat treatment at 500°C under hydrogen or by stirring with excess $NaBH_4$ solution at room temperature. The template was then removed with hydrofluoric acid and a platinum metal/carbon nanotube composite was obtained.

TEM images of composites prepared at 500°C showed the presence of uniform nanotubes with outer diameter and wall thickness of 30 nm and ~ 5 nm, respectively. Some tubes were filled with platinum nanorods (some > 1 μm long) of high crystallinity (~ 300 nm), more abundant at the open tube ends. Room temperature reduction produced mostly platinum crystallites (2–5 nm). Thus platinum within these carbon nanotubes may be prepared either as nanorods or nanoparticles and their length, diameter and thickness are controllable and are monodisperse.