Synthesis of High-Surface-Area Platinum Nanotubes Using a Viral Template

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The demand for green, efficient, low-cost, portable energy supplies has never been greater. One promising approach is the use of fuel cells such as the direct methanol fuel cell (DMFC). These promise significant increase (×10) energy density storage over conventional lithium-ion batteries, with potential to reach levels of 4.8 $kWhL^{-1}$ (or 6.1 Whg^{-1}). A key component in such DMFCs is the anode, at which methanol is oxidized, to produce carbon dioxide, hydrogen ions and electrons. Platinum (and its alloys) has proven to be a material with strong potential for use as an anode, due to its ability to adsorb hydrogen.

A novel method for the synthesis of high surface area, Platinum - Tobacco mosaic virus (Pt-TMV) nanotubes is presented. Platinum salt is reduced to metallic form on the external surface of a rod-shaped TMV by methanol, which serves as a solvent and reductant simultaneously. The method provides enhanced control of surface roughness and Pt thickness than under strongly reducing conditions (eg DMAB or $NaBH_4$). It was found that for the same Pt loading, Pt-TMV nanotubes had electrochemically active surface area (ECSA) 3.7 times larger than Pt nanoparticles. The Pt-TMV system, used as a catalyst for methanol oxidation, shows 65% higher catalytic mass activity than catalyst based on Pt nanoparticles [1]. Whilst we present results for coating of TMV, the route is more general and should work on any charged protein/surfactant system.

References

[1] Marcin Ł. Górzny, Alex S. Walton, and Stephen D. Evans, Adv. Funct. Mater., **2010**, *20*, 1295-1300.

Figures

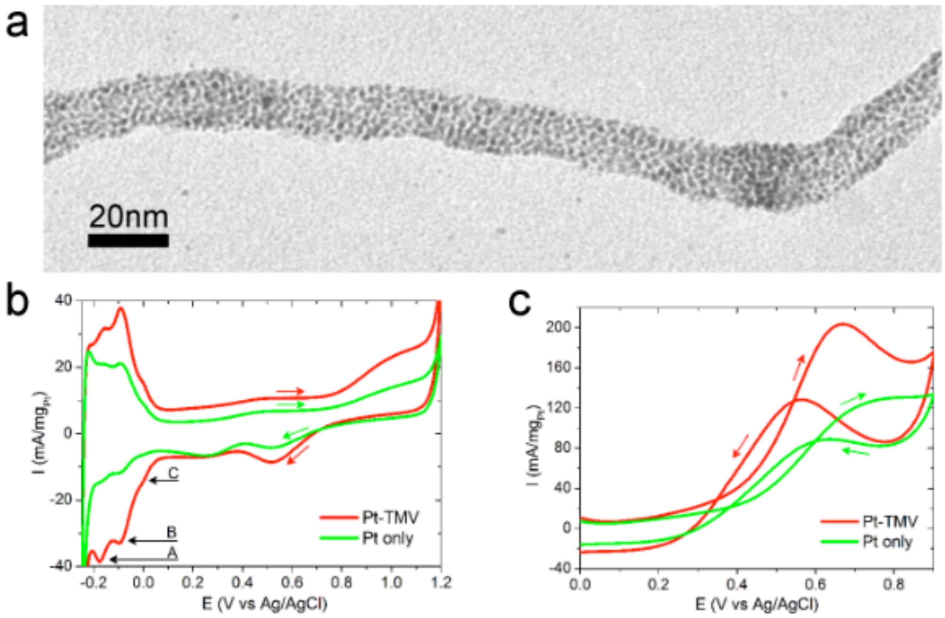

Figure 1: TEM image of Pt-TMV nanotube (a). Panel b, shows two cyclic voltammogram curves corre sponding to Pt-TMV (red trace) and PtNPs (green trace) in 0.5 M H_2SO_4. Peaks A, B and C correspond to hydrogen adsorption on Pt(110), Pt(100) and Pt(111) crystal planes respectively. These characteristics were used to evaluate the surface area. Panel b shows a cyclic voltammogram curves for the oxidation of methanol. Two CV curves corresponding to Pt-TMV (red trace) and PtNPs (green trace) in mixture of 0.5 M H_2SO_4 and 2 M CH_3OH, nitrogen purged, sweep rate 100 mVs^{-1}.