PREPARATION OF MANGANESE OXIDES HOLLOW NANOTUBES

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Manganese oxides (MOs) micro- and nano-structures have attracted attention due to their wide applications in different fields such as catalysis, ion-sieves, rechargeable batteries, chemical sensing devices, and microelectronics (Brock et al).[1] The differences of the synthesis methods can be attributed to variations in particles size, the type and amount of defects in the structures. There are many reports in the literature regarding synthetic processes that include either oxidation of Mn(II) in basic solution (Golden et al),[2] or oxidation by MnO_4^- (Lou et al),[3] O_2, $K_2S_2O_8$, and H_2O_2 (Moon et al),[4] or by reduction of MnO_4^- using different routes (Cai et al).[5] To open up new applications of manganese oxides, novel morphologies or nanostructures are required to be developed. In that respect, manganese oxide-coated carbon nanotubes (CNT) and other organic/inorganic nanofibers or manganese oxide nanotubes are prepared via a variety of methods which include chemical in situ coating, electrodeposition and hydrothermal syntheses for high performance energy storage devices, lithium batteries, rechargeable zinc-air batteries, electrocatalytic water splitting and supercapacitor applications.

A novel rapid method is developed for the preparation of manganese oxides (MOs) hollow nanotubes using multi-wall carbon nanotubes (MWCNTs) as templates with an acidic permanganate reaction and heat treatment. The method developed has the advantage of uniform coating the surface of MWCNTs structure with a thickness controllable amorphous manganese oxide layer. The rapid synthesis process with the evolution of gaseous by-product leaves with very high porosity within the coated manganese oxide layers. Further heat treatments under 650°C lead to the removal of CNT templates, resulting in the formation of crystalline manganese oxide hollow nanotubes with highly porous walls. The manganese oxide coated MWCNTs, and amorphous manganese oxide nanotubes of this synthesis process are characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM).

Acknowledgement
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References

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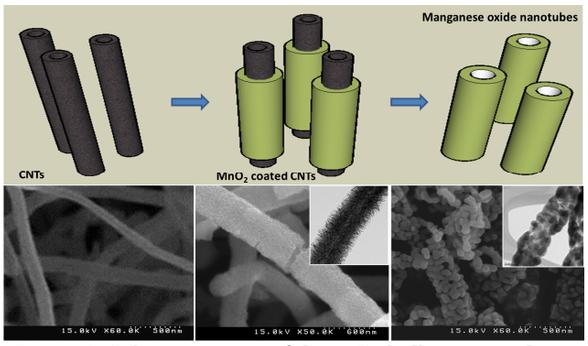

Figure 1. Schematic view of the MOs hollow nanotubes preparation

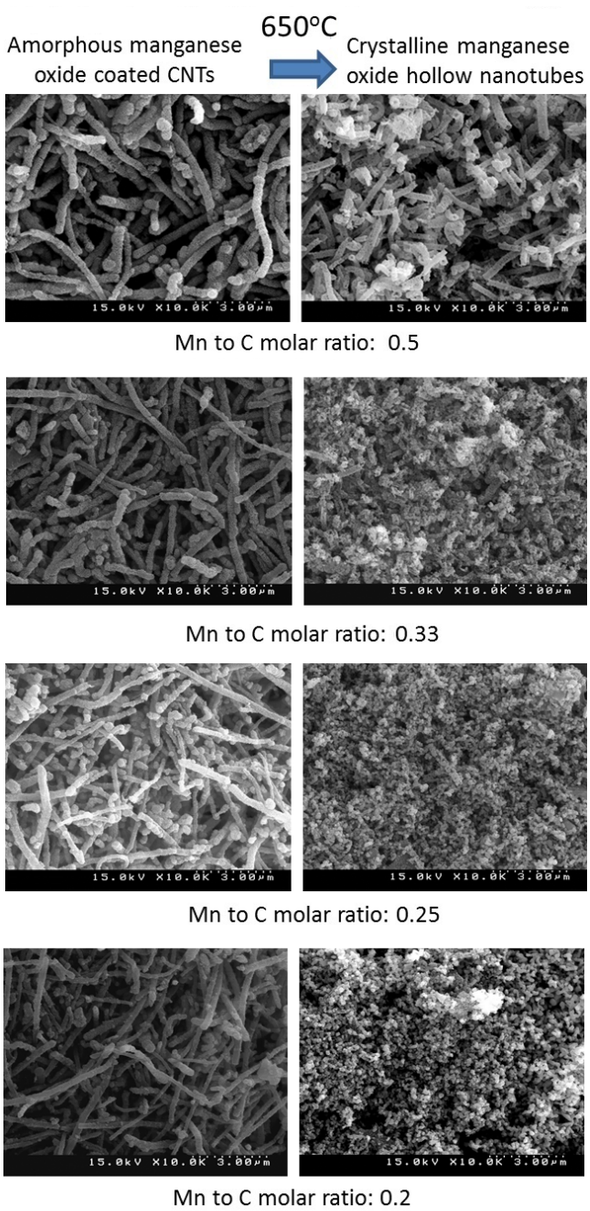

Figure 2. Effect of the Mn-to-C molar ratio on the morphology of amorphous manganese oxide coated CNTs and heat-treated amorphous manganese oxide nanotubes (at 650°C for 15 hours).