Supplementary Material (ESI) for Chemical Communications

Supplementary Material for:

High Surface Area Carbon Aerogels as Porous Substrates for Direct Growth of Carbon Nanotubes

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Experimental Details

Sample Preparation. The ACA substrates were prepared through the sol-gel polymerization of resorcinol (R) and formaldehyde (F) using acetic acid as the reaction catalyst, as previously reported.[1] The organic RF aerogels were then carbonized at 1050ºC under N_2 and subsequently activated at 950ºC using carbon dioxide. An electric cutting tool was used to slice thin slab of the ACA with approximate dimensions of 20 x 5 x 1 mm. For the catalyst loading, these parts were immersed in a 0.1 M acetone solution of $NiCl_2.6H_2O$ for ~24 h, then removed from the metal salt solution and dried under a stream of N_2. The slabs of the Ni-loaded CA were placed in a 2.5-cm long segment of 1-cm diameter quartz tubing and inserted into the middle of a 2.7-cm inner diameter quartz process tube. The tube was flushed with He (60 sccm) for 20 minutes and then placed into a clamshell furnace. The sample was then heated to 400ºC under a stream of He (60 sccm) and H_2 (40 sccm) and held at that temperature for 10 min to reduce the impregnated nickel ions to metal nanoparticles. Ethylene (10 sccm) was introduced to the He/H_2 stream and the temperature was held at 400ºC for 5 min to facilitate diffusion of ethylene into the sample. Finally, the sample was heated to 800ºC at a rate of 40ºC/min and held at that temperature for 5 min to allow for CNT growth. The tube was subsequently removed from the furnace and cooled to room temperature under a flow of He (60 sccm).

Characterization. The bulk densities of the composites were determined by measuring the dimensions and mass of the monolithic samples. Scanning electron microscopy (SEM) was performed on a JEOL 7401-F. Imaging was done at 5-10keV (20 μA) in SEI mode with a working distance of 2-8 mm. Transmission electron microscopy (TEM) was performed on a Phillips CM300FEG operating at 300 keV. Surface areas and pore volumes were determined from Brunauer-Emmett-Teller (BET) and Horvath-Kawazoe (HK) methods using an ASAP 2010 Surface Area Analyzer (Micromeritics).[2] Composite samples were heated to 300ºC under vacuum (10^{-5} Torr) for 24 hours to remove all adsorbed species prior to analysis. Electrical conductivity was measured using the four-probe method similar to previous studies.[3] Metal electrodes were attached to the ends of the CNT-ACA slabs. The amount of current transmitted through the sample during measurement was 100 mA and the voltage drop along the sample was measured over distances of 3 to 6 mm with seven or more measurements taken on each sample.

[1]T. F. Baumann, M. A. Worsley, T. Y. Han, J. H. Satcher, J. Non-Cryst. Solids 2008, **354**, 3513.
[2]F. Rouquerol, J. Rouquerol, K. Sing, *Adsorption by Powders & Porous Solids*, Academic Press, London, **1999**.
[3]X. P. Lu, O. Nilsson, J. Fricke, R. W. Pekala, *J. Appl. Phys.* 1993, **73**, 581.