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Electronic Supplementary Information for: Agitation Induced Loading of Sulphur into Carbon CMK-3 Nanotubes: Scavenging of Noble Metals from Aqueous Solution

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1. Apparatus

X-ray diffraction patterns were collected on a Bruker D8 Advance Analytical X-ray System operating at 40 kV and 30 mA, using Cu-Kα (1.54 Å) radiation. SEM images were obtained using a LEO 1530 field emission scanning electron microscope. To avoid surface charging, specimens in the LEO 1530 were first sputtered with a thin layer of gold. Backscattering detection mode was used to obtain the micrographs. High resolution SEM images were taken with a Hitachi HD-2000 scanning transmission electron microscope (STEM) at a voltage of 200 KV. These specimens were not coated with any conductive layer; therefore, faithful surface morphology was provided. The N_2 sorption-desorption isotherms were measured at -196 °C by using a Quantachrome Autosorb Surface Area Analyzer. Solution concentration was determined by inductive coupled plasma mass spectrometry (ICP-MS) carried out by the Galbraith Laboratories (Tennessee, USA). Thermal gravimetric analysis (TGA) measurements were performed on a SDT Q600 analyzer.

2. Experimental

Nano-CMK-3 was prepared by the nanocasting method using SBA-15 nanorods as a template. In a synthesis of SBA-15 nanorods, 2 g of Pluronic P123 was dissolved in 360 ml of 2 M HCl at 38 ºC. Tetraethylorthosilicate (TEOS, 4.2 g) was added into the above, vigorously stirred solution. The mixture was stirred for 6 min and remained quiescent for 24 hrs at 38 ºC. It was subsequently heated at 100 ºC for another 24 hrs in an autoclave. The as-synthesized SBA-15 was collected by centrifugation, dried, and calcined at 550 ºC in air. To make the carbon replica, 1.25 g of sucrose was dissolved in 5.0 ml aqueous solution containing 0.14 g of H_2SO_4. Next, 1.0 g of surfactant free SBA-15 nanorods were dispersed into the above solution and the mixture was sonicated for 1 hr. The mixture was heated at 100°C for 12 hrs and 160°C for another 12 hrs. The above impregnation process was repeated once with another 5.0 ml aqueous solution containing 0.8 g sucrose and 0.09 g H_2SO_4. The composite was completely carbonized at 900°C for 5 hrs in argon atmosphere. To remove the SBA-15 template, the composite was stirred in a 5% HF solution at room temperature for 4 hrs. Nano-CMK-3 nanorods were obtained after filtration. CMK-3 was prepared similarly by the nanocasting method using bulk morphology SBA-15 as a template.

For the melt-diffusion process, a mixture of nano-CMK-3 and sulfur was ground together, and heated to 155°C. In a typical agitation-friction process, sulphur powder (0.1 g or 0.011g) and mesoporous carbon 0.1 g were simultaneously dispersed into 5 ml de-ionized water. The mixture was vigorously stirred for 24 hrs. The composite was collected by filtration and dried at 50°C.

For adsorption kinetics studies, two sets of analyses with different dosage concentration were carried out. In the first set of analyses, an excess of sorbents (10 mg, 100 mg/L) was dispersed into a dilute solution of H_2PtCl_6 (100 ml, Pt: 5 mg/L). After specific time intervals, portions of the mixture were filtered to collect the filtrate for analysis. The solution concentration was determined by inductive coupled plasma mass spectrometry (ICP-MS) carried out in by the Galbraith Laboratories (Tennessee, USA). In the second set of analyses, sorbents (30 mg, 10 mg/L) were dispersed into an H_2PtCl_6 solution containing an excess of Pt (3000 ml, Pt: 5 mg/L). Portions of the mixture after specific time intervals were filtered to collect the adsorbents for analysis. The uptake of Pt by sorbents was measured by thermal gravimetric analysis (TGA).

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3. Supplemental figures

Fig.S1. N_2 adsorption-desorption isotherms of (a) CMK-3, (b) nano-CMK-3.

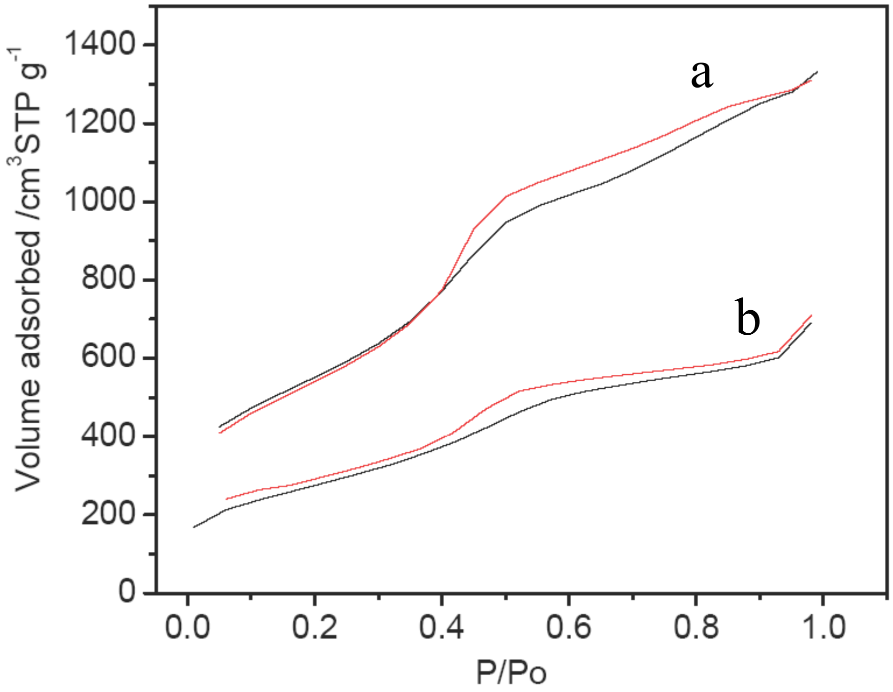

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Fig. S2. Schematic diagram depicting the agitation-friction process: (a) initial mixture of nano-CMK-3 and sulfur, (b) infiltration, (c) final stage corresponding to the complete infiltration of sulphur.

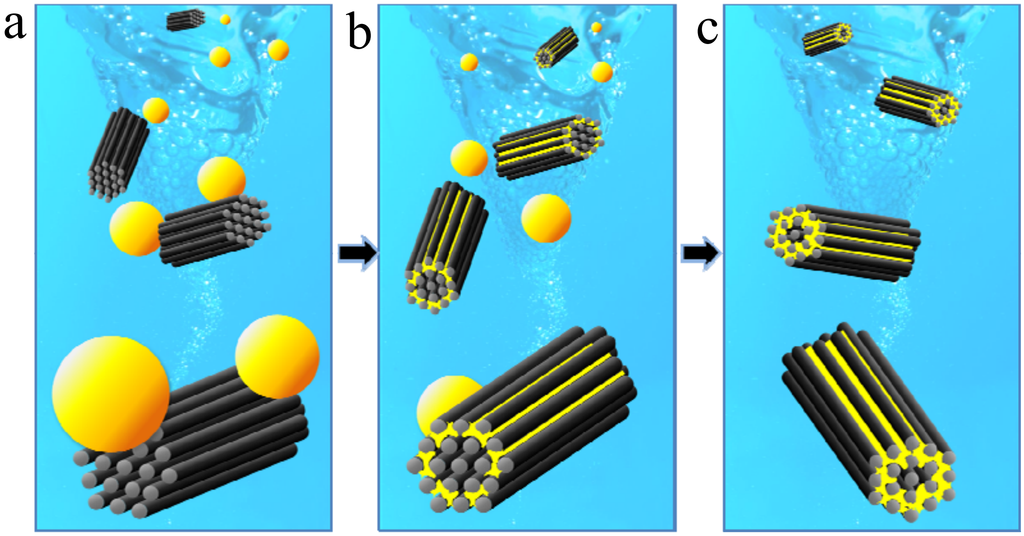

Fig. S3 Pore size distribution curves of (a) nano-CMK-3, and nano-CMK-3/S prepared by agitation-friction (b) before sulfur melting; (c) after sulfur melting.