Supporting Information:

Multi-Shelled Co_3O_4-Fe_3O_4 Hybrid Hollow Spheres with Even Magnetic Phase Distribution: Synthesis, Magnetic Properties and Application in Water Treatment

Xi Wang, Yeteng Zhong, Tianyou Zhai, Yanfeng Guo, Ying Ma, Jiannian Yao, Yoshio Bando and Dmitri Golberg

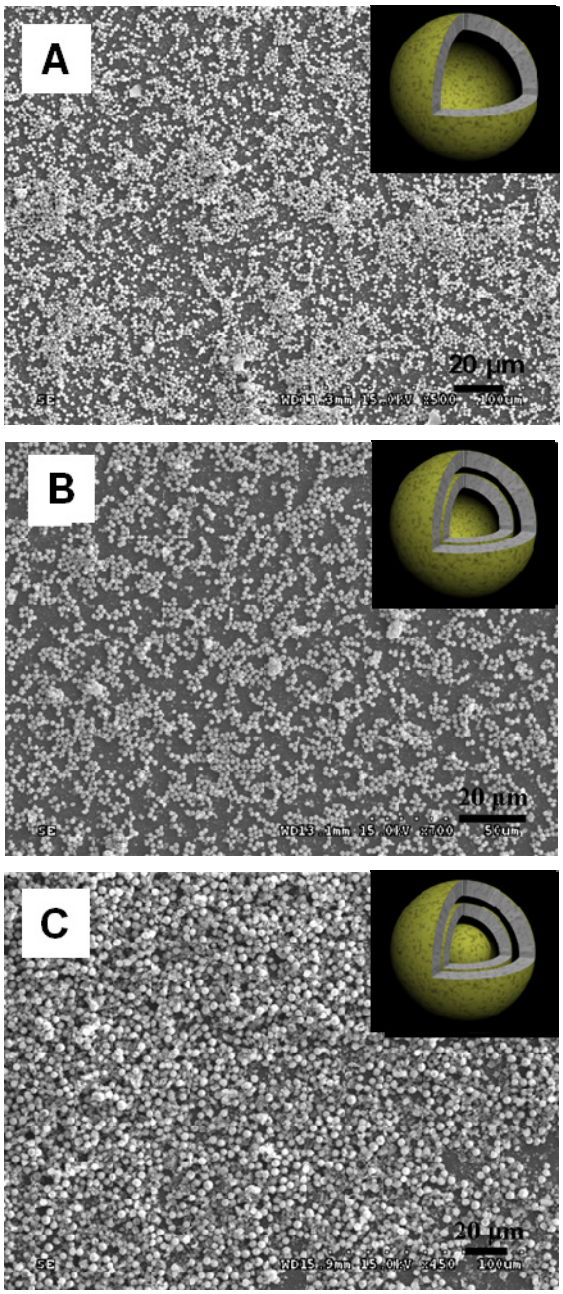

Figure S1. Low-magnification SEM images and corresponding schematic models of M-MHs: A) M-SHs, B) M-DHs, C) M-THs.

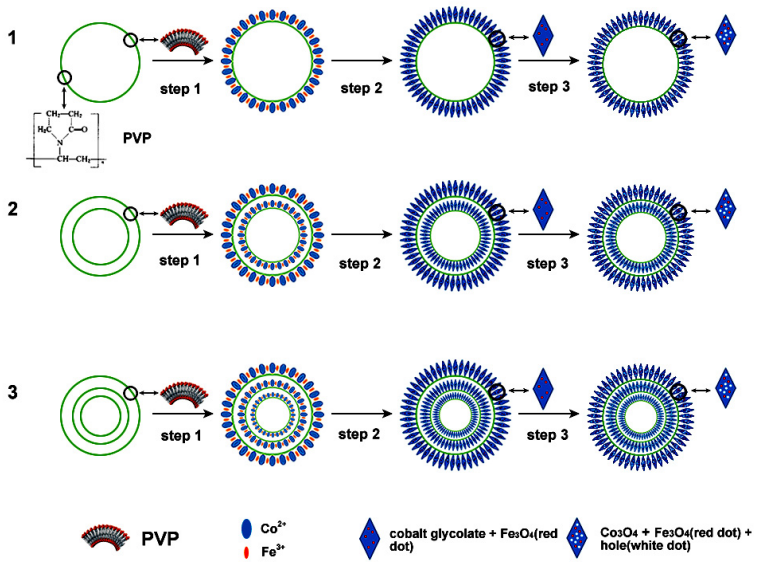

Figure S2. Schematic illustration depicting the fabrication of multi-shelled Co_3O_4-Fe_3O_4 hybrid hollow spheres in the presence of PVP templates: (1) single-shelled, (2) double-shelled, (3) triple-shelled. Based on the above observations and analysis, the possible formation mechanism, i.e. selective in situ soft template reduction based route, was proposed. Firstly, multi-lamellar PVP micelles with different number of shells form in the present reaction system, then Co^{2+} and Fe^{3+} ions can be absorbed onto the shell of multi-lamellar PVP micelles due to the coordination rule between –N and/or C=O groups of PVP and metal ions (step 1). This ensures that iron species are homogenously distributed in the entire matrix. In the second step, upon heating to about 180-200 ºC, longer chains of cobalt and iron glycolate oligomer further grow into nanosheets on the shell of PVP templates through van der Waals interactions (step 2). It is noted that iron glycolate oligomer can be in-situ reduced into Fe_3O_4 due to the high reduction power of glycol in the present reaction system, while no metallic cobalt formed in this process because Co^{2+}/Co (-0.277 V) has a smaller standard reduction potential than Fe^{3+}/Fe^{2+} (0.77 V). Finally, multi-shelled Co_3O_4-Fe_3O_4 hybrid hollow spheres composed of the oriented self-assembled nanosheets are obtained via a thermal treatment at low temperature (step 3).

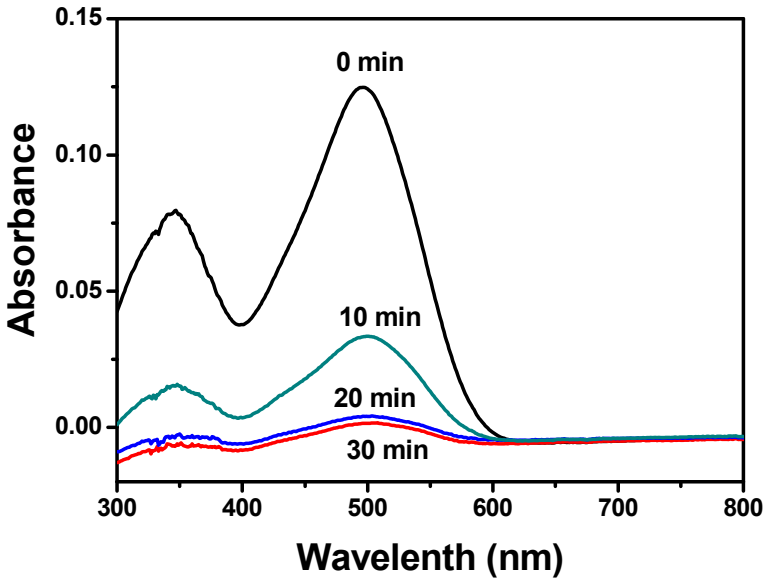

Figure S3. Absorption spectra of a solution of Congo red (100 mg L^{-1}, 20 mL) in the presence of M-THs (30 mg) at different time intervals of: 0 min, 10 min, 20 min, and 30 min.

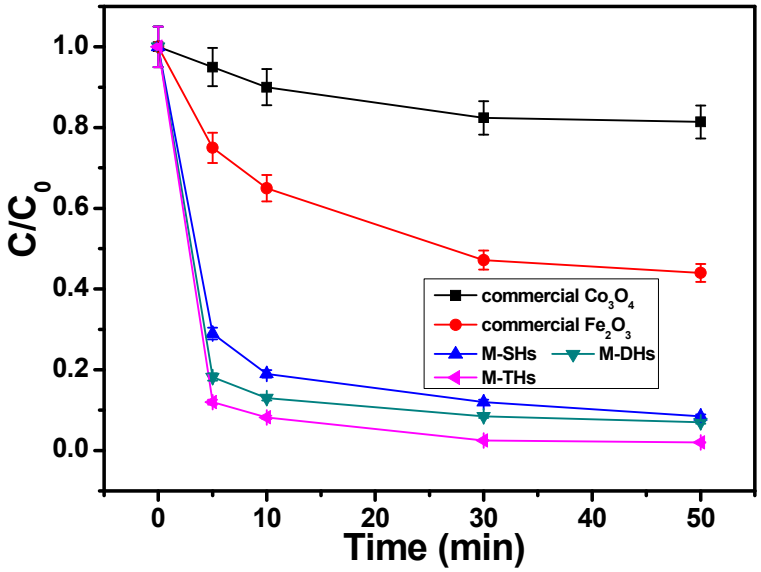

Figure S4. Adsorption rate of the Pb (Ⅱ) ions on different products and commercial Co_3O_4 and commercial γ-Fe_2O_3 nanoparticles.