Supplementary Information

Experimental Section

The hollow core-shell η-Fe_2O_3 microspheres were prepared through a solution process followed by a calcination treatment under ambient pressure. The preparation process basically involved two steps. First, 0.21 g $FeSO_4 \cdot H_2O$ and 0.7 g PVP (30K) were dissolved in 60 mL DMF (N, N-Dimethylformamide (A.R.)). 0.8 mL hydrazine hydrate was gradually dropped in after the solution was heated to 40 ℃. Then the solution was heated to 160 ℃ and maintained for 3 h. In the second step, the precipitation separated from the solution was rinsed for several times with absolute ethanol and distilled water. Then dried precipitation was calcined in muffle furnace for 4 h at 500 ℃. Thus the hollow core-shell η-Fe_2O_3 microspheres were obtained.

The as-prepared samples were characterized by X-ray diffraction (XRD, X Pert Pro MPD) analysis, Hitachi TM-1000 and S-4800 scanning electron microscope (SEM), Hitachi H-800 transmission electron microscope (TEM) with a tungsten filament and an accelerating voltage of 200 kV, and Brunauer-Emmett-Teller nitrogen adsorption-desorption measurements (Shimadzu Micromeritics ASAP 2010). The Fe_2O_3-based sensors were fabricated by dip-coating the as-prepared hollow core-shell η-Fe_2O_3 microspheres alcohol colloids on the ceramic tube of the sensor body without an additional annealing process except for aging in the gas sensor system for 240 h. The gas sensing properties were measured on a static test system (Hanwei Co. Ltd., China).

The working electrode was fabricated by compressing a mixture of the hollow core-shell η-Fe_2O_3 microspheres (75 %), acetylene black (20 %), and poly (vinylidene fluoride) (PVDF) (5 %) onto a copper foil. Lithium foil was used as the counter electrode. The electrolyte solution was prepared with 1 M $LiPF_6$ dissolved in ethyl carbonate/dimethyl carbonate (EC/DMC) (1:1 volume ratio). A galvanostatic cycling test of the assembled cells was carried out on a LAND CT-2000A cell test instrument in the voltage range of 0.01-3.0 V at a discharge/charge current of 150 mA g^{-1} and 20 ℃.