Supplementary information

Magnetic Yolk-Shell Mesoporous Silica Microspheres with Supported Au Nanoparticles as Recyclable High-Performance Nanocatalysts

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Figure S1. The FT-IR spectra of (a) Fe$_3$O$_4$@SiO$_2$, (b) Fe$_3$O$_4$@SiO$_2$@RF, and (c) Fe$_3$O$_4$@SiO$_2$@hollow mSiO$_2$ (YS-320) after the calcination in air at 550 ºC for 5 h. For the Fe$_3$O$_4$@SiO$_2$@RF, the bands observed at 1460-1480 cm$^{-1}$ and 1620 cm$^{-1}$ attributed to the –CH$_2$– group and the aromatic group of resorcinol-formaldehyde resins, respectively. After calcinations at 550 ºC for 5 h in air, the adsorption peaks of RF resins almost disappeared for the Fe$_3$O$_4$@SiO$_2$@hollow mSiO$_2$ microspheres, suggesting that the RF resin was completely removed.
Figure S2. TEM images of the yolk-shell structured Fe$_3$O$_4$@SiO$_2$@hollow mSiO$_2$ microspheres (a, b) YS-370 and (c, d) YS-430 with different hollow space size of 370 and 160 nm and 430 nm, respectively.
Figure S3. Wide-angle XRD patterns of Fe$_3$O$_4$ particles, YS-320 and Fe$_3$O$_4$@SiO$_2$@hollow mSiO$_2$-Au microspheres (YS-320-Au).
Figure S4. TEM image of the recycled YS-430-Au catalysts after catalyzing the styrene epoxidation for 12 times