

## Electronic Supporting Information

Ultra-fast microwave assistance reverse microemulsion synthesis of  $\text{Fe}_3\text{O}_4@\text{SiO}_2$  core-shell nanoparticles as a highly recyclable silver nanoparticles catalytic platform in the reduction of 4-nitroaniline

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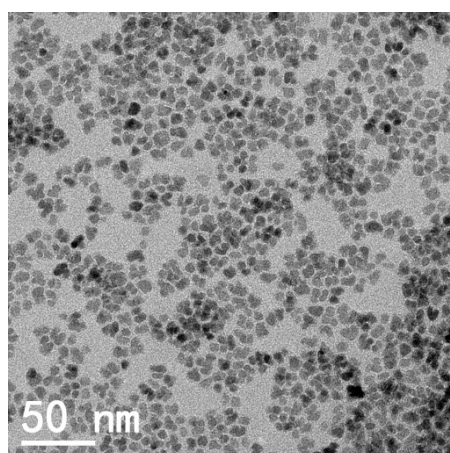


Figure S1. TEM overview of  $\text{Fe}_3\text{O}_4$  nanoparticles.

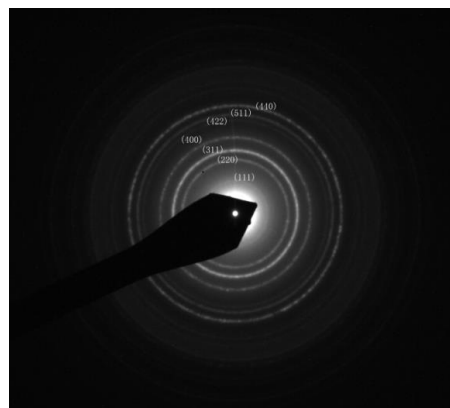


Figure S2. Electron diffraction of  $\text{Fe}_3\text{O}_4$  nanoparticles.

Figure S1 indicates that the synthesized  $\text{Fe}_3\text{O}_4$  nanoparticles are highly dispersed in hexane with a narrow size distribution and the average diameter is about 8nm. The electron diffraction pattern shows that the nanoparticles are well crystallized and has a good agreement with X-Ray diffraction results (Figure 2).

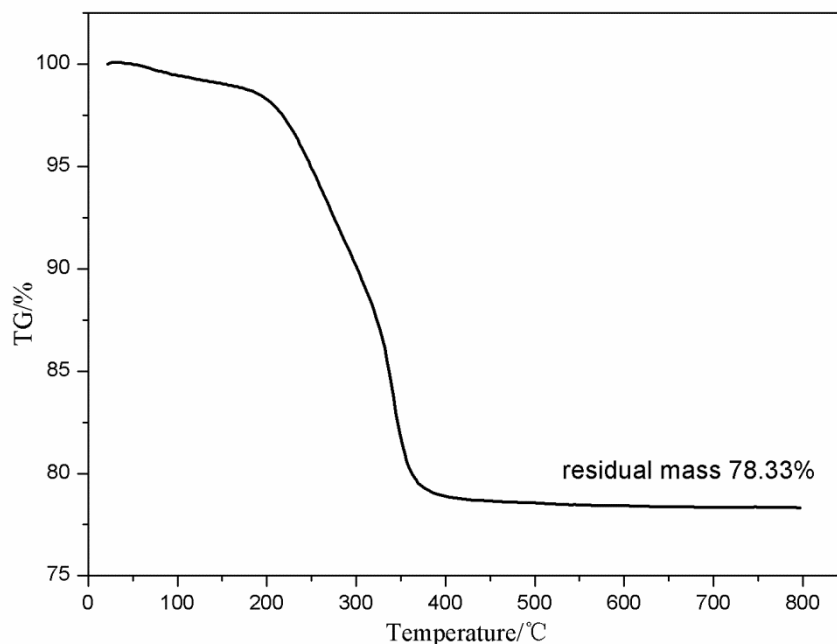


Figure S3. Thermogravimetric analysis of  $\text{Fe}_3\text{O}_4$  nanoparticles.

Concentration of ammonia	71mM	141mM	211mM	280mM
Shell thickness	2.3nm	4.2nm	4.4nm	6.6nm

Table S1. Shell thickness of  $\text{Fe}_3\text{O}_4@SiO_2$  core-shell nanoparticles prepared with different concentration of ammonia without microwave irradiation.

From Table S1, the increase of ammonia had great impact on the shell thickness; this is because with a higher concentration of ammonia the system form a larger size of micelle makes it possible to have more space to form silica shell in one core-shell nanoparticles.

#### **Weight percentage calculation of $\text{Fe}_3\text{O}_4$ in core-shell structure**

In order to justify whether magnetite materials were changed or not during the reaction, the weight percentage of  $\text{Fe}_3\text{O}_4$  in core-shell structure was calculated based on the following assumption and equation (1). Since the sample prepared by using 200mM Igepal CO-520 and

280mM ammonia (TEM image corresponds to Figure 6a), there are more than one  $\text{Fe}_3\text{O}_4$  nanoparticles inside the core-shell structure and there are still some  $\text{SiO}_2$  exists between the  $\text{Fe}_3\text{O}_4$  nanoparticles, the whole system could be seen as each  $\text{Fe}_3\text{O}_4$  nanoparticle were covered by  $\text{SiO}_2$  forming core-shell structure with only one core inside (see Figure S5).

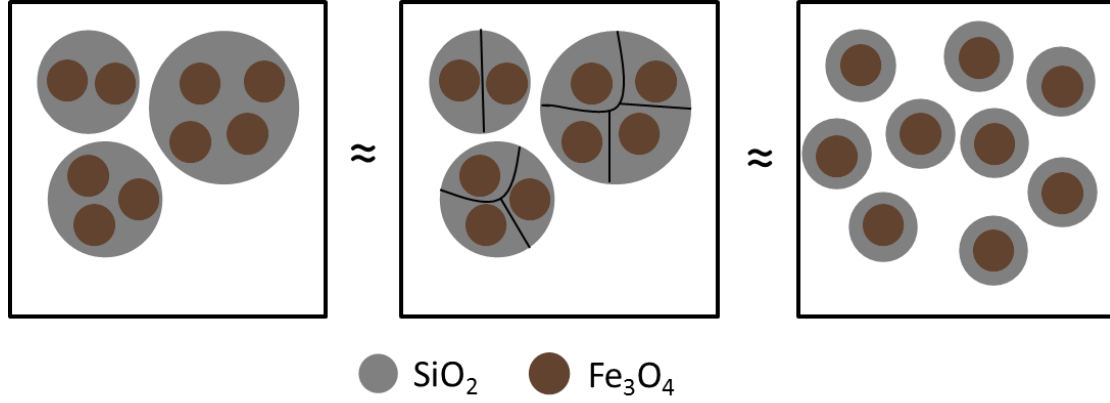


Figure S4. Assumption of core-shell nanoparticles with multicore inside

$$W = \frac{\frac{4}{3}\pi R_1^3 \times \rho_{\text{Fe}_3\text{O}_4}}{\left[\frac{4}{3}\pi(R_1+d)^3 - \frac{4}{3}\pi R_1^3\right] \times \rho_{\text{SiO}_2} + \frac{4}{3}\pi R_1^3 \times \rho_{\text{Fe}_3\text{O}_4}} \times 100\% \quad \text{Equation (1)}$$

$R_1$ : Average radius of  $\text{Fe}_3\text{O}_4$  nanoparticles measured through TEM images (4.1nm).

$d$ : Average shell thickness of the sample prepared with 200mM Igepla CO-520 and 280mM ammonia, measured by TEM images (3.2nm)

$$\rho_{\text{Fe}_3\text{O}_4} = 5.17 \text{ g/cm}^3$$

$$\rho_{\text{SiO}_2} = 2.2 \text{ g/cm}^3$$

According to equation (1), the weight percentage of  $\text{Fe}_3\text{O}_4$  was calculated to 33.6%. The theoretical magnetization saturation of  $\text{Fe}_3\text{O}_4$  nanoparticles could be calculated to 97.2emu/g by using the magnetization saturation of core-shell nanoparticles (32.7emu/g) divided by the weight percentage of  $\text{Fe}_3\text{O}_4$  (33.6%), which is slightly larger than the real magnetization saturation of  $\text{Fe}_3\text{O}_4$  measured by SQUID (96.9emu/g). This could be due to the overestimate of the percentage of  $\text{SiO}_2$  in the system, since there are  $\text{Fe}_3\text{O}_4$  nanoparticles stack together in some core-shell nanoparticles. The calculation indicates that the magnetization  $\text{Fe}_3\text{O}_4$  nanoparticles didn't change during the reaction.

### Element distribution test

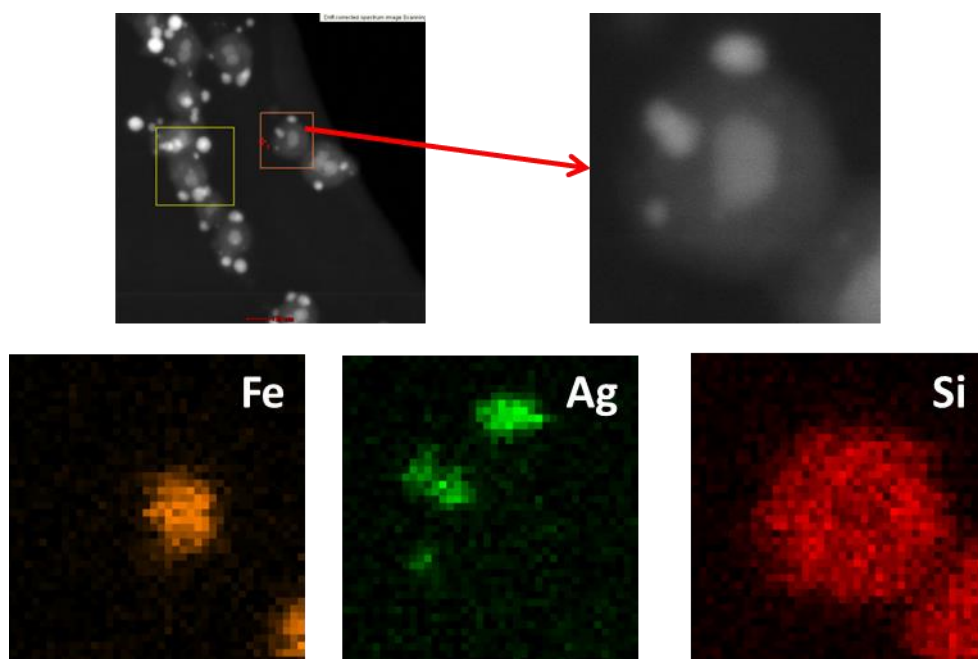


Figure S5. High angle annular dark-field scanning TEM (HAADF-STEM) image and corresponding elements mapping images of synthesized Ag/Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> nanoparticles.

The high angle annular dark-field scanning TEM (HAADF-STEM) image and corresponding elements mapping images (Figure S5) indicated that the Fe atoms were only distributed in the core and the Si atoms were homogeneously distributed around the Fe<sub>3</sub>O<sub>4</sub> core suggested a clearly core-shell structure. From the element mapping image of silver, the Ag atoms were mainly distributed outside the SiO<sub>2</sub> shell revealed a successful decoration of Ag nanoparticles on the surface of Fe<sub>3</sub>O<sub>4</sub>@SiO<sub>2</sub> core-shell nanoparticles.

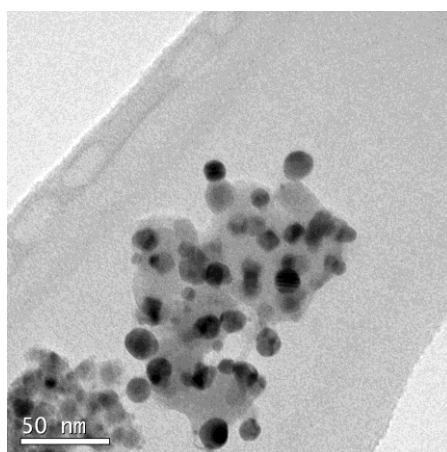


Figure S6 TEM image of Ag/Fe<sub>3</sub>O<sub>4</sub>/SiO<sub>2</sub> nanoparticles after 20 times repetitions of catalytic reaction.

The TEM image of Ag/Fe<sub>3</sub>O<sub>4</sub>/SiO<sub>2</sub> nanoparticles after 20 times repetitions of catalytic

reaction revealed that the nanoparticles start to aggregate after the catalytic reaction, during the formation of aggregation, some Ag nanoparticles are covered by SiO<sub>2</sub> layer and located inside the aggregates leading to the decreasing of catalytic property. But, it is worth to note that there were still many Ag nanoparticles located outside the aggregates, which guarantee a relatively high catalytic efficiency even after 20 times repetitions.

[1] S. H. Sun, H. Zeng, D. B. Robinson, S. Raoux, P. M. Rice, S. X. Wang and G. X. Li, *J. Am. Chem. Soc.*, 2004, 126(1): 273.