Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Fabrication of Fe_3O_4@Au hollow spheres with recyclable and efficient catalytic properties

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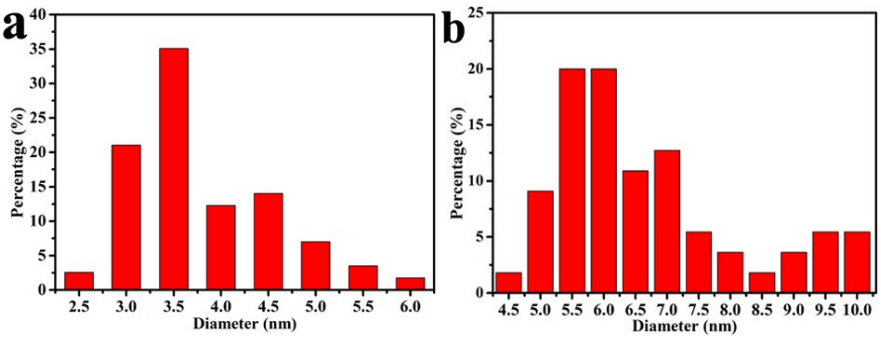

Fig. S1 The size distribution of Au NPs of (a) Fe_3O_4@Au nanoseeds and (b) Fe_3O_4@Au hollow spheres.

Specific surface areas of the samples were determined using N_2 adsorption–desorption isotherms at 77 k (Micromeri–tics TriStar II 3020) with the Brunauer–Emmett–Teller (BET) method.

Figure S2 shows the nitrogen adsorption desorption isotherms. The BET surface area were calcined 41.71 m^2/g, 42.67 m^2/g and 37.57 m^2/g for Fe_3O_4 hollow spheres, Fe_3O_4@Au nanoseeds and Fe_3O_4@Au hollow spheres, respectively. The pore volume was found to decrease from 0.222966 cm^3/g^{-1} for Fe_3O_4 hollow spheres to 0.213055 cm^3/g^{-1} for Fe_3O_4@Au nanoseeds and 0.205445 cm^3/g^{-1} for Fe_3O_4@Au hollow spheres.

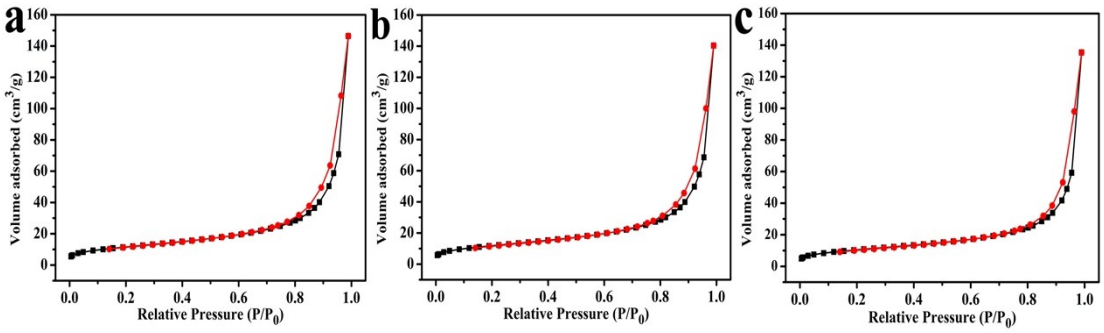

Fig. S2 N_2 adsorption/desorption isotherm of (a) Fe_3O_4 hollow spheres, (b) Fe_3O_4@Au nanoseeds, (c) Fe_3O_4@Au hollow spheres.

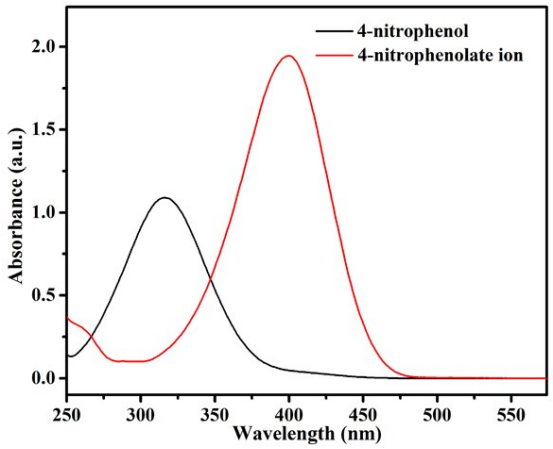

Fig. S3 The UV-vis characteristic peaks of freshly prepared 4-nitrophenol and 4-nitrophenolate ion aqueous solution at 317 and 400 nm, respectively.

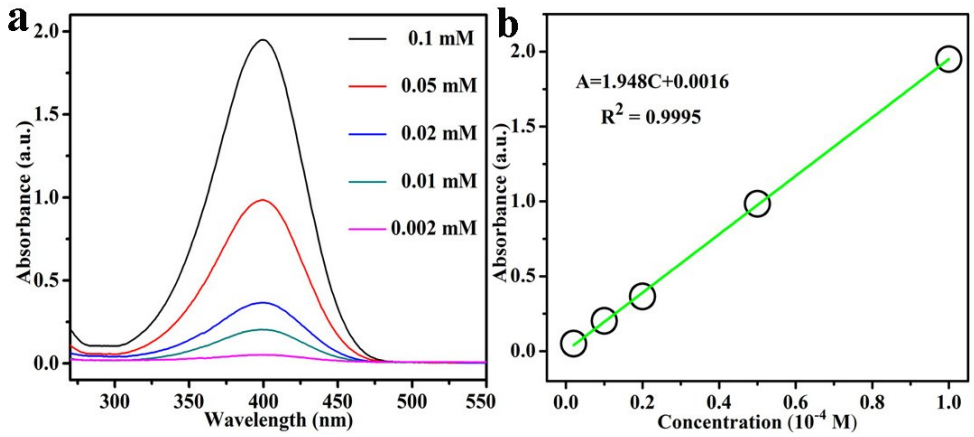

Fig. S4 Absorption spectra of aqueous mixture solutions of 4-NP and $NaBH_4$ at different concentrations of 4-NP and Plot of the peak absorbance against the concentration of 4-NP.

Table S1 Comparison of pseudo-first-order rate constants for 4-NP reduction by magnetic nanomaterials containing Au NPs.

Catalyst	**Type**	**Initial concentration of the 4-NP**	**Final amount of catalyst**	**Rate constant**	**References**
Fe_3O_4@Au hollow spheres	Supported	1.09×10^{-4} M	0.0256 mg/mL	20.15×$10^{-3}s^{-1}$	This work
Fe_3O_4@Au	Core-shell	6.15×10^{-4} M	0.77 mg/mL	Within 68 min	1
Fe_3O_4@SiO_2 Au@m SiO_2	Nanocomposites	2.4×10^{-4} M	1.43 mg/mL	0.20-0.35 min^{-1}	2
Au–Fe_3O_4	Hybrid hollow spheres	5×10^{-5} M	0.67 mg/mL	1.76 min^{-1}	3
Au–Fe_3O_4	Hybrid nanoparticles	2.25×10^{-3} M	0.125mg/mL	10.48×$10^{-3}s^{-1}$	4
Fe_3O_4@PND @Au	Core-shell	1.31×10^{-4} M	0.0164mg/mL	4.16×$10^{-3}s^{-1}$	5

Reference:

1 Y. P. Wu, T. Zhang, Z. H. Zheng, X. B. Ding and Y. X. Peng, *Mater. Res. Bull.*, 2010, **45**, 513–517.

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3 Q. Gao, A. W. Zhao, H. Y. Guo, X. C. Chen, Z. B Gan, W. Y. Tao, M. F. Zhang, R. Wu and Z. X. Li, *Dalton Trans.*, 2014, **43**, 7998–8006.

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5 G. Q. Liu, D. A. Wang, F. Zhou and W. M. Liu, *small*, 2015, **11**, 2807–2816.

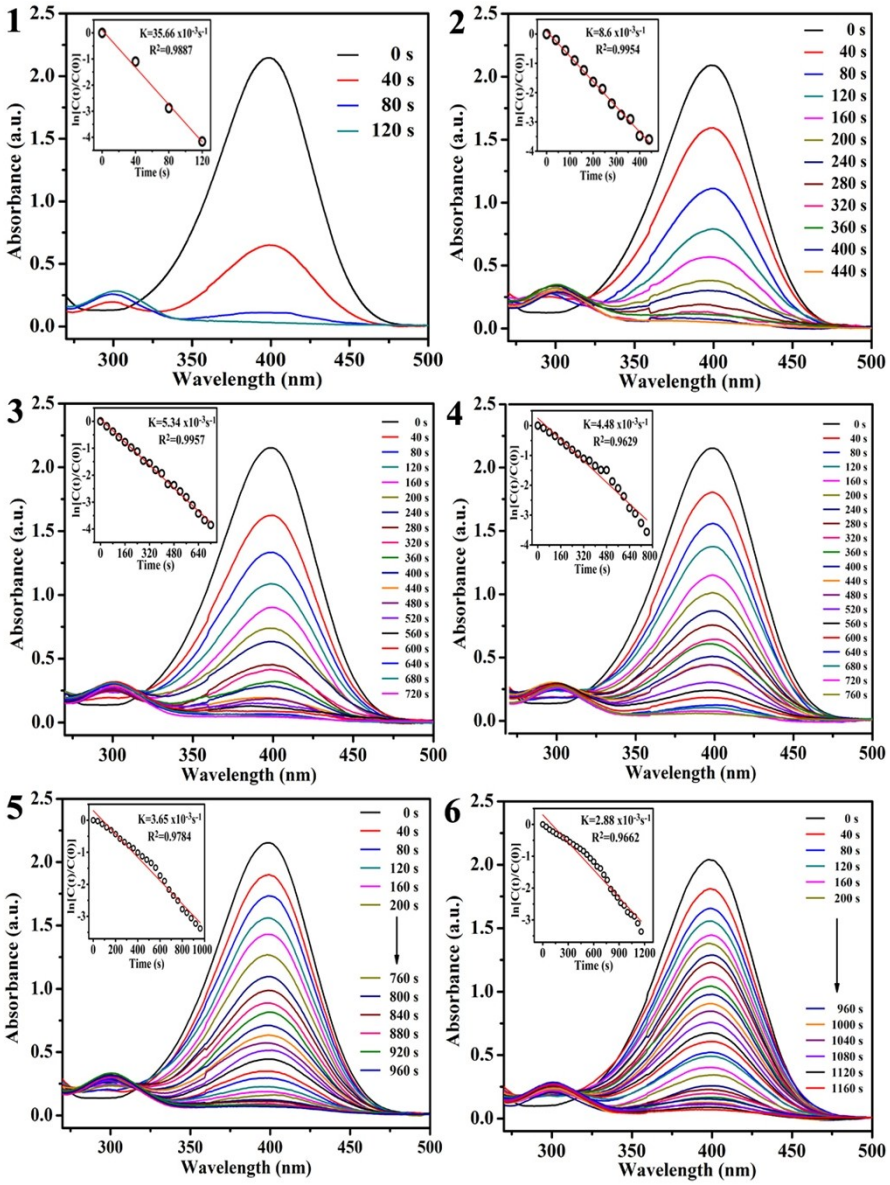

Fig. S5 The UV−vis spectra and kinetic rate of reduction of 4-NP by $NaBH_4$ under the catalysis of Fe_3O_4@Au hollow spheres for 1-6 times.

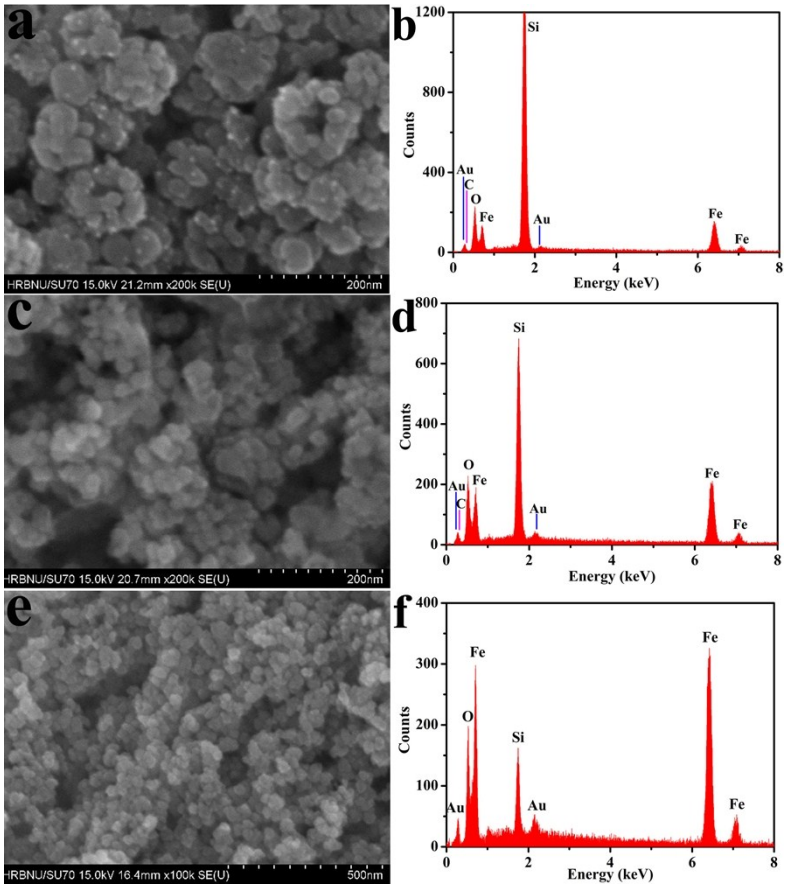

Fig. S6 The SEM (a, c, e) and EDX (b, d, f) of the Fe_3O_4@Au hollow spheres as catalyst after reused 1st, 3rd, 6th times, respectively.

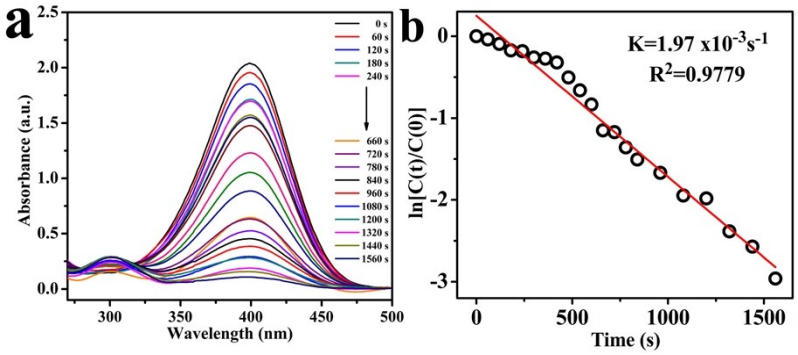

Fig. S7 The UV−vis spectra (a) and (b) kinetic rate of reduction of 4-NP by $NaBH_4$ under the catalysis of Fe_3O_4@Au hollow spheres for 7th times.

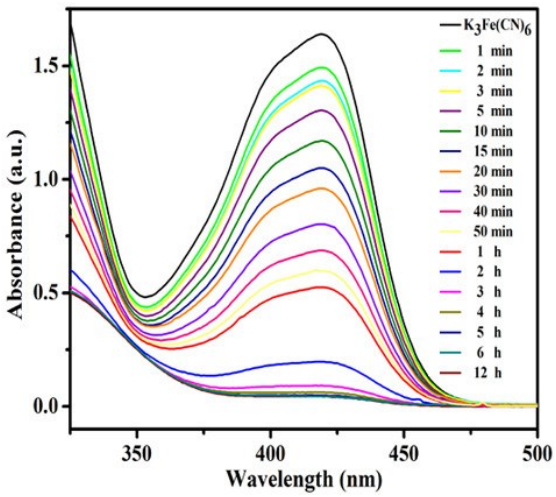

Fig. S8. UV-vis spectra of the reduction of $K_3Fe(CN)_6$ solution upon the addition of $NaBH_4$ recorded at different times from 1 min to12 h at 25℃, $[[Fe(CN)_6]^{3-}]=3\times10^{-3}$ M, $[BH^{4-}]=0.04$ M in the absence of catalyst.

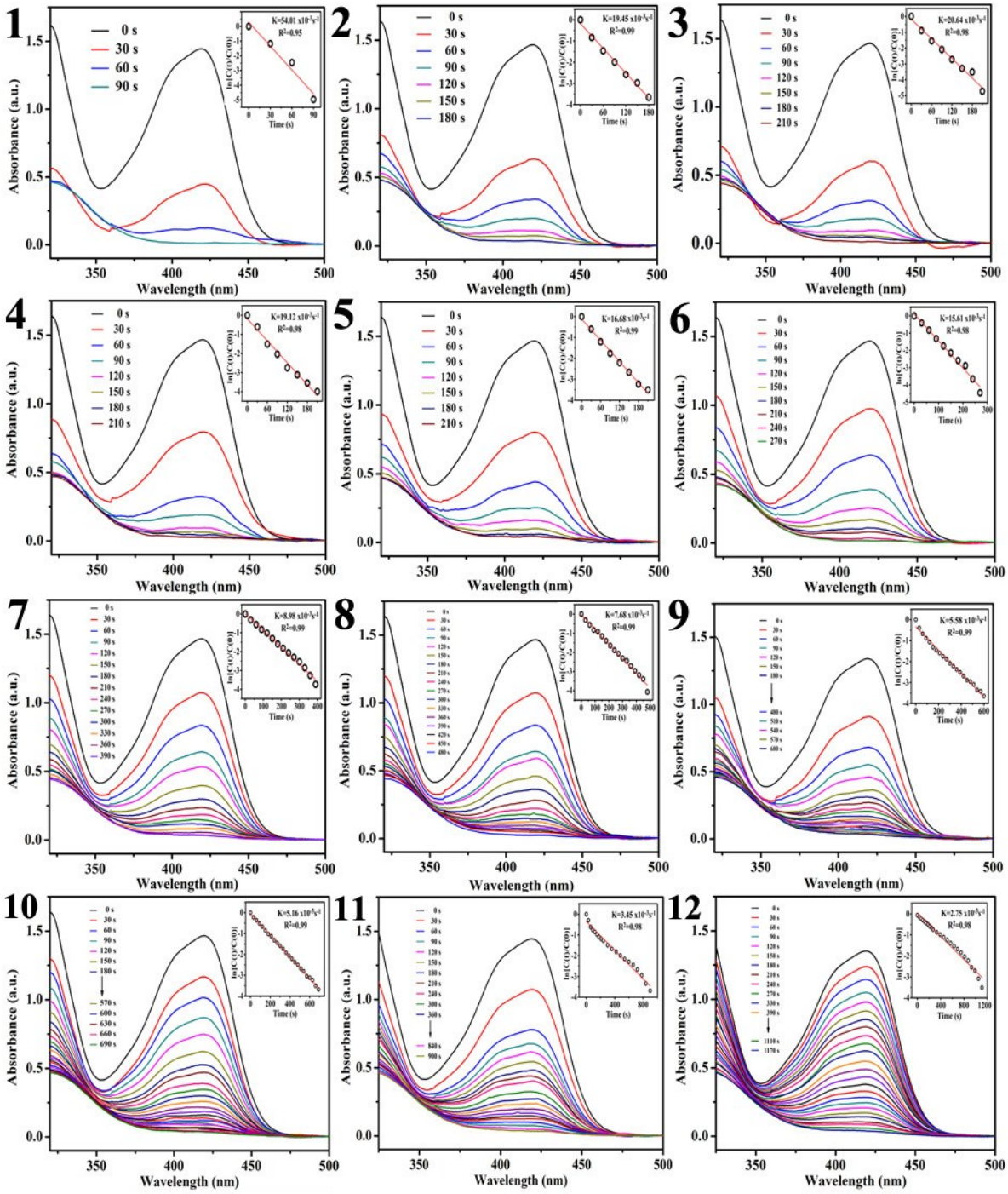

Fig. S9 The UV−vis spectra and kinetic rate of reduction of $K_3Fe(CN)_6$ by $NaBH_4$ under the catalysis of Fe_3O_4@Au hollow spheres for 1-12 times.