

Fig. S1 XPS spectra of the Fe2p regions

It is well known that the binding energy of element increases with the increase of its valence state. And the binding energy of Fe  $2p_{3/2}$  is about 709eV for Fe<sup>2+</sup>, and 711eV for Fe<sup>3+</sup>. (J. Phys. D: Appl. Phys. 44 (2011) 075003). Fig. S1 shows the X-ray photoelectron spectra (XPS) signals of the Fe 2p regions, and the peak of Fe  $2p_{3/2}$  at 710.76, which indicates that both Fe<sup>2+</sup> and Fe<sup>3+</sup> should be existed showing the formation of Fe<sub>3</sub>O<sub>4</sub>. The satellite peak situated at about 719 eV is a characteristic peak of Fe<sup>3+</sup> in  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>, suggesting that the Fe<sub>3</sub>O<sub>4</sub> nanoparticles were partly oxides.