**Electronic Supplementary Information (ESI)** 

## Structural evolution and characteristics of the phase transformations between α-Fe<sub>2</sub>O<sub>3</sub>, Fe<sub>3</sub>O<sub>4</sub> and γ-Fe<sub>2</sub>O<sub>3</sub> nanoparticles under reducing and oxidizing atmosphere

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Fig S1 TG curves of  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> reduced to Fe<sub>3</sub>O<sub>4</sub> nanoparticles in Hydrogen-Argon (5%:95%) atmosphere. All samples were tested at a heating rate of 5°C/min, 10°C/min and 15°C/min, respectively.



Figure S2 DTA curves of  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> reduced to Fe<sub>3</sub>O<sub>4</sub> nanoparticles in Hydrogen-Argon (5%:95%) atmosphere. All samples were tested at a heating rate of 5°C/min, 10°C/min and 15°C/min, respectively.



Figure S3 TG curves of Fe<sub>3</sub>O<sub>4</sub> transformed to  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> nanoparticles in oxygen atmosphere. All samples were tested at a heating rate of 5°C/min, 10°C/min and 15°C/min, respectively.



Figure S4 DTA curves of Fe<sub>3</sub>O<sub>4</sub> transformed to  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> nanoparticles in oxygen atmosphere. All samples were tested at a heating rate of 5°C/min, 10°C/min and 15°C/min, respectively.



Figure S5 XRD pattern of as-prepared sample 1 treated at 294°C for 0.5h.



Figure S6 FTIR spectrum of as-prepared  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> sample in the region of 200-600 cm<sup>-1</sup>



Figure S7 FTIR spectrum of as-prepared Fe<sub>3</sub>O<sub>4</sub> sample in the region of 200-650cm<sup>-1</sup>



Figure S8 FTIR spectrum of as-prepared  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> sample in the region of 200-650 cm<sup>-1</sup>



Figure S9 digital photographs of (a)  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub>, (b) Fe<sub>3</sub>O<sub>4</sub>, (c)  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> nanoparticles without and with a magnet