Exchange-Biased Hybrid $\gamma$-Fe$_2$O$_3$/NiO Core-Shell Nanostructures: Three-Step Synthesis, Microstructure, and Magnetic Properties

Xue-Min He, Chuang-Wei Zhang, Fang-Fang Guo, Shi-Ming Yan, Yong-Tao Li, Li-Qing Liu, Hong-Guang Zhang, You-Wei Du, and Wei Zhong

$^a$ New Energy Technology Engineering Laboratory of Jiangsu Province, Research Center of Information Physics and School of Science, Nanjing University of Posts and Telecommunications, Nanjing 210023, P. R. China.
$^b$ National Laboratory of Solid State Microstructures, Nanjing University, Nanjing 210093, P. R. China.
$^c$ Zernike Institute for Advanced Materials, Faculty of Science and Engineering, University of Groningen, Groningen 9747 AG, the Netherlands.
$^d$ College of Science, Henan University of Technology, Zhengzhou 450001, P. R. China.

Figure S1. XPS spectra of Fe 2p region for (a) Fe$_3$O$_4$, (b) Fe$_3$O$_4$/Ni(OH)$_2$, (c) $\gamma$-Fe$_2$O$_3$/NiO-300°C, (d) $\gamma$-Fe$_2$O$_3$/NiO-350°C and (e) $\gamma$-Fe$_2$O$_3$/NiO-400°C samples.

Figure S2. XPS spectra of Ni 2p region for (a) Fe$_3$O$_4$, (b) Fe$_3$O$_4$/Ni(OH)$_2$, (c) $\gamma$-Fe$_2$O$_3$/NiO-300°C, (d) $\gamma$-Fe$_2$O$_3$/NiO-350°C and (e) $\gamma$-Fe$_2$O$_3$/NiO-400°C samples.

Figure S3. Raman spectra of (a) Fe$_3$O$_4$ and (b) Fe$_3$O$_4$/Ni(OH)$_2$ samples.

Figure S4. RT (300 K) hysteresis loop of Fe$_3$O$_4$ sample. Inset shows the detail of the same loop around the origin.
Figure S1. XPS spectra of Fe 2p region for (a) Fe$_3$O$_4$, (b) Fe$_3$O$_4$/Ni(OH)$_2$, (c) γ-Fe$_2$O$_3$/NiO-300°C, (d) γ-Fe$_2$O$_3$/NiO-350°C and (e) γ-Fe$_2$O$_3$/NiO-400°C samples.
**Figure S2.** XPS spectra of Ni 2p region for (a) Fe₃O₄, (b) Fe₃O₄/Ni(OH)₂, (c) γ-Fe₂O₃/NiO-300°C, (d) γ-Fe₂O₃/NiO-350°C and (e) γ-Fe₂O₃/NiO-400°C samples.

**Figure S3.** Raman spectra of (a) Fe₃O₄ and (b) Fe₃O₄/Ni(OH)₂ samples.
**Figure S4.** RT (300 K) hysteresis loop of Fe$_3$O$_4$ sample. Inset shows the detail of the same loop around the origin.