

## Supplementary information

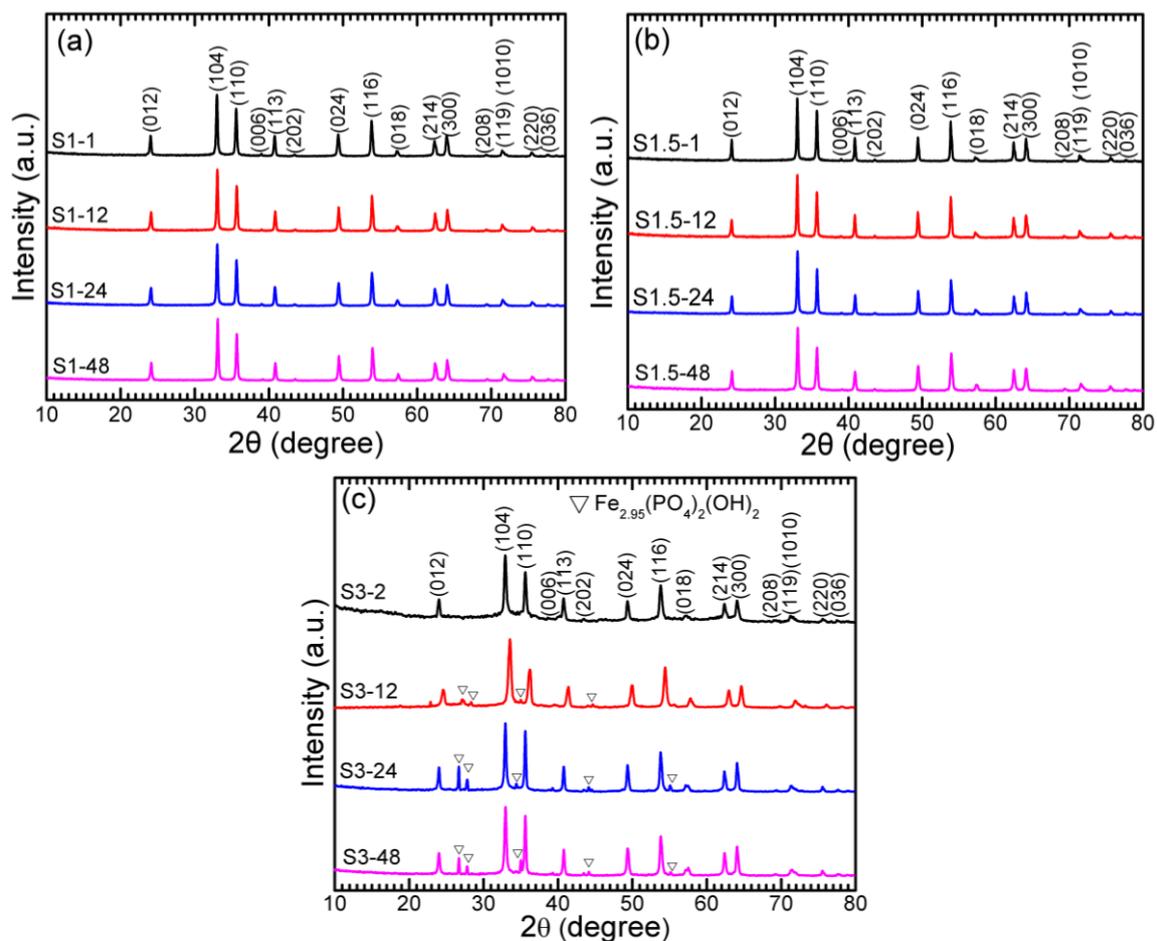
### Controllable synthesis of hollow $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> nanostructures, their growth mechanism, and the morphology-reserved conversion to magnetic Fe<sub>3</sub>O<sub>4</sub>/C nanocomposites

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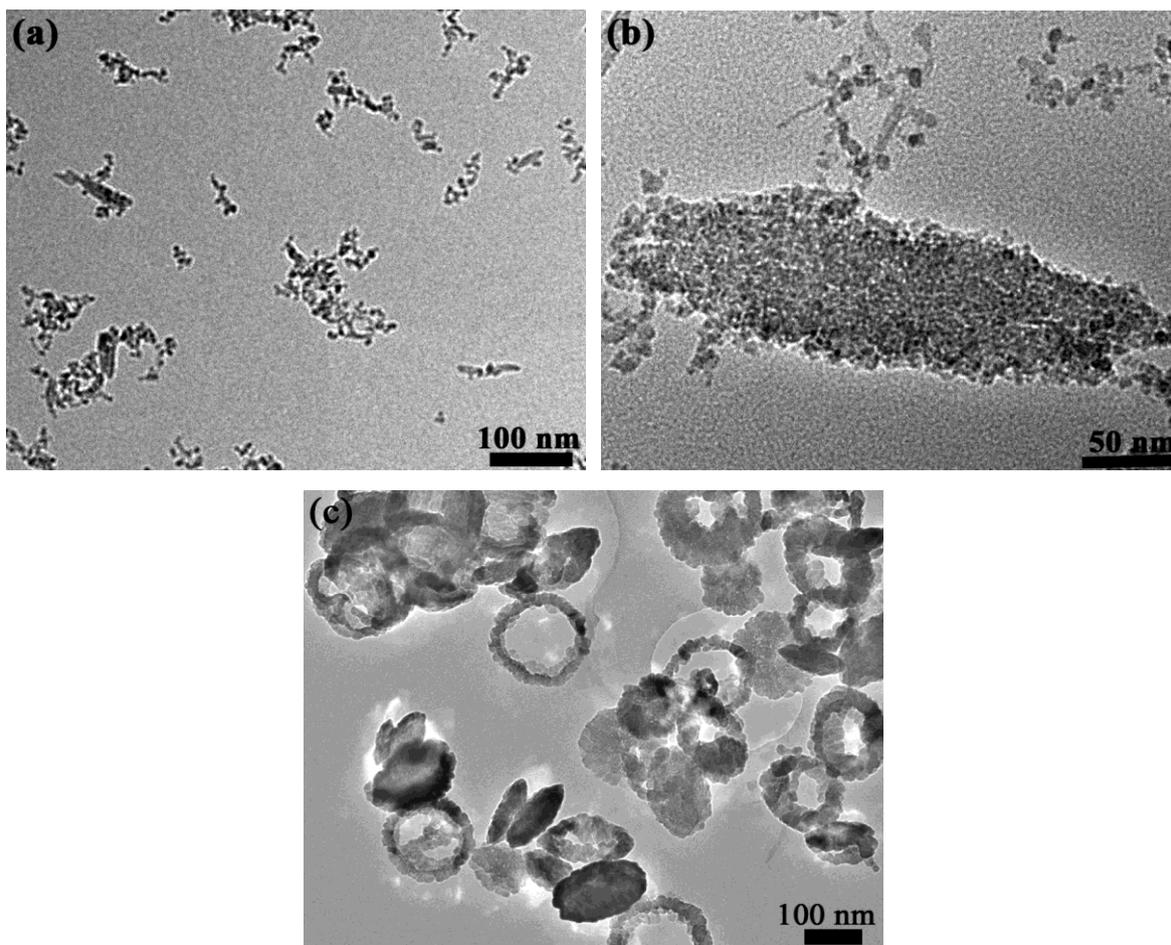
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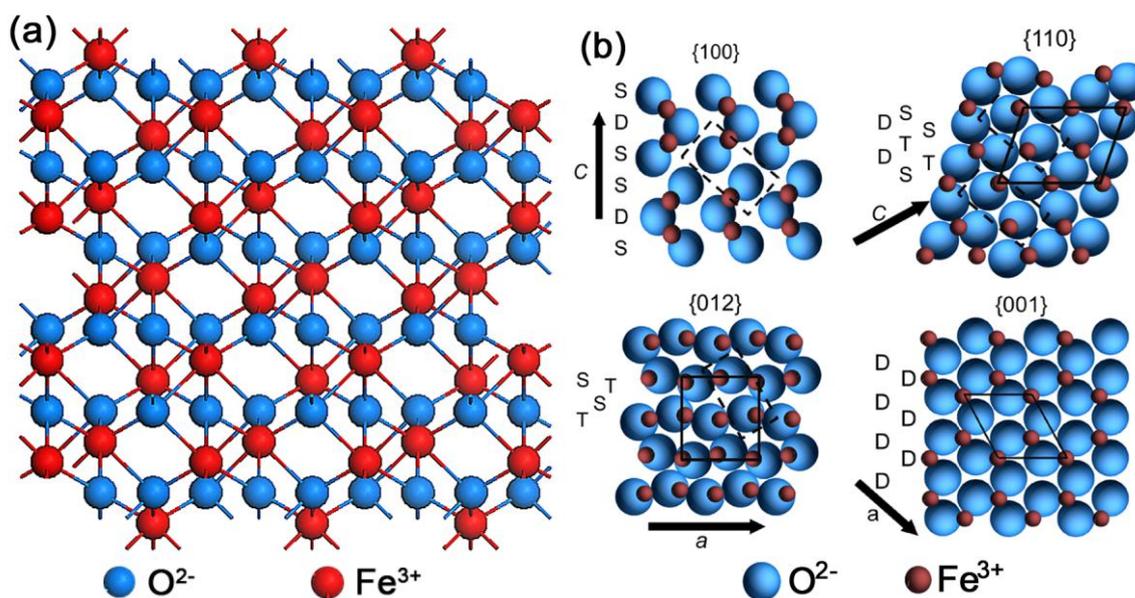
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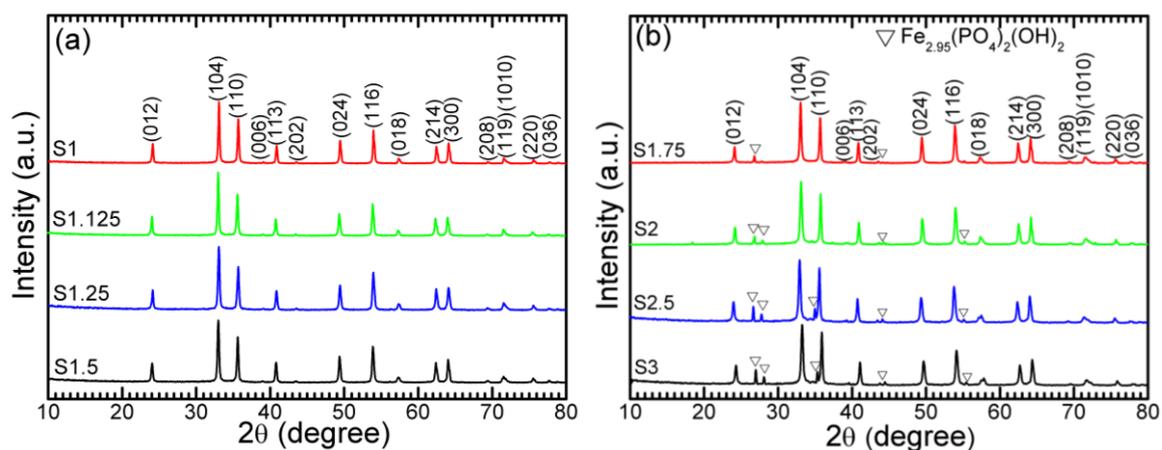
**Fig. S1** Selected XRD patterns of hematite (a) nanotubes, (b) nanobeads, and (c) nanorings obtained at different reaction time.



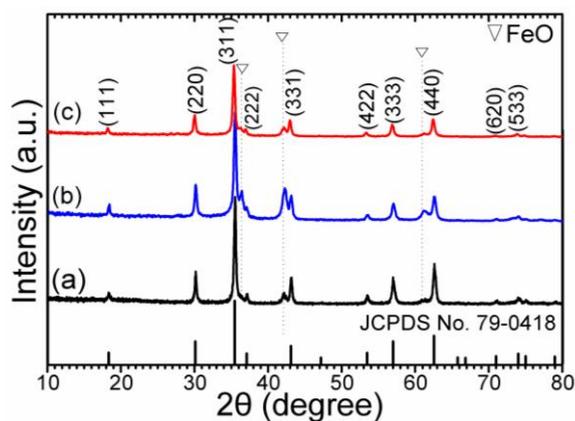
**Fig. S2** (a) TEM image of primary particles in the nucleation process, (b) TEM image of the intermediate product in the aggregation process, and (c) TEM image of the nanodisks/nanorings in the dissolution and re-crystallization process.



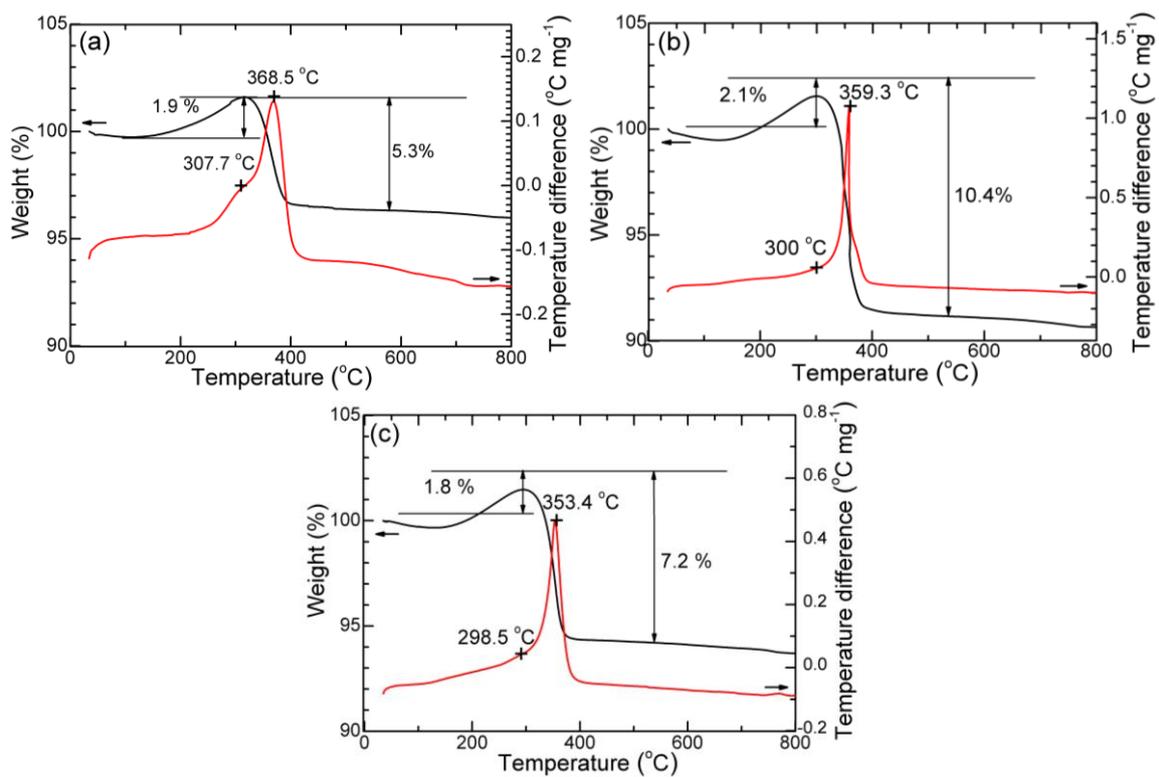
**Fig. S3** (a) Side view of hematite along (001) direction and (b) surface hydroxyl configuration of the hematite {100}, {110}, {012}, and {001} faces. The ions projected in these figures are those situated below the projection plane. Rows of singly, doubly, and triply coordinated oxygen ions are indicated by S, D, and T, respectively. Solid-line rectangles represent the two-dimensional (surface) unit cell. Dash-line rectangles represent contiguous singly coordinated hydroxyls.



**Fig. S4** XRD patterns of hematite morphologies with different phosphate anions concentrations.



**Fig. S5** XRD patterns of  $\text{Fe}_3\text{O}_4/\text{C}$  nanocomposites converted from  $\alpha\text{-Fe}_2\text{O}_3$  (a) nanotubes, (b) nanobeads, and (c) nanorings by CVD method.



**Fig. S6** TGA-DSC plots of Fe<sub>3</sub>O<sub>4</sub>/C nanocomposites (a) nanotubes, (b) nanobeads, and (c) nanorings.