

**Figure. S1** (a) TEM images of the  $\alpha$ - $\text{Fe}_2\text{O}_3$  particles and (b) the high resolution TEM image of the edge of the sample.

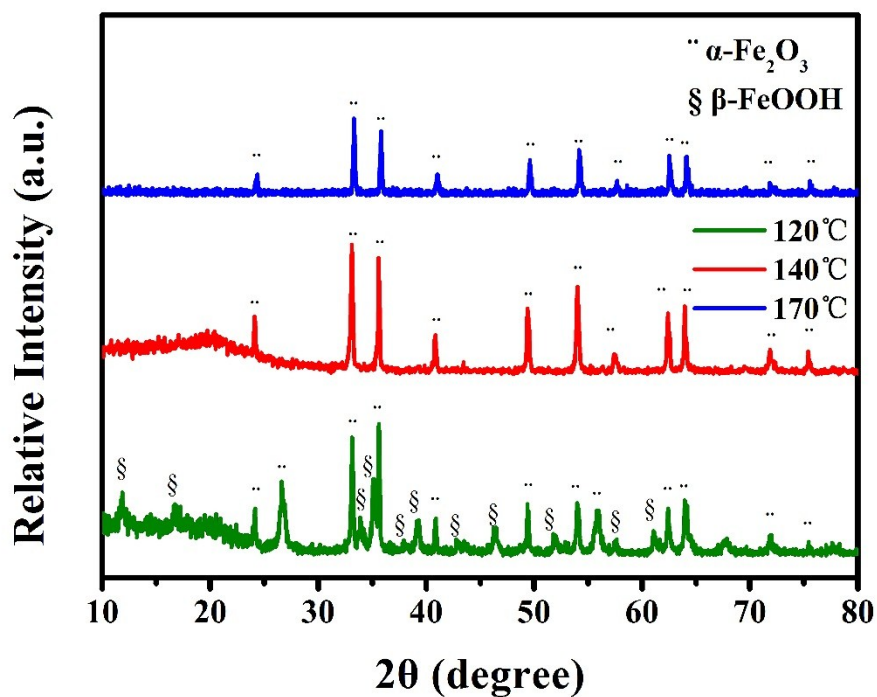


Figure. S2 XRD patterns of the products prepared in different temperature

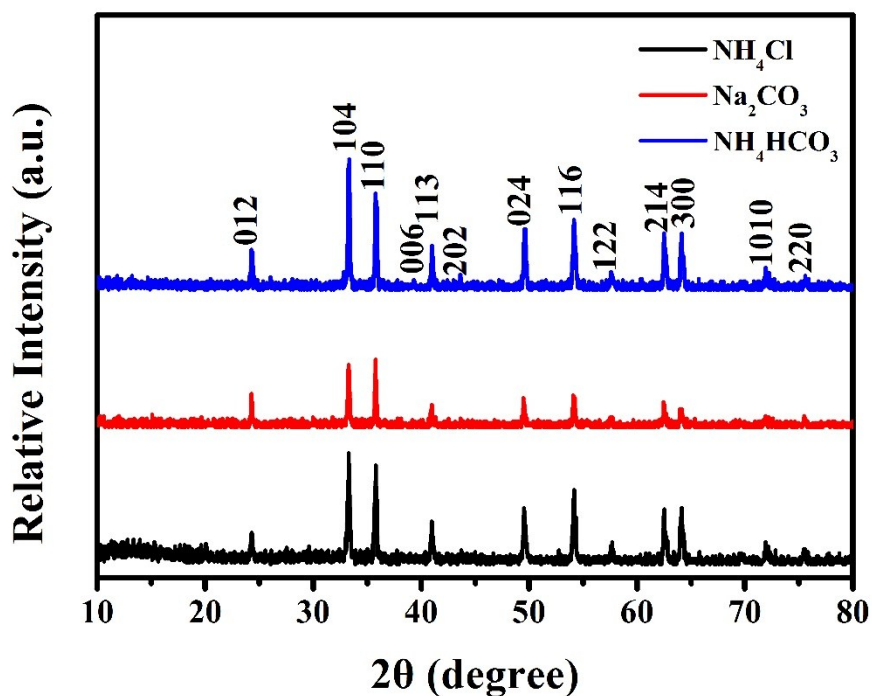
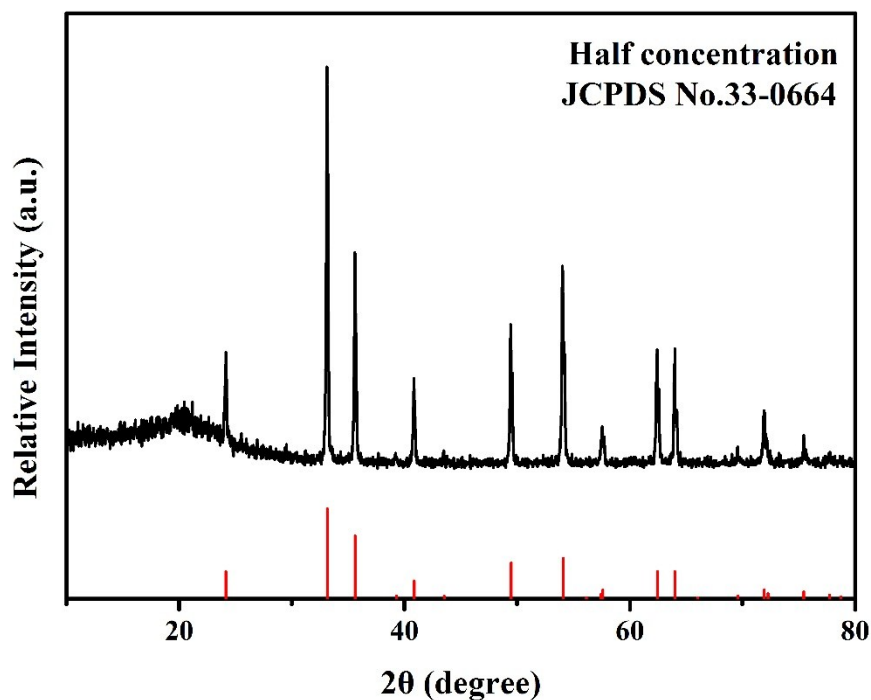
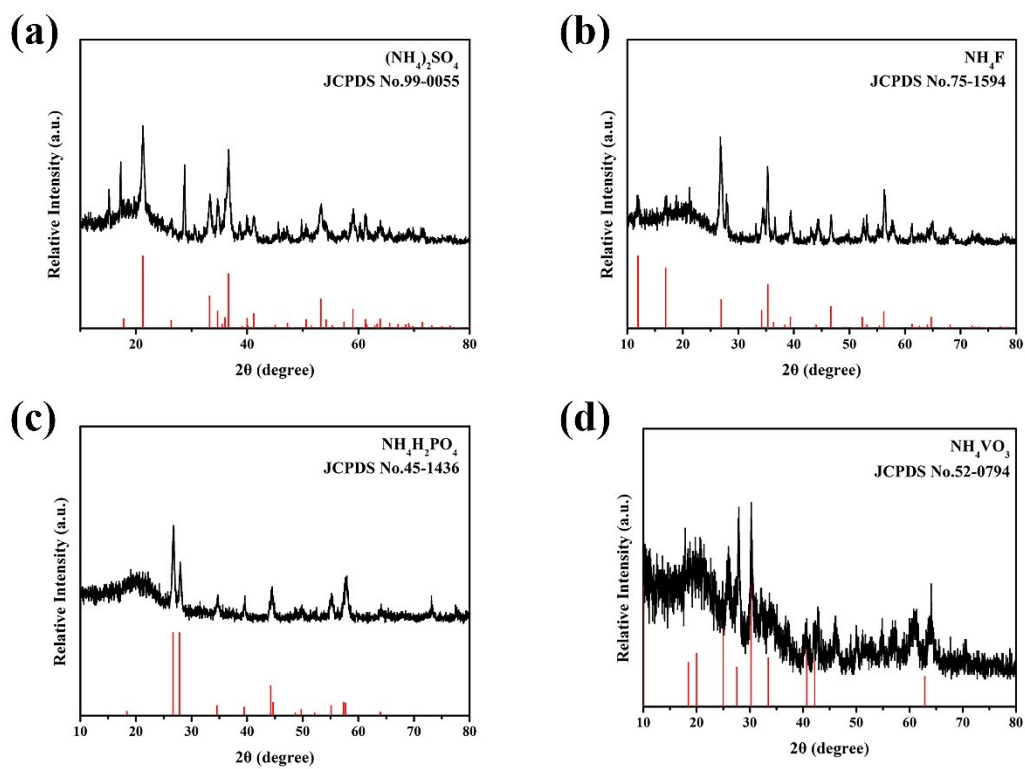


Figure. S3 XRD patterns of the products synthesized by  $\text{NH}_4\text{Cl}$ ,  $\text{Na}_2\text{CO}_3$  and  $\text{NH}_4\text{HCO}_3$  respectively.



**Figure. S4** XRD pattern of the products synthesized under the condition in which urea and  $\text{FeCl}_3$  were in half concentration.



**Figure. S5** XRD patterns of the samples synthesized by (a)  $(\text{NH}_4)_2\text{SO}_4$ , (b)  $\text{NH}_4\text{F}$ , (c)  $\text{NH}_4\text{H}_2\text{PO}_4$ , (d)  $\text{NH}_4\text{VO}_3$ .

**Table. S1** Summary of the reaction products and morphology of the Fe<sub>2</sub>O<sub>3</sub> particles in different parameters.

<i>Reactants</i>	<i>Time (h)</i>	<i>Temperature (°C)</i>	<i>Product</i>	<i>Morphology</i>
2mmol FeCl <sub>3</sub> +2mmol urea	24	120	β-FeOOH+α-Fe <sub>2</sub> O <sub>3</sub>	Nanorods+double hexagonal pyramid particles
	24	140	α-Fe <sub>2</sub> O <sub>3</sub>	Well-defined double hexagonal pyramid particles
	24	170	α-Fe <sub>2</sub> O <sub>3</sub>	Dull double hexagonal pyramid particles
	1	140	β-FeOOH	Nanorods
	6	140	β-FeOOH+α-Fe <sub>2</sub> O <sub>3</sub>	Irregular particles+nanorods
	12	140	β-FeOOH+α-Fe <sub>2</sub> O <sub>3</sub>	Nanorods+double hexagonal pyramid particles
	48	140	α-Fe <sub>2</sub> O <sub>3</sub>	double hexagonal pyramid particles with dull edge
	72	140	α-Fe <sub>2</sub> O <sub>3</sub>	double hexagonal pyramid particles with many defects
2mmol FeCl <sub>3</sub> +2mmol NH <sub>4</sub> Cl				Amorphous particles
2mmol FeCl <sub>3</sub> +2mmol NH <sub>4</sub> HCO <sub>3</sub>	24	140	α-Fe <sub>2</sub> O <sub>3</sub>	Double hexagonal pyramid particles
2mmol FeCl <sub>3</sub> +2mmol Na <sub>2</sub> CO <sub>3</sub>				Rhombohedral particles
1mmol FeCl <sub>3</sub> +1mmol urea				Double hexagonal pyramid particles with plenty holes