Supporting data

Influence of Precursor on Phase evolution of nano iron oxide/ oxyhydroxides: optical and magnetic properties

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Table S_1 Some of the recent literature on synthesis of iron oxides/oxyhydroxides

Method	Procedure	Result
Hydrothermal[19]	$K_3Fe(CN)_6$, NaOH solutions. Heated to 120-200 °C in autoclave	Flowerlike α-Fe_2O_3
Calcination[20]	$FeCl_3.6H_2O$ solution heated at100^{0}C for 4 h, After drying annealed in a tube furnace at 350^{0}C for 2h.	α-Fe_2O_3 nanorods with an average L of 400 nm and dia of 75 nm.
Solvothermal[21]	Ferrous ammonium sulfate, H_2O_2, pH 3, 24 h stirring.	Crystallization to goethite and/or hematite.
Solvothermal[22]	Ferric chloride, ethanol. Heated to 180 °C for 15 h in autoclave	Peanut-like α-Fe_2O_3 super structures.
Hydrothermal[23]	$FeSO_4 \cdot 7H_2O$, $NaClO_3$. Heated to 160- 180 °C for several hours in autoclave	Three-dimensional (3D) urchin-like α-Fe_2O_3 nanorods
Solvothermal[24]	Ferric acetylacetonate distilled water.Heated at temperatures (140–180 °C) and reaction times (1.5–12 h)	Different product morphologies of α-Fe_2O_3.
Hydrothermal[25]	$FeCl_3$, $FeNO_3$. Urea, NaH_2PO_4/NH_4OH. Solution heated at 90 ^{0}C for 3h followed by autoclave 115^{0}C 24 h,	Nano rod/ellipsoidal α-Fe_2O_3
Calcination[26]	$FeCl_3$, $FeCl_2$, HCl, NH_3 Mixed solutions kept at room temperature for 2h. Calcined in air at 500 ^{0}C for 1-2 h.	Nano particle α-Fe_2O_3
Hydrothermal calcination[27]	Tri block copolymer ($HO(CH_2CH_2O)_{106}(CH_2\text{-}CH(CH_3)O)_{70}(CH_2CH_2O)_{106}H$) (F127), EG, $Fe(NO_3)_3 \cdot 9H_2O$. vigorous stirring 2 h, aged in air at 40 °C for 7 days, gradual heating to 150 °C (1 °C/min) and maintaining at 150 °C for 24 h. Finally, sintered at 400 °C for 5 h	α-Fe_2O_3 nanostructure with different unique morphology.
Hydrothermal calcination[28]	$FeCl_3$, NaOH autoclaved150 ^{0}C for 18 h Washed upto pH 7 dried at 100 ^{0}C., calcined 600 ^{0}C for 1 h	α-Fe_2O_3 nanostructure with different unique morphology

Hydrothermal[29]	$Fe(acac)_3$, ethanol. Heated in autoclave at 150 °C for 24 h	Mesocrystalline hematite nanoplates
Microwave-aging-Calcination[30]	$Fe(NO_3)_3$, $NaHCO_3$ microwaved until boiling ,aged for 3 days. pH adjusted at 12 aged at 90 ^{0}C for 30–168 h. heated at 300^{0}C in air for 1 h	Porous Y-shaped hematite rods
Calcination[1]	The ferric nitrate heated up to 800 ^{0}C for 4 h.	Pomegranate-like hematite
Hydrothermal[31]	Ferric chloride, urea were added into the THF– ethanol mixture followed by the addition of PVP under ultrasonic conditions for a few minutes. Heated in autoclave at 180 ^{0}C for 12 h. Dried in air at 60^{0}C for 6 h.	3D hierarchical hematite nanostructure,
Surfactant mediated-hydrotermal[32]	CTAB, ferric chloride solution Stirred to form homogeneous clear solution.Heated in autoclave at 120^{0}C for 12 h.	α-Fe_2O_3 nano rhombohedra, nanorods, and nanocubes
Hydrothermal calcination[33]	Ferric nitrate, sodium citrate, and urea solution heated at 160 ^{0}C for 10 h in autoclave. Precipitate washed with water and absolute ethanol, and dried at 60 ◦C for 4 h. Heating the precursor in air at 500 ^{0}C for 2 h.	α-Fe_2O_3 porous nanospheres
Precipitation[34]	Ferric nitrate, KOH, final pH 6.5 ageing	goethite rods
Precipitation[35]	Ferric nitrate, $NaNO_3$, NaOH, pH 8 ageing	Nano ferrihydrite
Precipitation[36]	Ferric nitrate, NaOH, pH 7 ageing	Nano ferrihydrite
Precipitation[37]	Ferric chloride, NaOH, pH 7	Nano ferrihydrite

Table S_2. Crystallite Size and Lattice Parameters of K_1, K_2, K_3 and K_4 Samples Annealed at 400, 600 and 800 ^{0}C.

Annealing Temperature (^{0}C)	Sample	MCD (nm)	a=b (Å)	c (Å)
400	K_1	16±3	5.0497	13.7983
	K_2	22±3	5.0494	13.7958
	K_3	9±2	5.0489	13.8003
	K_4	35±3	5.0503	13.7978
600	K_1	46±4	5.0506	13.7996
	K_2	49±5	5.0508	13.7943
	K_3	25±3	5.0499	13.7983
	K_4	57±5	5.0483	13.8018
800	K_1	96±6	5.0526	13.7966
	K_2	113±4	5.0523	13.7979
	K_3	58±4	5.0516	13.7993
	K_4	106±5	5.0497	13.8003

Table S_3. Mössbauer Parameters I.E., Isomer Shift (IS), Quadruple Splitting (QS), Hyperfine Field (B_{HF}), Line Width (LWD) and Area Ratios Of The Phases Indicated at the Right Most Columns of As-Prepared Samples.

Sample	IS(mm/s) (±0.02)	QS(mm/s) (±0.02)	LWD(mm/s) (±0.02)	B_{HF} (T) (±0.1)	Area (%) (±2)	Phase
K_1	0.34	-0.23	0.33	37.8	66	Goethite
	0.35	-0.23	0.43	34.3	34	Goethite
K_2	0.30	0.67	0.42	-	66	Ferrihydrite
	0.36	-0.19	0.36	50.7	20	Hematite
	0.38	-0.29	0.36	37.0	5	Goethite
	0.34	-0.25	0.35	33.4	9	Goethite
K_3	0.31	0.68	0.43	-	100.0	Ferrihydrite
K_4	0.30	0.67	0.40	-	40	Ferrihydrite
	0.36	-0.19	0.27	51.0	38	Hematite
	0.34	-0.24	0.45	37.4	13	Goethite
	0.26	-0.23	0.44	31.8	9	Goethite

Table S_4. Raman Data for Annealed K_1, K_2, K_3 And K_4 Samples

Peak position in Raman spectra for various annealed samples												
400 ^{0}C				600 ^{0}C				800 ^{0}C				
Peak positions cm^{-1}												
K_1	K_2	K_3	K_4	K_1	K_2	K_3	K_4	K_1	K_2	K_3	K_4	
220	224	224	224	229	229	229	229	229	231	229	229	
290	290	290	290	294	294	294	294	297	297	297	297	
400	407	407	407	407	407	407	407	411	411	411	411	
500	500	500	500	500	500	500	500	493	500	493	493	
609	611	611	611	611	611	611	611	612	612	612	612	
								659	-	659	-	
1305	1314	1314	1314	1316	1322	1316	1316	1322	1322	1322	1322	
Literature (hematite)								Assignment				
226								A_{1g} (1) Fe-Osym str				
247								Eg(1) Fe-O sym.bend				
292								Eg(2)+Eg(3)Fe-Osym.bend				
406								Eg(4)Fe-O sym.bend				
495								A_{1g} (2)Fe-Osym str				
600, 613								Eg(5)Fe-O sym bend				
1320								2nd harmonic vib				

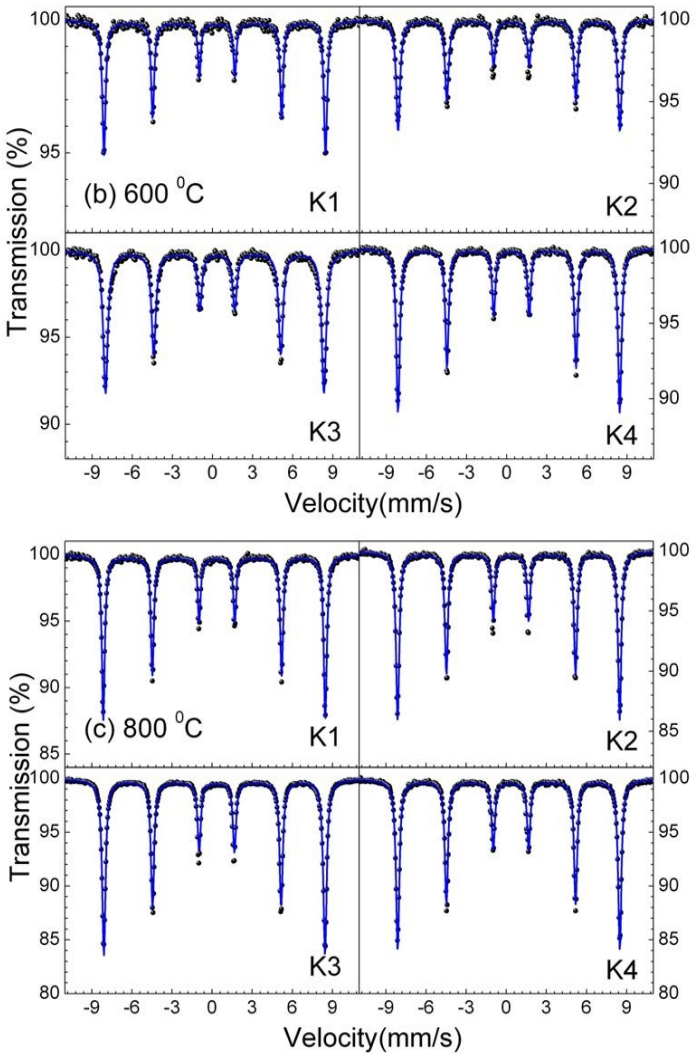

Fig. S_1. Mössbauer spectra of the samples annealed at 600 ^{0}C and 800 ^{0}C.

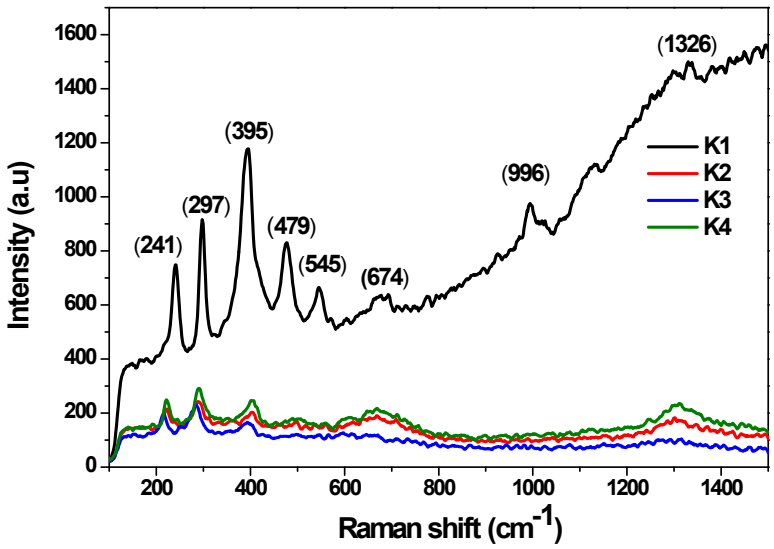

Fig. S_2. Raman spectra of as-prepared nano iron oxide samples.

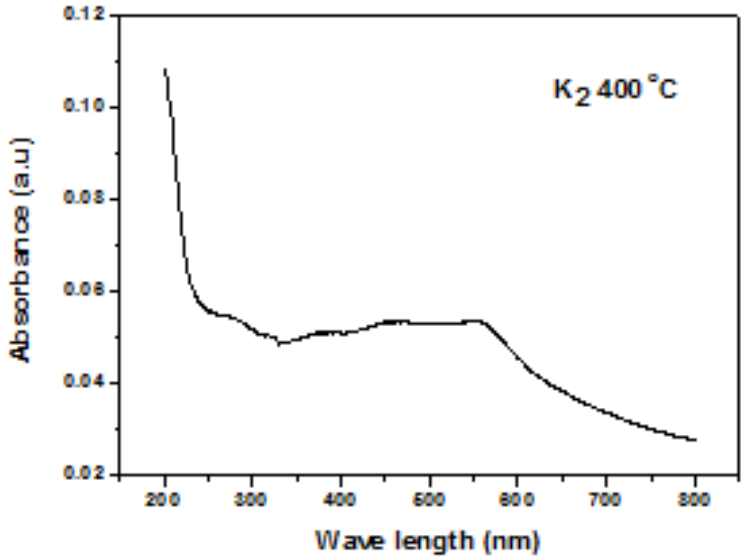

Fig. S_3. UV-Visible spectra of a typical annealed sample (K_2 sample annealed at 400 ^{0}C).