Synthesis and magnetic properties of various ferric-oxide phases

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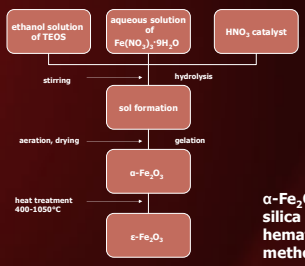
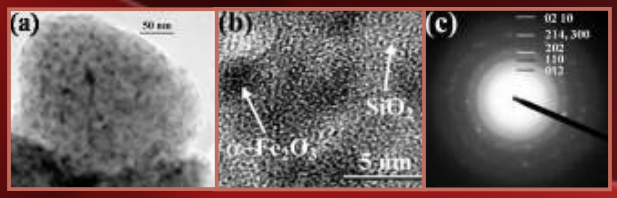
Iron-oxide nanoparticles were prepared by sol-gel and reduction precipitation method. The so-obtained samples were characterized by transmission electron microscopy, X-ray powder diffraction and SQUID magnetic measurements. X-ray diffraction, SAED and TEM studies confirm formation of different oxide phases with mean particle diameter in range 4-20 nm. Nanoparticle samples showed different magnetic ordering, from antiferromagnetic to ferrimagnetic. Magnetization measurements indicate typical behaviour of superparamagnetic nanoparticle systems such as existence of blocking temperature, irreversibility of zero-field cooled (ZFC) and field cooled (FC) curves and emergence of magnetic hysteresis below blocking temperature. Typical magnetic properties such as remanent magnetization and coercive field strongly depend on particular ferric-oxide phase. Mr varied from 0.435 emu/g for α-Fe_2O_3 to 11 emu/g for ε-Fe_2O_3. Measured values for coercivity were in very wide range, from 200 Öe for γ-Fe_2O_3 to 17 kÖe for ε–Fe_2O_3.

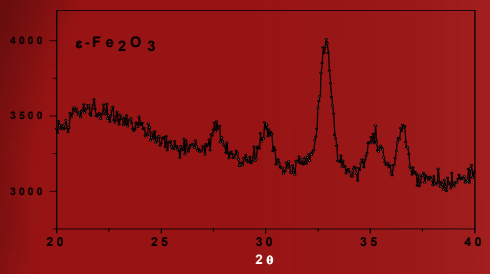
Preparation route:



α-Fe_2O_3 nanoparticles (4nm) in a silica matrix containing 30 wt.% of hematite synthesized by the sol-gel method



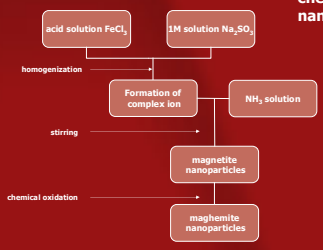
Transmission electron micrograph of α–Fe_2O_3/SiO_2: (a) silica grain with embedded α–Fe_2O_3 nanoparticles; (b) high resolution image of selected grain region; (c) the SAED pattern of the same region

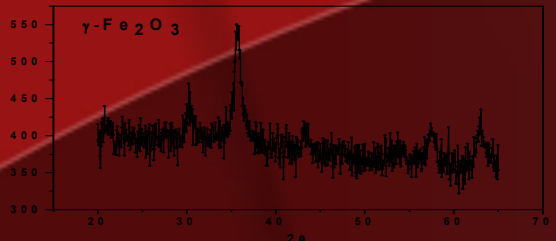


X-ray diffraction spectra of iron oxide particles embedded in a silica matrix heat-treated at the indicated temperature

Preparation route:

γ-Fe_2O_3 nanoparticles obtained by chemical oxidation of magnetite nanoparticle suspension



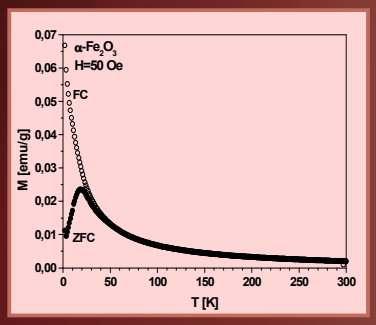


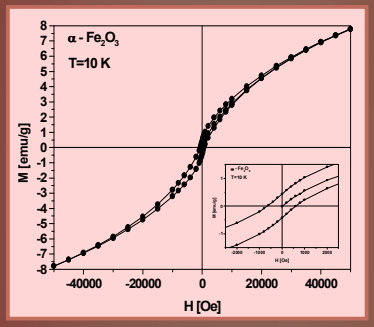
X-ray diffraction spectra of γ-Fe_2O_3

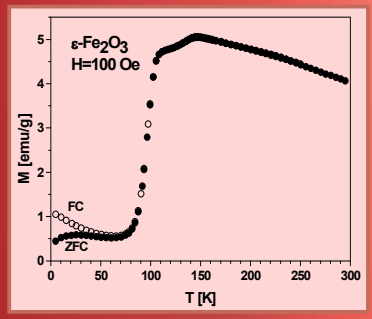
Magnetic measurements:

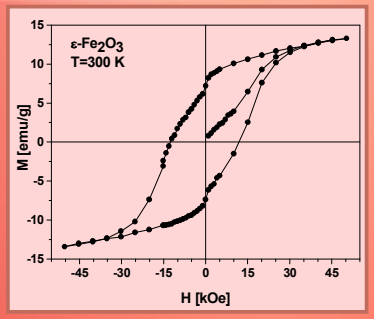
Temperature dependence of magnetization measured in ZFC (open symbols) and FC (full symbols) regimes in the applied fields of H=50 Öe and H=100 Öe

Field dependence of magnetization at 10 K for α- and γ- phase samples and at 300 K for ε- phase sample. Inset: remanent magnetizations and coercive fields for samples at 10 K.









sample	T_B (K)	H_c (Öe)	M_r(emu/g)
α -Fe_2O_3	19	610	0,435
ε -Fe_2O_3	28	17000	11
γ -Fe_2O_3	110	200	10