



 INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Název: Úvod a vysvětlení základních způsobů modifikace magnetických částic

Školitel: Vojtěch Adam

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Reg. č. projektu: CZ.1.07/2.4.00/31.0023
 Název projektu: Partnerská síť centra excelentního bionanotechnologického výzkumu



Applications of iron oxide based nanoparticles

Industry: catalysts, pigments, abrasives, gas sensors, magnetic storage media, ferrofluid technologies, magnetocaloric refrigeration, solar energy transformation

Mineralogy: magnetic separations **Biology:** magnetotactic bacteria

Archaeology: magnetic prospecting of archeological areas

Medicine: contrast agents in magnetic resonance imaging, blood detoxication – dialysis, treatment of certain tumors, drug delivery

Syntheses

Nanocomposites, films

Sol-gel process, aerosol pyrolysis, microwave plasma synthesis, mechanical activation of Fe-bearing precursors, hydrothermal deposition, diode sputter deposition, chemical vapor deposition methods

Nanopowders

Ball-milling, thermally, laser or microwave induced pyrolyses of Fe-bearing solutions, combustion flame process, sonochemical syntheses, hydrolysis-based syntheses

Syntheses based on the thermally induced solid-state reactions

Advantages

- simple and cost-effective methods
- the preparation of a large amount of pure nanopowder without any support material or matrix (technological aspect)
- properties of Fe-bearing precursors predetermine the properties of iron(III) oxide nanoparticles (particle structure and morphology)

“genetic models”: $\gamma\text{-FeO(OH)} \rightarrow \gamma\text{-Fe}_2\text{O}_3$ $\alpha\text{-FeO(OH)} \rightarrow \alpha\text{-Fe}_2\text{O}_3$

- possibility to control the structure, size and morphology of nanoparticles using the precursor properties (structure, particle morphology, crystallinity) and reaction conditions (temperature, atmosphere, diffusion conditions, external magnetic field)

Problems

- postprocessing (magnetic, sedimentation, dissolution) separation of nanoparticles from solid precursors or by-products

nanophase	precursor	temperature	size	reference
α -Fe ₂ O ₃	Mg _{3-x} Fe _x Al ₂ Si ₂ O ₁₂	1100 °C	15-20 nm	R. Zboril, M. Mashlan, K. Barcova, J. Walla, E. Ferrow, P. Martinec: <i>Phys. Chem. Mater.</i> 30 (2003) 620-627.
β -Fe ₂ O ₃	NaCl, Fe ₂ (SO) ₃	400 °C	15-22 nm	R. Zboril, M. Mashlan, D. Petridis: <i>Chem. Mater.</i> 14 (2002) 969.
β -Fe ₂ O ₃	Fe ₂ (SO) ₃	600 °C	40-50 nm	R. Zboril, M. Mashlan, D. Krausova, P. Pikal: <i>Hyperfine Interact.</i> 121-122 (1999) 497.
γ -Fe ₂ O ₃	Fe ₂ (C ₂ O ₄) ₃	250 °C	4-7 nm	R. Zboril, M. Mashlan, K. Barcova, M. Vujtek: <i>Hyperfine Interact.</i> 139 , (2002) 597.
γ -Fe ₂ O ₃	Fe _{3-x} Mg _x Al ₂ Si ₂ O ₁₂	900 °C	7-12 nm	A. Bourinos, R. Zboril, D. Petridis: <i>Micropor. Mesopor. Mater.</i> 58 (2003) 155.
δ -Fe ₂ O ₃	Fe ₂ (SO ₄) ₃	530 °C	40-60 nm	R. Zboril, M. Mashlan, V. Papaefthymiou, G. Hadjipanayis: <i>J. Nucl. Radioanal. Chem.</i> 255 (2003) 413.
am.-Fe ₂ O ₃	Fe ₄ [Fe(CN) ₆] ₃	230 °C	1-3 nm	R. Zboril, I. Machala, M. Mashlan, V. Sharma: <i>Crystal Growth & Design</i> 4 , (2004) 1317.
am.-Fe ₂ O ₃	FeC ₂ O ₄	180 °C	1-2 nm	M. Mashlan, R. Zboril, et al.: <i>J. Metastab. Nanocryst. Mater.</i> 20-21 (2004) 641.
Fe ₃ O ₄ /MgO	am. Fe ₂ O ₃ , Mg	300 °C	30-40 nm	O. Schneeweiss, R. Zboril, N. Pirzova, M. Mashlan, E. Petrovsky, J. Tucek: <i>Nanotechnology</i> 17 , 607-616 (2006).
α -Fe/MgO	am. Fe ₂ O ₃ , Mg	600 °C	50 nm	

<i>Experimental system</i>	
<i>Particle size and morphology, surface characterization, size distribution</i>	
<ul style="list-style-type: none"> • AFM, BET surface area measurements, DLS particle size analysis • TEM 	
<i>Structural and magnetic characterization</i>	
<ul style="list-style-type: none"> • XRD, EPR, IR spectroscopy (UP Olomouc) • SQUID magnetization measurements (NCSR Demokritos, Athens) • low/high temperature, external field Mössbauer spectroscopy (1.5 -1200 K, 10T, UP Olomouc) • VSM magnetic measurements (IPHT Jena) • HRTEM (Hahn-Meitner Institute Berlin) 	
<i>Thermal behaviour</i>	
<ul style="list-style-type: none"> • TG/DTA/DSC (25-1000 °C, UP Olomouc) • Thermomagnetic curves (25-1000 °C, IPM ASCR Brno) 	



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Děkuji Vám za pozornost

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