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Influence of ligands on physicochemical characteristics of magnetic nanoparticles

Szucsova Jaroslava, Zelenakova *Adriana*, Nagy *Lubos*, Barutiak *Michael*, Benova *Eva*, Zelenak *Vladimir* and Zavisova *Vlasta*

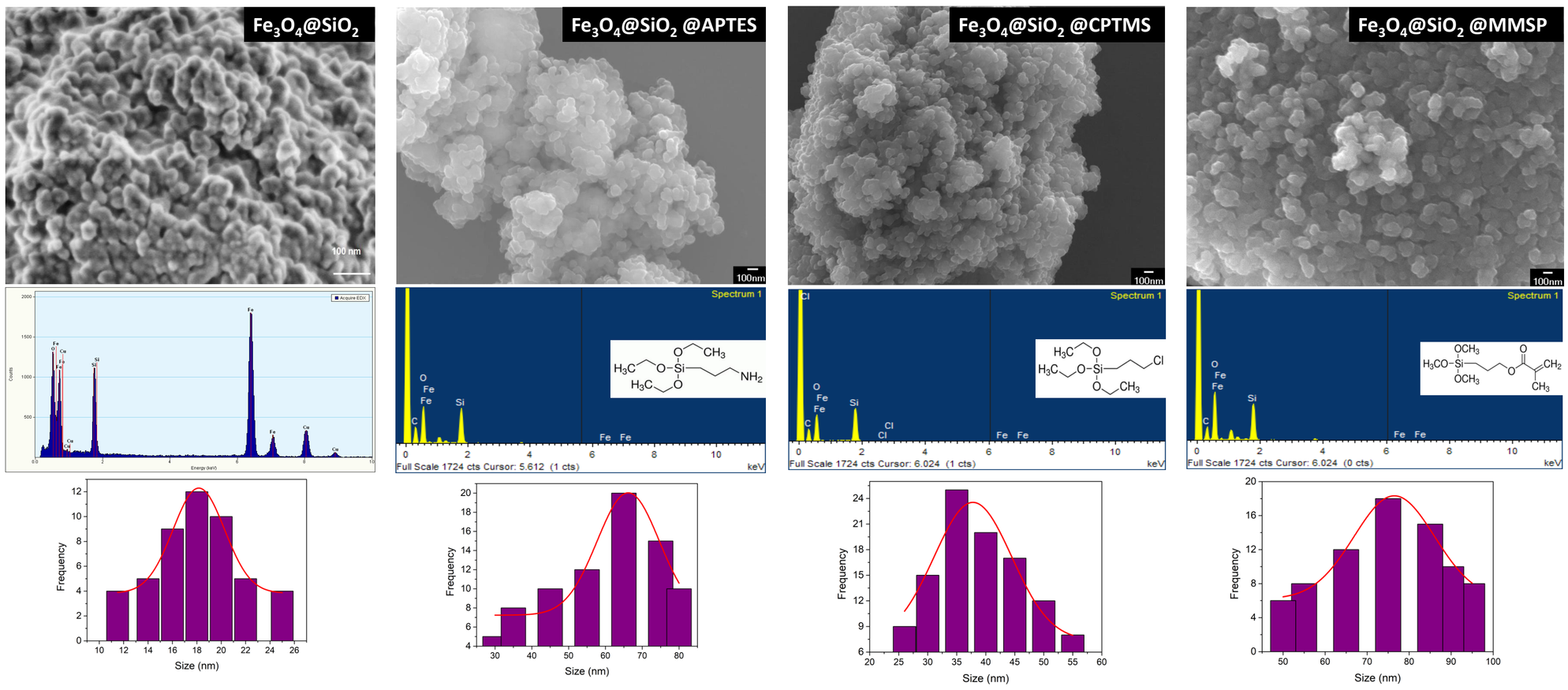
{ Department of Condensed Matter Physics *and* Department of Inorganic Chemistry - **Pavol Jozef Safarik University in Kosice** }
{ Institute of Experimental Physics - **Slovak Academy of Sciences** }

About:

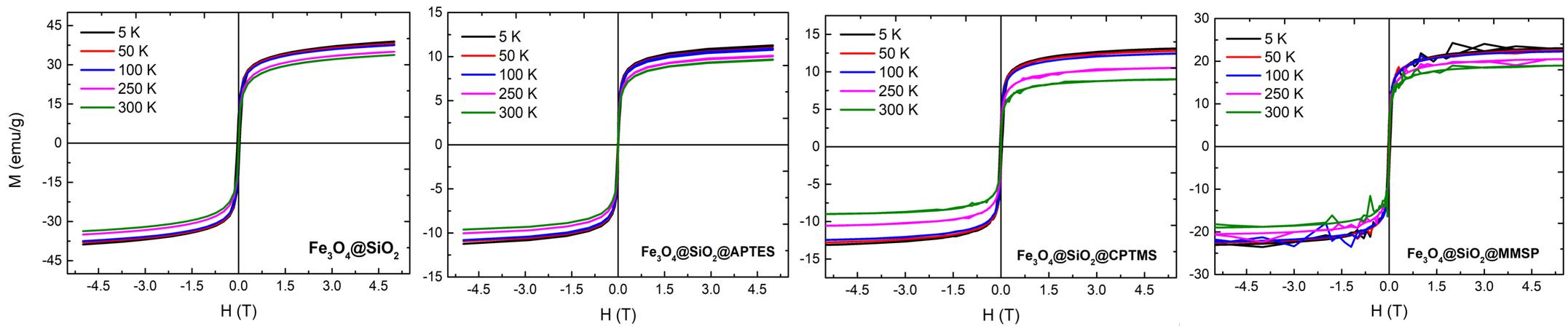
Magnetic nanoparticles are widely applied in many technological fields and in recent years also the specialists in medicine are trying to utilize their unique and scalable properties such as high surface-to-volume ratio, high mobility in free state and their ability to enter cells or be designed to bind to specific cells. Recent pandemic shows that conventional magnetic nanoparticles with **modified surface** can be used for effective magnetic separation of DNA and RNA samples and, also in diagnostic of different range of viruses.

We prepared and characterized core-shell magnetic nanoparticle samples consisted of Fe_3O_4 core coated with SiO_2 shell. Samples were coated with ligands **APTES**-(3-Aminopropyl)triethoxysilane, **CPTMS**-(3-Chloropropyl)trimethoxysilane and **MMSP**-3-(Trimethoxysilyl)propyl methacrylate. Such samples were further investigated for their magnetic properties, size and morphology. Magnetic properties were studied in DC field up to 5 T in temperature range 5-300 K. Size and morphology were determined from SEM micrographs and elemental compositions of the samples were investigated using EDX analysis.

SEM & EDX:



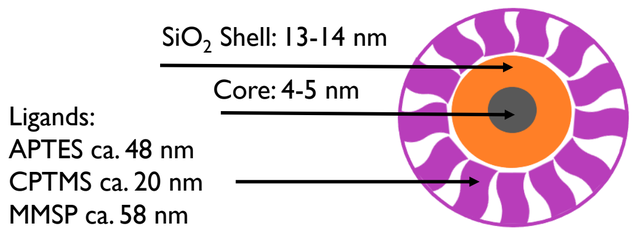
Magnetic Measurements:



Results:

- In this work we investigated coating of magnetic nanoparticles with specific ligands. Coating of nanoparticles with SiO_2 ensures their biocompatibility and modification of nanoparticle surface with different ligands leads to modification of active centers on the SiO_2 surface on which the DNA and RNA molecules can be bounded.
- It was confirmed by SEM and DLS measurements that ligands contributed to overall size of nanoparticles. Presence of ligands had effect also on magnetic properties where significant decrease of magnetization can be observed.
- Ligand groups differ in their chemical composition, molecular weight and functional groups which was also responsible for different thickness of the second shell. Thickest shell was observed for MMSP, while the coating with CPTMS ligand with chlorine group formed the most thin shell.

Sample	Magnetic Measurements	SEM	Hydrodynamic Size (DLS)
$Fe_3O_4@SiO_2$	3.25 nm	18.6 nm	104 d.nm
$Fe_3O_4@SiO_2$ @APTES	4.22 nm	66.19 nm	162 d.nm
$Fe_3O_4@SiO_2$ @CPTMS	5.59 nm	37.7 nm	152 d.nm
$Fe_3O_4@SiO_2$ @MMSP	4.63 nm	76.4 nm	168 d.nm



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jaroslava.szucsova@upjs.sk