SPECTROSCOPIC STUDIES OF FUNCTIONAL NANOCOMPOSITES BASED ON NATURAL POLYMERS FOR WATER TREATMENT

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Humic materials have the most striking feature in the context of environmental chemistry due to constellation of such unique properties as non-toxicity, biocompatibility, resistance to biodegradation, and polyfunctionality. As a result, diverse functional and hybrid materials can be derived on the basis of humic materials. These materials can be competitive on the market of biobased products, nominally, green special chemicals as dispersants, flocculants, chelators, etc.

A set of experimental approaches undertaken to produce nanocomposites based on Fe3O4 nanoparticles coating by humic acids (HA) for the sorption of ecotoxicants included: chemical precipitation methods *in situ* and *ex situ*. The average particle size calculated by the Scherrer equation tended to decrease from 8.4 nm for Fe_3O_4-HA20 to 4.5 nm for Fe_3O_4-HA80.

Magnetic nanoparticles were stabilized due to the immobilization in the polymer matrix and the formation of core/shell structures that enabled limiting particle size growth due to the encapsulation inside of the stabilizer matrix of humic acids. The bonds formed between COO^- and OH^- functional groups of HA (content of the COOH group – 4.2 mmol/g and of the phenolic group − 1.1 mmol/g) and Fe^{3+} of iron oxide surfaces evidenced by FTIR spectroscopy involved enhanced electrostatic and steric stabilization of the particles due to the absorbed layer of highly charged macromolecular compounds.

Mössbauer measurements let identify the nanoparticle core composition as a non-stoichiometric magnetite and maghemite mixture and locate the “iron-polymer” interface in the composite formed by the interaction between iron oxide and HA macromolecules.

Optical spectroscopy indicated that the fluorescence quantum yield depended on the HA content in the nanocomposite and confirmed that the humic component interacted with ferric ions.

The small size of the nanoparticles results in a very large exposed surface area for metal absorption, achieved without the use of porous materials that inevitably introduce a high mass transfer resistance. It has been evinced that Fe_3O_4-HA nanocomposite efficiently removed radioactive and heavy metal ions from contaminated water. Being magnetic, the nanocomposites are readily separable using an external magnetic field, while the humic acid coating effectively stabilizes the particles against aggregation.