Gd-Doped Hydroxyapatite Nanoparticles as a Perspective MRI Contrast Agent: Synthesis, Characterization and First MR Study

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Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body. MRI contrast agents (CA) is using to improve the visibility of internal body structures. Gadolinium-based contrast agents are used in up to 35% of magnetic resonance imaging (MRI) examinations for T1 mode in clinical practice. Chelating complexes, such as Primovist® and Omniscan®, in the same cases can have a toxic effect on humans. Development of a new types of non-toxic and biocompatible contrast agents is still under discussion. Our approach is to introduce the gadolinium ions to non-toxic and biocompatible host to make it more applicable in medical practice. Hydroxyapatite (Hap) biocompatible nanoparticles was chosen as a host for a new contrast agent.-

The first stage of the work is dedicated to the development of the synthetic procedure to produce the Gd high doped Hap nanoparticles (NPs) with a different size and shape which are considered as a key factor impact on MRI signal. The NPs were synthesized by co-precipitation method followed by the thermal treatment under atmospheric and hydrothermal conditions with the using of low and high concentration of initial reagents. The regulation of this parameters can initiate an orientational attachment process which leads to interaction between initial particles. In this case, the parameters of the "initial" NPs depend on the concentration of the initial reagents in the reaction medium, and the "final" NPs - on the holding temperature. All samples were fully characterized by XRD, TEM, FTIR, AES. Synthesized particles were monocrystalline with a rod-like shape and a size from 11 to 32 nm and aspect ratio 1:3. The band gap values diminish after doping from 3,64 to 4,67 eV, the Gd amount is close to 2,5mol.% for all the samples.

At the second stage of the work the MRI date of nanoparticles embedded in agarose matrix were taking of T1 and T2 modes. The relaxation time in T1 mode depends on nanoparticles size from 352 to 2730 ms, and in T2 mode is constant and close to 25 ms, which is a good result and non-usual for T1 contrast agents. Thus, the possibility of using the Gadolinium doped hydroxyapatite nanoparticles as T1 contrast agents was successfully demonstrated for the first time.

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