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Novel maghemite nanoparticles: biotechnologists and mineralogists for a common purpose

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Magnetic nanoparticles of iron oxide, namely maghemite and magnetite, play a key role in modern biomedical and biotechnological applications. Nanosized iron-oxide based magnetic particles possess many superior properties, including magnetic and biochemical characteristics that empower their prominent application position in diverse fields of medicine. Recently we have developed a novel wet synthesis [1,2] pathway for producing a new type of superparamagnetic nanoparticles of maghemite (called surface active maghemite nanoparticles, SAMNs) revealing peculiar characteristics such as excellent colloidal stability, reversible direct binding of organic molecules without the necessity of any additional modifications , unique spectroscopic properties and well defined stoichiometric structure. SAMN's unique features differ from conventional maghemite nanoparticles for surface characteristics, crystallinity and thus, electrocatalitic properties. In a specific case, glucose oxidase was immobilized on the surface of rhodamine modified magnetic nanoparticles, generating a fluorescent, magnetically drivable, enzymatically active, nanomaterial, that was used to develop a carbon paste based, glucose biosensor [3].
SAMN nanoparticles represent the final product of synthesis procedure, however, during the synthesis different intermediates were isolated and characterized by means of a multianalytical approach. The complete characterization was performed by X-Ray powder diffraction (XRPD) at both ambient and high temperature conditions, Mössbauer (MS) and Fourier Transform Infrared (FTIR) spectroscopies and Transmission Electron Microscopy (TEM; HRTEM). In addition in situ high temperature X ray diffraction studies were carried out in the temperature range from room temperature to 700°C, in order to study the effect of temperature on phase modifications, mainly crystallize size and maghemite $\rightarrow$ hematite phase transformation. The principal aim of the present work is to discuss the mechanisms and kinetics of polymorphous transitions with respect to the characteristics of the original material. The comparison among different samples highlights that the maghemite $\rightarrow$ hematite phase transformation is not affected by sample characteristics. This phase transformation occurs at Temperature higher than those reported in literature [4, 5] due to the effect of crystallite size, higher than those of other materials studied in quoted references. The evolution of sample during the maghemite $\rightarrow$ hematite phase transformation at 600°C was monitored: hematite line appears after 30 minutes, while maghemite line can be considered faded out after 480 minutes of thermal treatment.

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