PRESSURE-INDUCED PHASE TRANSITIONS IN MAGNETITE NANOPARTICLES DOPED WITH Sm AND La IONS

A.V. Rutkauskas[1], O.N. Lis[1], S.E. Kichanov[1], E.V. Lukin[1] , D.P. Kozlenko[1], G.S. Rymski[2] and A.L. Zhaludkevich[2]

[1] *Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research, Dubna, Russia*
[2] *Scientific-Practical Materials Research Centre of the National Academy of Sciences of Belarus, Minsk, Belarus*

E-mail: ranton@nf.jinr.ru

Bulk and nanostructured ferrites with a spinel-type crystal structure (AFe_2O_4) have been actively studied for many decades due to their attractiveness from both fundamental and practical points of view. Such compounds exhibit a wide range of physical phenomena: high electrical resistivity, low electrical losses, high chemical stability, magnetic phase transitions of various types, geometric frustration effects, and much more. This makes possible the wide technological application of ferrites as materials for transformers, solar cells, biomedicine, magnetic sensors, catalysts, drug delivery systems, electronic and magnetic components.

Depending on the chemical composition and size of nanoparticles, ferrites with a spinel structure have different distributions of cations in tetrahedral (A) and octahedral (B) oxygen coordination. In particular, the case can be realized when Fe^{3+} ions are in positions A, and there is also a mixture of Fe^{3+} and Fe^{2+} ions located in positions B. When doping with transition metals or alkali elements in positions A or B or creating vacancies in the cubic spinel structure, magnetic interactions between iron ions change. This leads to significant changes in the physical properties of these ferrites.

In our work we have studied the crystal structure of $R:Fe_3O_4$ nanostructured ferrites (where R is Sm, La and R= 5%) under high pressure.

The $Sm:Fe_3O_4$ compound has been studied in the pressure range of 0-26 GPa. At pressures above 17 GPa, a structural phase transition has been detected from the initial cubic phase with space group $Fd\bar{3}m$ to the orthorhombic structure Bbmm.

The $La:Fe_3O_4$ compound has been studied in the pressure range of 0-25 GPa. For this compound the structural transition from cubic phase $Fd\bar{3}m$ to the orthorhombic structure Bbmm has been observed at pressure 8 GPa.

For both compounds the phase transition is a wide range of phase coexistence pressures. Under pressure there is a gradual suppression of the initial cubic phase and an increase in the volume fraction of the orthorhombic phase. The lattice parameters, bond lengths, and bulk modulus have been determined for both the cubic and orthorhombic phases in this ferrite.

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