Nanocomposites and nanomaterials

Neutron diffraction studies of the polycrystalline and nano-particle TbMnO$_3$

W. Bażela[1], M. Dul[1], V. Dyakonov[2], A. Hoser[3],

J.-U. Hoffmann[3], B. Penc[4], K. Dyakonov[5], A. Szytuła [4]

[1] Cracow University of Technology, Institute of Physics, Podchorążych 1, 30-084 Kraków, Poland, E-mail: wbazela@pk.edu.pl

[2] Institute of Physics, PAS, Al. Lotników 32/46 ,02-668 Warszawa, Poland.

[3] Helmholtz -Zentrum Berlin fur Materialien und Energie GmbH , Hahn-Meitner Platz1, D-14 109 Berlin ,Germany.

[4] M. Smoluchowski   Institute of Physics, Jagiellonian University, Reymonta 4, 30-059 Kraków, Poland.

[5] A. F. Ioffe   Physico-Technical Institute RAN, Politekhnicheskaja 26, St.-Petersburg 194021, Russia.

Investigations on crystal and magnetic structures of the orthorhombic perovskite TbMnO$_3$ are reported. Our X-ray and neutron diffraction studies were performed for two nano-specimens and a conventional polycrystalline sample. Obtained data confirmed the orthorhombic crystal structure without noticeable differences of the lattice parameters for all samples. For the polycrystalline sample, a subsequent ordering of the Mn and Tb sublattices upon lowering temperature was observed. Namely, the Mn sublattice exhibits a modulated magnetic structure with propagation vector $\mathbf{k} = (k_x, 0, 0)$ between 41- 5 K. At temperature of 27 K a change from collinear (C_x mode) into non-collinear (C_xA_z mode) structure was evidenced. Further lowering of the temperature below 5 K results in the magnetic ordering in the Tb sublattice (modulated - F_yA_z mode). For investigated nano-samples magnetic ordering of the Mn and Tb sublattice is described by propagation vector $\mathbf{k} = (k_x, 0, 0)$ with k_x components significantly higher than observed for polycrystalline sample. The magnetic ordering in the Mn sublattice is described by collinear C_x mode down to 1.6 K, where the Tb magnetic moments become ordered (A_z mode). The observed broadening of Bragg peaks connected to the Tb sublattice suggests the cluster like character of its ordering.