Nanocomposites and nanomaterials

Magnetic interactions in Mn sublattice of the polycrystalline and nanoparticle $TbMnO_3$ manganite

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Crystal structure and magnetic interactions in the Mn sublattice of the polycrystalline and two nanopowder samples of $TbMnO_3$ manganite are discussed. All the samples exhibit the orthorhombically distorted perovskite structure (space group Pnma). The Tb atoms and O1 atoms are in (4)c site: x, 1/4, z; Mn atoms in 4(b) site: 0, 0, 1/2 and O2 atoms in 8(d) site: x, y, z. In this work we have focused our attention on the changes of the Mn-O bond length and Mn-O-Mn bond angles as a function of temperature for two nano-specimens and polycrystalline sample. In the orthorhombic unit cell there are the three crystallographically independent (Mn-O2 $(8d)_1$, Mn-O2$(8d)_2$, Mn-O1(4c)) bond lengths and the two (Mn- O1- Mn, Mn - O2 - Mn) bond angles. The $TbMnO_3$ manganite exhibits a para-antyferromagnetic phase transition at 41 K, where the Mn^{3+} ions develop the sinusoidal ordering along the a – axis of the unit cell described by C_xA_z – mode. The magnetic order in the Mn sublattice is collinear of C_x – type in the temperature range of 21 – 41 K. For investigated nano- samples the magnetic ordering in the Mn sublattice is described by collinear C_x – mode only. In $TbMnO_3$ manganite the superexchange interactions between Mn – O2 – Mn spins along the a – c plane (J_1) are ferromagnetic, while the interactions between Mn – O1 – Mn along the b- axis are antiferromagnetic (J_2). The values of Mn – O2 – Mn bond angles for polycrystalline and nanosize samples are similar and exhibit anomalies at temperature T_N. The values of Mn – O1 – Mn bond angles are higher for nanoparticle samples. This fact suggests an increase of super – exchange mechanism. For nanosamples the Jahn – Teller distortion parameter (JT) and Mn-O_6–octahedron distortion parameter (delta) are lowered in comparison to the polycrystalline sample.