Phase transitions in $TbMnO_3$

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Magnetic properties of $TbMnO_3$ multiferroic as a function of grain size, temperature and magnetic field have been studied. The nanosize (45, 60 and 70 nm) $TbMnO_3$ manganites were synthesized with a sol-gel method at 800, 850 and 900 °C temperatures. The $TbMnO_3$ film was grown onto the single crystal [001] $SrTiO_3$ substrate using magnetron sputtering technique. The peculiarities of magnetic ordering in polycrystalline, nanosize and film $TbMnO_3$ manganites were compared. Magnetization and the Nèel temperature corresponding to antiferromagnetic ordering of the Tb^{3+} sublattice decrease as the particle size is reduced. Magnetization of the $TbMnO_3$ film and specific heat of the nanosize samples exhibit anomalies related to the magnetic ordering of the Tb^{3+} and Mn^{3+} sublattices. The magnetic field and temperature dependences of the electric polarization of $TbMnO_3$ film have shown that the ferroelectric phase appears below 30 K in magnetic field $H > 1$T applied along both the a and c axis.