Temperature evolution of the crystal structure of MnTiO₃

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MnTiO₃ stabilises in the ilmenite structure with space group $R\bar{3}$ in which Mn $^{2+}$ and Ti $^{4+}$ layers are arranged alternatively along the hexagonal c-axis. This compound is interesting in the perspective of being a linear magnetoelectric material where there is strong interplay between magnetism and ferroelectric behaviours. In addition, this material exhibits paramagnetic to antiferromagnetic transition at around 64 K. There occurs spin flop transition at ~ 6 T when the magnetic field is applied parallel to c-axis similar to another ferrotoroidic system, Cr₂O₃. Polycrystalline MnTiO₃ was synthesized by conventional solid state route after several rounds of optimising the preparation conditions. This compound was characterized using powder x-ray diffraction, temperature dependent d.c. magnetisation at 0.1 T during the zero field cooled (ZFC) and field cooled (FC) cycles and specific heat measurements. The characterization studies reveal that the synthesized compound is single phase. The magnetization measurement shows a broad hump and a change of slope at around 100 K and 64 K respectively. A sharp peak is also observed at ~64 K in the specific heat measurement. To understand the structural connectivity with its magnetic behaviour, Rigaku make temperature dependent powder x-ray diffraction experiments were carried out for 13 different temperatures (300 K to 23K). The x-ray diffraction patterns were analysed using the FULLPROF Rietveld profile refinement software. No structural transition was observed and the lattice parameters show interesting behaviour across the region of magnetic phase transition. On reducing the temperature both the lattice parameters $a$ and $c$ of the hexagonal unit cell exhibit sharp decrement until 200 K due to thermal effect. On further reducing the temperature, the lattice parameters decrease gradually and below 100 K it remains almost the same. This suggests the signature of structural link with the onset of the magnetic transition at temperatures occurring at temperatures much above Neel temperature. Our earlier structural studies carried out on multiferroic Ca₃Co₂O₆ have also observed such kind of precursor effects.

References


Presentation Method : Poster