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Synthesis, structural, microstructural and electrical properties of the $TbMnO_3$ compound obtained by high-energy ball milling

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Abstract – Magnetoelectric multiferroic $TbMnO_3$ has emerged as a new class of multiferroic materials where a cycloidal spiral spin structure is responsible for the ferroelectricy. This new class of multiferroics where the ferrolectricity is related to a magnetic order is reported to present a large magnetoelectric effect, a sudden change of electric polarization by the application of magnetic fields. In this work we reported the synthesis of $TbMnO_3$ by high energy ball milling, which until now haven't been reported in literature, our results points to the formation of single phase materials where the structural, microestructural and electral properties were investigate.

Multiferroic magnetoelectrics has emerged as a new class of materials that combine coupled electric and magnetic properties, where the interaction between these two properties is named magnetoelectric effect [1]. The induction of a magnetization by an applied electric field and of a polarization by an applied magnetic field opens a new degree of freedom in device design, from which we can expect new type of device applications such as: electric field controlled magnetic data storage devices, sensors, transducers and spintronic ones [1,2]. However, very few exist, since that ferroelectric and magnetic ordering are mutually exclusive [1] and the magnetoelectric interactions, in the so far studied materials, are too small. The work temperatures are too low and the phase transitions temperatures of the two orders are very different. All these finds limit practical device applications.

In recent years, a new class of multiferroics has surged such as $TbMnO_3$ and $Ni_3V_2O_8$. In these multiferroic magnetoelectrics the ferroelectric order arises from a cycloidal spiral structure [2], which is a new class of ferroelectric where the origin of ferroelectricty is related to a magnetic order. This magnetically induced ferroelectricity gives rise to a strong magnetoelectric coupling and a large magnetoelectric effect, a sudden change of electric polarization by the application of magnetic fields.

In this work the $TbMnO_3$ multiferroic magnetoelectric compound was processed by high-energy ball milling. Our results point to the formation of perovskite structured single phased materials, with orthorhombically distorted symmetry in the Pbnm space group. The high energy ball milling process is associated with a number of interesting and unique phenomena, including refinement in crystallite size, structure deformation, creation of point, surface and lattice defects [3]. In this way, the focus of this this work is to investigate the structural, Fig. 1, microestructural, Fig. 2, and electrical properties of $TbMnO_3$, produced by high energy ball milling, and compare the obtained results with those available in literature for materials processed by other techniques. To the best of our knowledge, this material has never been reported to be produced by high energy ball milling.

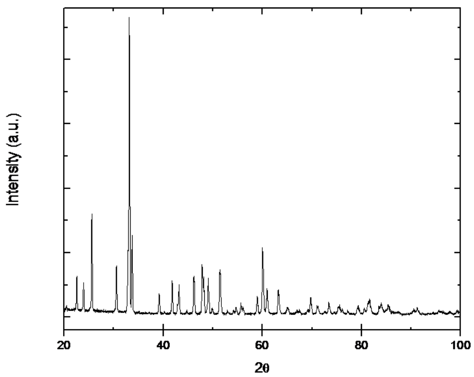

Figure 1 X-ray diffraction patterns for the $TbMnO_3$ magnetoelectric compound.

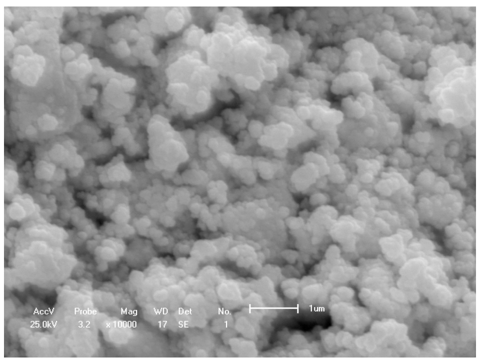

Figure 2 Scanning electron microscopy image for the high-energy ball milled (12 h/400 rpm) $TbMnO_3$ powder EM image for $TbMnO_3$.

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