Structural and magnetic properties of mechanochemically synthesized nanosized $YTiO_3$

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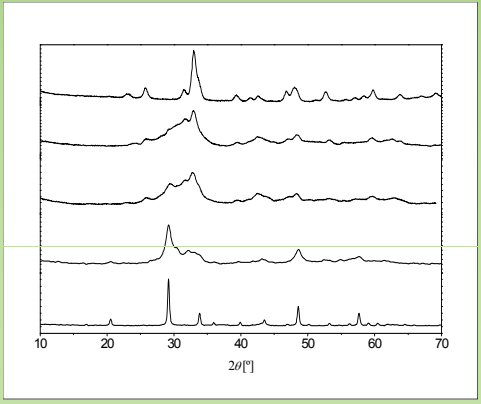
Abstract

In this work we investigated magnetic and structural properties of novel nanosized $YTiO_3$. The sample was prepared using the mechanochemical treatment. A mixture of comercial Y_2O_3 powder and mechanochemically synthesized TiO in a molar ratio 0.5:1 was milled for 10, 30, 60 and 180 minutes under nitrogen atmosphere. X-ray diffraction revealed that the crystal structure of $YTiO_3$ is a pseudo-cubic perovskite with an orthorhombic distortion (the $GdFeO_3$-type distortion). The sample was further characterized by the SQUID measurements in the temperature range 2-300 K and by the thermo gravimetric analysis (TGA).



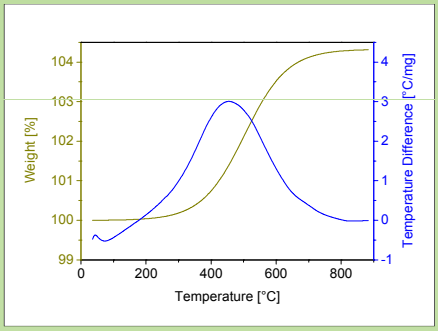
XRD patterns of the mixture of Y_2O_3 and TiO powders in stoichiometric ratio for $YTiO_3$, milling for 0, 10, 30, 60 and 180 min.

Experimental

Commercial Y_2O_3 powder and mechanochemically synthesized TiO were weighed in a molar ratio 0.5:1. A planetary ball mill Fritsch Pulverisette 7 with a pair of tungsten carbide vials of 45 ml volume containing 144 tungsten carbide balls of 5 mm diameter was used for the grinding of the mixtures under nitrogen atmosphere. Balls to powder weight ratio was 20:1. The angular velocity of the supporting disc and vial was 104.7 rad s−1 (1000 rpm). After selected milling times (10, 30, 60 and 180 min) the samples of powder were taken for X-ray diffraction measurements (Philips PW 1050 powder diffractometer with Ni filtered CuKα radiation and scintillation detector) within 10−70° 2θ range in steps of 0.05°, and scanning time of 2 s per step. After XRD measurements, the powder was placed back in a vial to obtain the same grinding conditions (balls to powder weight ratio).

Magnetic measurements were done by using Quantum Design MPMS SQUID magnetometer. ZFC were carried out in the temperature range of 2–300 K, and in applied fields of 0, 2 and 2000 Öe. The hysteresis loops measurements were recorded in magnetic fields between –50 and 50 kÖe at temperature of 2 K. AC magnetic measurements were done for 1, 10, 100 and 1000 Hz frequencies in the temperature range 2 – 60 K in applied field of 2 Öe.

Simultaneous TGA/DTA measurements were carried out up to 900°C in the air atmosphere at a heating rate of 20°C min^{-1} using the thermobalance TA SDT Model 2090. The oxidation of $YTiO_3$ to $Y_2Ti_2O_7$ was assessed from the mass increase observed by TGA on heating above 250°C. The oxidation was accompanied by DTA exothermic effects at 450°C.



Conclusion

The successful synthesis of the single-phase pseudo-cubic YTiO3 was accomplied by the mechanochemical method. The system possess ferromagnetic ordering up to Tc≈18 K. It exibits narrow coercivity value of Hc ≈ 170 Öe and saturation of 14 emu/g (0.45mB), pointing to the soft ferromagnetic behaviour.