Structural and magnetic properties of mechanochemically synthesized $Y_{1-x}Gd_xTiO_3$ solid solution

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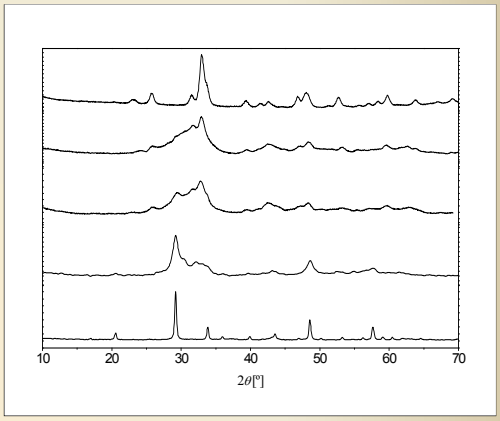
Abstract

Magnetic and structural properties were investigated for novel nanosized $Y_{1-x}Gd_xTiO_3$ (x = 0, 0.25, 0.5, 0.75 and 1) solid solution. The samples have been prepared using the mechanochemical treatment. A mixture of commercial Y_2O_3, Gd_2O_3, TiO_2 and Ti powders in stoichiometric ratio was mechanochemically treated in a planetary ball mill in argon atmosphere. X-ray diffraction revealed that the crystal structure of $Y_{1-x}Gd_xTiO_3$ solid solution is a pseudocubic perovskite with an orthorhombic distortion (the $GdFeO_3$-type distortion). Relevant structural and microstructural parameters were refined from the XRD data by full profile Rietveld's method within *Pbnm* space group. Magnetic properties were determined by SQUID measurements in the temperature range 2-300 K. The relation between magnetic, structural and microstructural properties was discussed.

Experimental

$Y_{1-x}Gd_xTiO_3$ samples (x = 0, 0.25, 0.5, 0.75 and 1) were prepared using the mechanochemical treatment. A mixture of commercial Y_2O_3, Gd_2O_3 and TiO_2 powders and sponge Ti, in stoichiometric ratio, were used as the starting material. Mechanochemical treatment was performed in a planetary ball mill (Fritsch Pulverisette 7) in argon atmosphere. A tungsten carbide vial of 45 ml volume filled with 140 g tungsten carbide balls of 5 mm diameters. 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 and FC measurements were carried out in the temperature range of 2–300 K, and in applied fields of 0, 2, 20, 50 and 2000 Öe. The hysteresis loops measurements were recorded in magnetic fields between –50 and 50 kÖe at temperature 2, 5, 15 and 100 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.



XRD patterns of the mixture of Y_2O_3 and TiO_2 powders and sponge Ti, in stoichiometric ratio for $YTiO_3$, milling for 0, 10, 30, 60 and 180 min.