

Keywords: neutron diffraction; polarized neutrons; X-ray magnetic circular dichroism

FA2-MS09-O4

Structural, Magnetic and Electric Properties of $\text{GaFe}_{1-x}\text{Mn}_x\text{O}_3$. M.Bakr^a, A. Senyshyn^a, H. Wang^a, G. Parzych^b, L.Dobrzynski^{b,c}, K.Szymański^c, H. Fuess^a. ^aInstitut for Materials Science, Darmstadt University of Technology, D - 64289 Darmstadt, Germany. ^bThe Soltan Institute for Nuclear Studies, Poland. ^cFaculty of Physics, University of Bialystok, Poland. E-mail: mbm1977@yahoo.com

Gallium iron oxide (GaFeO_3) is a member of a multiferroic family which exhibits ferrimagnetic and piezoelectric properties below room temperature [1-2]. This material has orthorhombic (double HCP Closed-Pack) crystal structure with space group $Pc2_1n$ with four different cation sites labeled Ga1, Ga2 (mostly occupied by gallium) and Fe1, Fe2 (mostly occupied by iron) [3-5]. The different physical properties of GaFeO_3 are strongly dependent on the distribution of cations within the structure. The magnetic properties of GaFeO_3 strongly depend on the preparation method which affects the cations distributed over different sites. Polycrystalline $\text{GaFe}_{1-x}\text{Mn}_x\text{O}_3$ materials have been prepared by a traditional solid state reaction (SR) and sol-gel (SG) methods. Structural analyses showed that the maximum Mn content is 10% and 50% for samples prepared by SR and SG, respectively. All samples crystallise in the orthorhombic system with $Pc2_1n$ space-group. The Curie temperature (T_C) for GaFeO_3 (SR) is about 190K and increases or reaches room temperature when the temperature of preparation is decreased from 1400°C to 700°C. The Curie temperature for SG reaction is slightly above room temperature. With increasing the Mn content the transition temperatures as well as the coercive field decrease. Dielectric investigations revealed a temperature independent anomaly at around 255 K with frequency dispersion of dielectric constant only for GaFeO_3 prepared at 700°C (SG) and Mn doped samples prepared by both methods. It follows from the neutron powder diffraction and Mössbauer spectroscopy revealed that GaFeO_3 exhibits a ferrimagnetic order with spins parallel to c-axis. Both, the cation and magnetic, orderings depend strongly on the preparation conditions.

[1] J.P. Reimeka, *J. Appl. Phys.* 31 263S, **1960**, [2] E.A. Wood, *Acta Cryst.* 13, 682, **1960**, [3] S.C. Abrahams, J.M. Reddy and I.L. Bernstein, *Chem. Phys.* 42, 3957-3968, **1965**, [4] G.T. Rado, *Phys. Rev. Lett.* 13, 335-337, **1964**, [5] T. Arima, D. Higashiyama, Y. Kaneko, J.P. He, T. Goto, S. Miyasaka, T. Kimura, K. Oikawa, T. Kamiyama, R. Kuumai, and Y. Tokura, *Phys. Rev. B* 70, 064426, 1-8, **2004**.

Keywords: multiferroics; magnetic; dielectric

FA2-MS09-O5

Neutron Diffraction Study of DyVO_3 and HoVO_3 . Manfred Reehuis^a, Clemens Ulrich^b, Jun Fujioka^c, Shigoki Miyasaka^c, Yoshinori Tokura^c, Bernhard

Keimer^b. ^aHelmholtz-Zentrum Berlin, Germany. ^bMPI-Stuttgart, Germany. ^cUniversity of Tokyo, Japan. E-mail: reehuis@helmholtz-berlin.de

Vanadates with the formula $R\text{VO}_3$ ($R = \text{Y}$ or rare-earth element) exhibit many exciting properties, which can be related to orbital or spin rearrangements [1], [2]. In order to provide a more complete basis for the theoretical description of the electronic properties of these compounds we have started to carry out a comprehensive investigation of the crystal and magnetic structures of YVO_3 , NdVO_3 and TbVO_3 [3], [4]. In the room-temperature lattice structure the influence of the relative ionic sizes leads to tilts of the VO_6 -octahedra. From La^{3+} to Lu^{3+} the distortions show a continuous increase due to the well-known lanthanide contraction. With decreasing temperature the vanadates show a structural phase transition at T_{S1} , where the orthorhombic structure ($Pbnm$) changes to a monoclinic structure with the space group $P2_1/b$ due to the onset of the cooperative *Jahn-Teller* effect and the onset of orbital ordering. In the monoclinic phase the magnetic moments of the V^{3+} -ions show antiferromagnetic ordering with the modes C_x , C_y and G_z , where the z -component is the weakest. A second structural phase transition (T_{S2}) could be observed for vanadates containing smaller R^{3+} -ions ($R^{3+} = \text{Y}^{3+}$, Ho^{3+} – Lu^{3+}) [1]. Below T_{S2} the crystal structure changes back to the orthorhombic structure and the vanadium moments are purely G -type ordered along z [3], [4]. In DyVO_3 , where the R^{3+} -ion is slightly larger than Ho^{3+} , a critical phase competition between different spin-orbital-ordered states was observed only recently [5]. Our neutron diffraction experiments of DyVO_3 showed that the transition to the pure G -type ordering sets in at $T_{S2} = 63(1)$ K. For YVO_3 , where Y^{3+} is only slightly smaller than Dy^{3+} , this transition sets in at considerably higher temperature $T_{S2} = 77(1)$ K. As found earlier for YVO_3 the G -type ordering in DyVO_3 remains stable upon cooling from T_{S2} down to 6 K. But with increasing temperature the monoclinic C -type phase surprisingly appears in DyVO_3 between 13 and 23 K. For HoVO_3 this intermediate phase could not be observed. On the other hand the second phase transition of this vanadate sets in (cooling process) at the strongly reduced temperature $T_{S2} = 26(1)$. With increasing temperature it sets in at the higher value $T_{S2} = 36(1)$ K, indicating the presence of strong hysteresis effects. Further it is important to note that both the magnetic moments of the Dy^{3+} - and Ho^{3+} -ions show a long-range ferrimagnetic order up to the unusually high temperatures 23(1) K and 36(1) K, respectively. Our study clearly showed that strong exchange interactions between the magnetically ordered V-moments and the magnetic Dy^{3+} - and Ho^{3+} -ions lead to a reduction of the transition temperature T_{S2} as well as to an increasing of the magnetic ordering temperature of the R^{3+} -ions.

[1] Miyasaka S.; Okimoto Y.; Iwama M.; Tokura Y., *Phys. Rev. B*, **2003**, 68, 100406(R). [2] Blake G.R.; Palstra T.T.M.; Ren Y.; Nugroho A.A.; Menovsky A.A., *Phys. Rev. Lett.*, **2001**, 87, 245501. [3] Ulrich C.; Khaliullin G.; Sirker J.; Reehuis M.; Ohl M.; Miyasaka S.; Tokura Y.; Keimer B., *Phys. Rev. Lett.*, **2003**, 91, 257202. [4] Reehuis M.; Ulrich C.; Pattison P.; Ouladdiaf B.; Rheinstädter M.C.; Ohl M.; Regnault L.P.; Miyasaka S.; Tokura