MS25-P4 Thermal and magnetic anomalies of $Mn_{1-x}Co_xGe$

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The helimagnets with chiral spin structure are interesting because of a wide range of unusual phenomena related to their magnetic ordering. An incomplete but representative list includes skyrmion structures, magnetostriction and magnetoresistance, coupling of structural and magnetic chiralities [1-5]; some of them may found application in the next generation spintronic devices. Besides well-known MnSi, this family includes MnGe, possessing a number of advantages, such as high transition temperature T_N of about 170 K (instead of ≈ 29 K in MnSi) and a large ordered Mn moment of about 1.8 μ_B at 2 K (compared to 0.4 μ_B at 2 K in MnSi) [6 - 8]. It was shown that MnGe has additional specific feature, namely a broad transition region from ordered helical phase to a disordered paramagnetic one, from T_N to T_C ≈ 270 K [6 - 8]. The nature of the region is not yet entirely clear, in particular ferromagnetic nanoregions (~ 1 nm) were suggested to exist between T_N and T_C based on small angle neutron scattering data [6]. Here we report an anomaly in thermal expansion in the same region for MnGe and follow the evolution of thermal properties as a function of x in the series of $Mn_{1-x}Co_xGe$ solid solutions, i.e. from the helimagnet MnGe to the diamagnet CoGe. Thermal expansion was studied by fitting the lattice parameter dependence on temperature based on synchrotron powder diffraction data in terms of the Debye model. The deviation from the Debye model increases with decreasing cobalt concentration, with the largest deviation for MnGe in the region between T_N and T_C. In particular, a negative increment to the linear thermal expansion coefficient was observed for MnGe in this temperature range. The reason for this effect is considered to be anomalous magnetic behavior.

Keywords: magnetostriction, powder diffraction

MS25-P5 Magnetic-crystallographic p,T-phase diagram of $Fe_{1+x}Te$: A high-pressure neutron diffraction study

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The crystal and magnetic structures of $Fe_{1+x}Te$ for x = 0.087 and 0.141 have been studied by neutron powder diffraction in the temperature range from 5 to 170 K at pressures in the range from ≈0.8 to ≈7 GPa. The p,T-phase diagrams of the two $Fe_{1+x}Te$ compounds contain three phases with monoclinic, orthorhombic and tetragonal symmetry. The tetragonal phase with space group *P4/nmm* is stable at ambient conditions as well as at pressures. In the case of $Fe_{1.087}Te$ the monoclinic and orthorhombic phases are both antiferromagnetically ordered and stable at temperatures below ≈69 K while the non-magnetic tetragonal phase is stable above this temperature. The monoclinic phase is stable for $p \lesssim 1.2$ GPa while the orthorhombic phase is stable for $1.2 \lesssim p \lesssim 1.7$ GPa and the tetragonal phase becomes stable at higher pressures at the lowest measured temperatures. The p,T-phase diagrams of $Fe_{1.087}Te$ are shown in Fig. 1. $Fe_{1.141}Te$ shows the same type of p,T-phase diagram as $Fe_{1.087}Te$ although the stability range of the orthorhombic is larger, $0.8 \lesssim p \lesssim 2.3$ GPa. The magnetic ordering is antiferromagnetic bicollinear and commensurate with propagation vector $\mathbf{k}$ = (½ 0 ½) in the monoclinic phase while it is incommensurate with propagation vector $\mathbf{k}$ = (½-δ 0 ½) in the orthorhombic phase. The wave-length of the modulation of the magnetic structure of the orthorhombic phases was found to increase with pressure. The pressure-induced collapse of magnetic order at ≈1.7 GPa in the case of $Fe_{1.087}Te$ is accompanied by an abrupt change in volume and compressibility, suggestive of a spin state change of the Fe^{2+} ions in the FeTe layers. The observed abrupt change in volume and compressibility is presumably related to the earlier observed transition from the tetragonal to a collapsed tetragonal phase at ≈4 GPa at ambient temperature [1].

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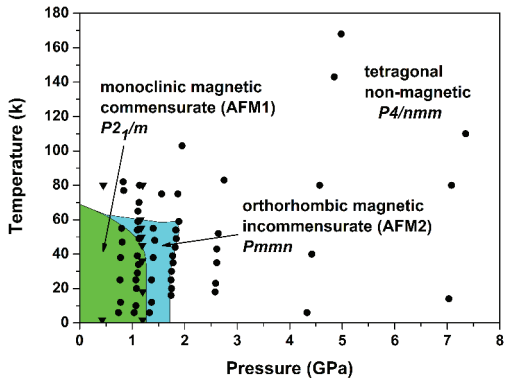

Figure 1. *p,T*-phase diagram of $Fe_{1.087}Te$. The tetragonal *P4/nmm* phase is paramagnetic while the monoclinic *P21/m* and the orthorhombic *Pmmn* phases are magnetically ordered. Experimental data points are marked with ● (this work) and ▼(Ref. 2).

Keywords: Magnetic structure, high-pressure, neutron diffraction

MS25-P6 Magnetic structures in complex materials revealed by resonant soft X-ray diffraction

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With magnetic scattering factors as large as 200 r_0 (classical electron radius) [1], x-ray diffraction using resonant photon energies in the soft x-ray regime provides particular sensitivity to magnetic ordering in transition metals by directly addressing the 3d or 4f electronic states. The corresponding wavelengths are of the order of 1 nm, yielding a rather small Ewald sphere. Notwithstanding, there are a number of important materials that can hardly be studied by other methods. From only one accessible magnetic Bragg peak detailed information about magnetic structures can be obtained, as discussed for a few examples.

Applied to a thin epitaxial film of the simple antiferromagnet EuTe, the method yields magnetic diffraction peaks that exhibit detailed Laue oscillations (Fig. 1). The temperature dependence of these profiles can be analyzed to obtain layer-resolved magnetization profiles [2].

Nickelate superlattices composed of layers of $LaNiO_3$ (LNO) and $LaAlO_3$ (LAO) or $DyScO_3$ (DSO) can be grown with excellent structural quality with varying substrate-induced strain. While bulk LNO is nonmagnetic, dimensionality-driven magnetic order was observed in the superlattices for nickelate layers of 2 unit cells thickness. In addition, by exploiting the polarization dependence of resonant magnetic scattering, strain-dependent spin-moment directions could be determined, paving a way for controlling magnetic order [3].

For bulk crystals of multiferroic $DyMnO_3$, the availability of circular polarized x-rays in combination with the magnetic sensitivity at resonance could be used to determine the chirality of the magnetic structures that are intimately linked to the ferroelectric properties of the material [4].

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