Exchange bias induced suppression of ferroelectric domain switching in multiferroic GeMnTe

H. Przybylińska[1], A. Grochot[1], G. Springholz[2], A. Ney[2], G. Bauer[2], and W. Jantsch[2]

[1] *Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warsaw, Poland*

[2] *Institute for Semiconductor and Solid State Physics, J. Kepler University, Altenbergerstr. 69, A-4040 Linz, Austria*

GeTe doped with manganese is a multiferroic semiconductor, in which ferroelectric and ferromagnetic orders coexist at low temperatures up to the Mn content of 50 %. We have recently demonstrated with use of ferromagnetic resonance (FMR) that in MBE grown GeMnTe layers deposited on (111) BaF_2 substrates the ferroelectric and ferromagnetic moments are coupled to each other, leading to reversal of ferroelectric polarization under relatively low externally applied magnetic fields [1]. In the present study we show that magnetic field induced ferroelectric polarization reversal can be even entirely suppressed in the presence of exchange bias.

We investigated a series of 500 nm thick $Ge_{1-x}Mn_xTe$ layers (with x ranging from 18 to 30 %) grown at exactly the same conditions as those used in Ref. 1 but terminated with a thin Te/Se cap layer to prevent sample degradation (Mn out diffusion and oxidation). In contrast to previous studies where two ferromagnetic resonance signals were observed, corresponding to two ferroelectric domains differing by rotation of oblique $<11\bar{1}>$ axes by 180º around the [111] growth direction, in the capped samples only one dominant FMR signal is observed. Whereas previously the intensities of the FMR signals could be switched between the two domains by appropriate rotation of the magnetic field, in the capped layers no domain switching occurs. Moreover, in all layers a significant (exceeding 300 G at 3 K) internal, unidirectional magnetic field $\mathbf{H}_{int}$ is detected. This field is tilted with respect to the [111] growth axis (which is the easy magnetization direction in the $Ge_{1-x}Mn_xTe$ composition range investigated) with the tilt angle depending on Mn composition and temperature, and points towards the substrate. We attribute $\mathbf{H}_{int}$ to exchange field induced by uncompensated and pinned Mn spins at the interface between the antiferromagnetic MnSeTe cap and ferromagnetic $Ge_{1-x}Mn_xTe$ layers. This assumption is supported by observation of a similar exchange field but oppositely directed (out of the layer surface) for $Ge_{1-x}Mn_xTe$ grown on a 20 nm thick PbEuSe buffer. Also in these samples no domain switching is observed.

In contrast to typical FM/AFM structures, where the direction of the bias field can be set by cooling below the Neel temperature in an applied magnetic field, in the studied samples the exchange field appears spontaneously with no field cooling and its direction cannot be changed with field cooling up to 1 T available in the experimental setup.

Acknowledgement:
Work supported by National Science Centre grant UMO-2014/15/B/ST3/03928.

[1] H. Przybylińska, G. Springholz, R.T. Lechner, M. Hassan, M. Wegscheider, W. Jantsch, and G. Bauer, *Phys.Rev. Lett.* **112**, 047202 (2014).