P30

X-RAY ABSORPTION AND MAGNETIC CIRCULAR DICHROISM ON MnSb LAYERS GROWN BY *MBE*

A. Wolska [1*], K. Lawniczak-Jablonska [1], M.T. Klepka [1], J. Sadowski [1,2], E. Holub-Krappe [3], A. Persson [4], and D. Arvanitis [4]

[1] *Institute of Physics PAS, al. Lotników 32/46, 02-668, Warsaw, Poland*

[2] *Lund University, MAX-Lab, Lund SE-221 00, Sweden*

[3] *Hahn-Meitner Institute, Department of Magnetism, Glienicker Str. 100, D-14109 Berlin, Germany*

[4] *Physics Department, Uppsala University, Box 530, 75121 Uppsala, Sweden*

Keywords: MnSb, EXAFS, XMCD, spintronics

**) e-mail: wolska@ifpan.edu.pl*

Among the compounds which can be used in spintronic applications, these created by introducing ferromagnetic inclusions in a semiconductor matrix seem to be very promising. In order to obtain materials with desired magnetic properties, it is reasonable to start with inclusions with a Curie temperature (T_C), above room temperature. One of the candidate materials is MnSb. It was showed that bulk MnSb has T_C of 587 K and the $Mn_{1-x}Sb_x$ layers grown on GaAs reach a T_C of 620 K [1, 2]. This indicates that MnSb can be a good compound to form ferromagnetic nano inclusions above room temperature.

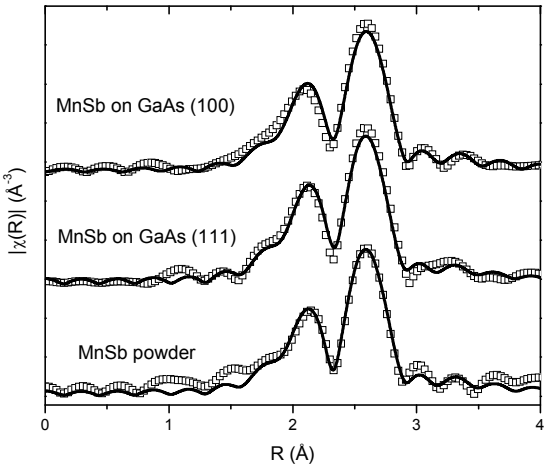

Figure 1. EXAFS spectra of the MnSb samples (squares) and the results of the fitting (full line).

Before establishing the best growth conditions for the new multiphase material, the characterization of thin layers is needed. The MnSb layers were grown on two types of substrates: GaAs(111) and GaAs(100) by MBE. The substrate temperature was about 250°C, the growth rate 20 nm/h. Prior to the MnSb growth the GaAs substrates were subjected to the typical procedure of native oxide desorption and high temperature GaAs buffer growth.

The XANES and EXAFS spectra at the Mn K-edge were measured at Hasylab (A1 station) using a single element germanium fluorescence detector. Additional spectrum of powdered MnSb standard sample was measured in transmission mode. The XMCD spectra at the Mn $L_{3,2}$-edges and Sb $M_{5,4}$-edges were measured at MAX-lab (beamline D-1011). The spectra were collected in the total electron yield mode with the samples remanently magnetized.

Table 1. Results of fitting MnSb layers on GaAs (111) and GaAs (100) together with the powder MnSb reference sample.

	powder	on GaAs (111)	on GaAs (100)
N_{Sb}	[6]	5.7 ± 0.7	5.6 ± 0.7
N_{Mn}	[2]	2.7 ± 0.6	2.2 ± 0.6
R_{Sb}	2.77 ± 0.01	2.76 ± 0.01	2.76 ± 0.01
R_{Mn}	2.84 ± 0.02	2.84 ± 0.02	2.84 ± 0.03

The Artemis and Athena programs [3], using the IFEFFIT data analysis package, were used for the analysis of the EXAFS data. The Fourier transforms of the EXAFS data show that the local surrounding of the Mn atoms up to 3 Å in thin layer samples resembles that of the MnSb powder sample (Fig. 1), although, they differ in details. Table 1 presents the results of the simultaneous fitting of all spectra, where the numbers of nearest neighbours for the powder sample were fixed according to the known crystallographic data. This helped to determine the amplitude reduction factor which was used in fitting the thin layer samples, in order to determine the number of nearest neighbors. The obtained results confirmed that the investigated layers consist of MnSb compound but can slightly differ in the number of defects or stoichiometric ratio.

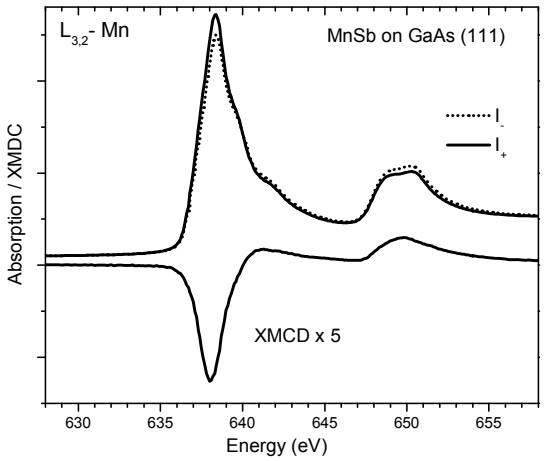

Figure 2. Dichroic XAS and XMCD spectra of the MnSb on GaAs (111) sample recorded at 100 K.

The dichroic signal obtained at 100 K was almost identical for both samples. An example of XMCD data is presented in Fig. 2. For the room temperature measurements, the XMCD signals were around two times weaker and showed slight differences between the samples. The shape of the signal agreed with those showed in Ref. 4. However, the absorption spectra show a smaller difference in the intensity between both polarizations. This can be due to the fact that the spectra presented in Ref. 4 were gathered with the samples under an applied magnetic field of 1.1 T, and not in remanence like in our case.

In conclusion, the EXAFS analysis confirmed that the local structure around Mn atoms is similar for both investigated layers and close to the one of MnSb. The XMCD signals of the samples show small differences in intensity at room temperature, an effect which disappears at 100 K. What's more, the XMCD at Sb $M_{5,4}$-edge is also visible and shows a similar temperature dependence.

Acknowledgements: This work was partially supported by national grant of Ministry of Science and High Education N202-052-32/1189 as well as by DESY/HASYLAB, MAX-lab (EC support program: Transnational Access to Research Infrastructures) and the European Community under Contract RII3-CT-2004-506008 (IA-SFS).

References

[1] A.F. Panchula, C. Kaiser, A. Kellock, S.S. Parkin, "Spin polarization and magnetotransport of Mn–Sb alloys in magnetic tunnel junctions", *Appl. Phys. Lett.* **83** (2003) 1812-1814.

[2] H. Akinaga, K. Tanaka, K. Ando, T. Katayama, "Fabrication and magneto-optical properties of epitaxial ferromagnetic $Mn_{1-x}Sb$ thin films grown on GaAs and sapphire", *J. Cryst. Growth* **150** (1995) 1144-1149.

[3] B. Ravel, M. Newville, "ATHENA, ARTEMIS, HEPHAESTUS: data analysis for X-ray absorption spectroscopy using IFEFFIT", *J. Synchrotr. Rad.* **12** (2005) 537-541.

[4] A. Kimura, S. Suga, T. Shishidou, S. Imada, T. Muro, S. Y. Park, T. Miyahara, T. Kaneko, T. Kanomata, "Magnetic circular dichroism in the soft-x-ray absorption spectra of Mn-based magnetic intermetallic compounds", *Phys Rev. B* **56** (1997) 6021-6030.