STRUCTURAL CHARACTERIZATION OF Mn^+ ION-IMPLANTED GaSb

J. Bak-Misiuk [1*], E. Dynowska [1], P. Romanowski [1], A. Kulik [2], and W. Caliebe [3]

[1]*Institute of Physics, PAS, al. Lotnikow 32/46, PL-02668 Warsaw, Poland*

[2]*Maria Curie-Sklodowska University, pl. M. Curie-Sklodowskiej 5, PL-20031 Lublin, Poland*

[3]*HASYLAB at DESY, Notkestr. 85, D-22603 Hamburg, Germany*

Keywords: GaSb, implantation, spintronics, X-ray, diffraction

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

Synthesis of ferromagnetic nanoclusters embedded in semiconductor matrix is of particular interest for potential application in spintronics. Due to high Curie temperature of MnSb (580 K), granular GaSb:MnSb may be interesting material for spintronic application.

The formation of Mn-based nanoclusters by ion implantation and subsequent annealing is a relatively simple technique if compared to the growth of diluted magnetic semiconductors by epitaxial method, with an advantage to control the relative Mn density. However, up to know, there are no papers concerning MnSb inclusions formed in GaSb by implantation.

Two sets of Mn^+-implanted GaSb crystals prepared by implantation at energy E = 150 keV and dose $D = 9\times10^{14}cm^{-2}$ were investigated.

For first set of samples implantation was performed at liquid nitrogen temperature. Before implantation, the samples were pre-implanted with He^+, Ne^+, or $He^+ + Sb^+$. The pre-implantation with above mentioned ions was carried out at such conditions, that their project ranges (R_p) were equal or near R_p for Mn^+ (94.7 nm). After implantation the samples were annealed face to face in Ar atmosphere for 5 min. at 620 K and next at 920 K for 10 min.

In the case of second set of samples, Mn^+ implantation was carried out at 340 K and 470 K. Next the samples were annealed at 620 K for 30 min. just in the implanter chamber.

Post-implanted structure investigation of the samples was carried out using synchrotron X-ray diffraction. The crystallographic orientation of inclusions in respect to the GaSb surface, as well as, the phase analysis of the near surface polycrystalline layers, were performed using the 2θ-ω and 2θ scans in glancing incidence geometry, respectively.

The diffraction patterns measured in these two modes are presented in Figs. 1 and 2. The high intensity peaks detected on the 2θ-ω scans, for both sets of samples, come from the GaSb bulk crystals. For all the samples, prepared by implantation at liquid nitrogen temperature, the diffraction peaks from polycrystalline Sb, MnO_2 and GaSb, as well as, single crystalline inclusions of MnSb, were detected (Fig. 1).

For the samples prepared by implantation at 340 K or 470 K, the polycrystalline phase from GaSb was detected only. An analysis of the 2θ-ω pattern suggests the creation of hexagonal MnGaSb inclusions with well-defined orientation. This effect deserves further research.

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 (EC support program: Transnational Access to Research Infrastructures) and by the European Community under Contract RII3-CT-2004-506008 (IA-SFS**).**

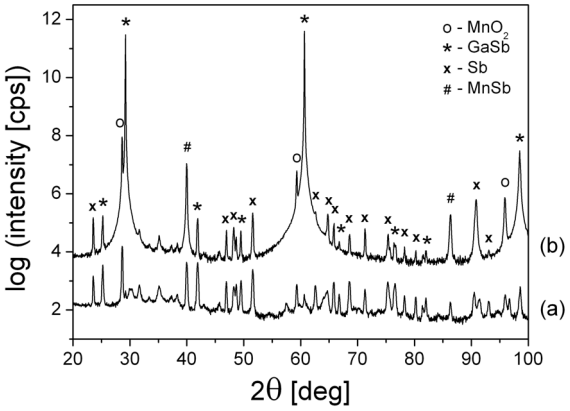

Figure 1. 2θ in glancing incidence geometry (a) and 2θ-ω (b) scans for GaSb sample implanted with He^+ and Mn^+ at liquid nitrogen temperature.

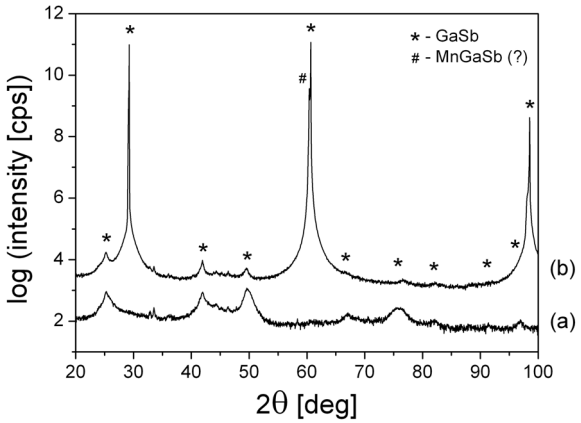

Figure 2. 2θ in glancing incidence geometry (a) and 2θ-ω (b) scans for GaSb sample implanted with Mn^+ at 470 K.