DEFECT STRUCTURE OF GaMnSb GROWN ON GaAs SUBSTRATE

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Ferromagnetic semiconductors have recently focused much interest since they hold out prospects for using electron spin in electronic devices. A possible way to yield such materials is producing of inclusions in a semiconductor matrix [1]. It has been shown that bulk MnSb has T_C of 587 K [2, 3], therefore it can be a good candidate to form nanoinclusions, ferromagnetic above room temperature.

We report the results concerning the defect structure and strain state of the $Ga_{1-x}Mn_xSb$ layer grown by MBE method on the GaAs(111) A substrates, with thin GaSb buffer layer, for various Mn concentration, x = 0.01, 0.06, 0.08. Secondary Ion Mass Spectroscopy (SIMS, Cameca 5F) was applied to determine the concentration of elements in the layers. To prepare the multiphase material the temperature of substrate during layer growth was equal to 770 K. Microscopic nature of the MnSb phase was studied by scanning electron microscopy (SEM).

Structural characterization of the layers was carried out by X-ray diffraction method using standard laboratory source or synchrotron radiation at the DESY-Hasylab at the F1, E2 and W1.1 experimental stations. The lattice parameter and strain state of samples were studied applying the X-ray high–resolution diffractometer. The strain state of the layers was determined from the in-plane and out-of-plane lattice parameters and from reciprocal space mapping made for the symmetrical and asymmetrical reflections. Two modes of diffraction measurement were applied with synchrotron radiation: the symmetrical ω-2θ and complanar 2θ scans in the glancing incidence geometry. Such measurements allow to detect the lattice planes of the layers parallel to the crystallographic orientation of the substrate and to obtain information concerning polycrystalline inclusions.

The $2\theta/\omega$ scan performed for $Ga_{0.99}Mn_{0.0}$·Sb/GaAs is presented in Fig. 1. The main diffraction peaks, observed for the layers grown on (111) GaAs, were indexed as 111 GaMnSb. Three phases: MnSb, Mn_2Sb and Mn_2O_3 were found also. For this sample no diffraction peaks originating from polycrystalline inclusions were also found.

SEM studies reveal the presence of isolated MnSb clusters with typical lateral dimension 200-600 nm.

White and monochromatic synchrotron topographs in the Bragg case geometry were made, but no misfit dislocations were detected.

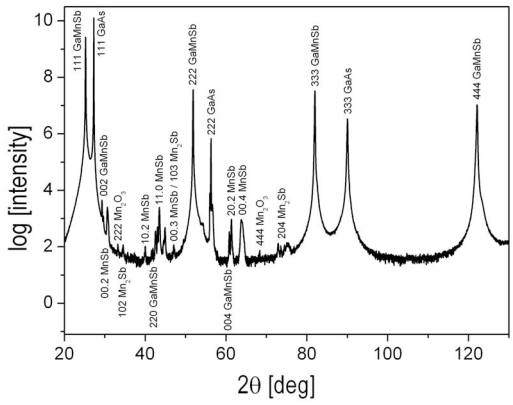

Figure 1. 2θ-ω X-ray diffraction pattern of $Ga_{0.99}Mn_{0.01}$·Sb grown on GaAs(111)A substrate.

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References

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