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Ferromagnetic Property in MnSb Grown by Molecular Beam Epitaxy

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Mn-doped III-V compounds are the most promising materials for spintronics applications because they show ferromagnetism at a relatively higher temperature. The result showed that the NiAs structure is more stable than the zinc-blende structure for MnSb has large magnetic moments with nearby half-metallic behavior [1]. In this study, the magnetic and structural investigation has been made on MnSb thin film. A single phase of MnSb was successfully grown on a Si (100): B substrate by using molecular beam epitaxy (MBE). Thin film has been grown on Si (100): B by codeposition of pure Mn and Sb in ultra high vacuum by using effusion cells. The XRD pattern for MnSb film on Si (100): B, showing the peaks of a single phase Ni-As-hexagonal type structure. Vibrating sample magnetometer (VSM) measurement showed that the MnSb film is clearly ferromagnetic at room temperature as shown in Fig. 1. The temperature dependence of magnetization measured from 50 K to 700 K by VSM. The Curie temperature (T_C), which is defined as temperature of the maximum slope in dM/dT, is determined to be 620 K. From 50-300 K, the resistivity increases with temperature for MnSb film, implying metallic behavior.

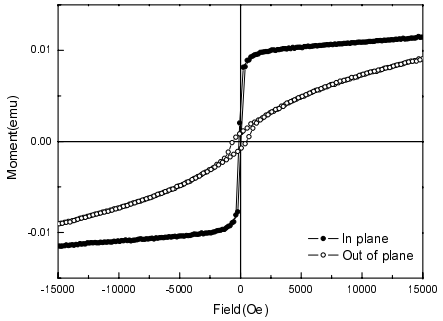

Fig. 1. Hysteresis loop of MnSb/Si(100) at room temperature.

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Enhanced Magnetoresistance of Diluted Mn-doped Ge by Annealing in Oxygen

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Giant magnetoresistance (*MR*) of Mn-doped Ge has been reported recently, which originated from interaction between clusters embedded in the diluted magnetic semiconductors, DMSs, matrix such as $Mn_{11}Ge_8$, Ge_2Mn, or pure Mn [1-3]. Furthermore, the Curie temperature can be increased by thermal annealing due to the transition from interstitial Mn to substitutional Mn [3].

In this work, we report the enhancement of MR of diluted Mn-doped Ge with Mn amount of around 1.38% mole after thermal annealing under oxygen. A negative *MR* of around -0.12% at 20K was shown for as-grown samples. After thermal annealing under oxygen environment at 600°C, the *MR* has negative value at low temperature and changed to positive value of ~45% at high temperature. The temperature dependent *MR* can be explained by nanoscale hybrid structure [4]. The maximum ratio of *MR* at 45K suggests the interaction of Mn_3O_4 clusters with DMSs ferromagnetic matrix. The cluster Mn_3O_4 may be generated by reaction of interstitial Mn with oxygen when samples were annealed. The evident anomalous Hall hysteresis up to 220K indicated enhanced magnetic moment which contributes to intensify spin dependent scattering. The Curie temperature was enhanced after annealing under oxygen. Hall effect measurement indicated two phase transitions: antiferromagnetism to ferromagnetism at low temperature and ferromagnetism to paramagnetism at high temperature. The similar behavior has been reported by Cho et al. for Mn-doped Ge bulk samples [5].

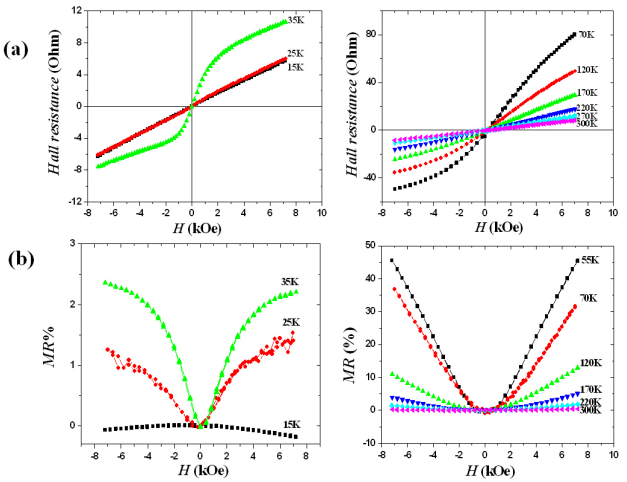

Fig. 1. Transport data of 1.38% Mn-doped Ge: (a) Hall resistance as the function of magnetic field, and (b) magnetic field dependent *MR* at selected temperatures of post annealing samples at 600°C under oxygen for one hour.

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