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Magnetotransport properties of (Ga,Mn)Sb channel in field-effect structures

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Magnetism of hole-induced ferromagnetic semiconductors can be controlled by the application of gate electric fields E_G through the modulation of hole concentration p [1,2]. For (Ga,Mn)As, it was reported that the relationship between p and the Curie temperature T_C is given by $T_C \propto p^{\gamma}$ with $\gamma \sim 0.2$, where p was changed by the application of E_G. The value of $\gamma \sim 0.2$ was shown to be explained by the adapted *p-d* Zener model with nonuniform hole distribution along the growth direction resulted from the presence of the interface depletion layer as well as the application of E_G [3,4].

We have investigated magnetotransport properties of thin (Ga,Mn)Sb layers in field-effect structures. Four 5 nm-thick (Ga,Mn)Sb layers are grown by low-temperature molecular beam epitaxy onto a buffer layer consisting of 5 nm GaSb/300 nm $Al_{0.80}Ga_{0.20}Sb$/10 nm AlSb (from the surface side) on a semi-insulating GaAs (001) substrate [5,6]. We fabricate field-effect structures with a Hall-bar geometry with a 40 nm-thick Al_2O_3 gate insulator formed by atomic layer deposition. We measure Hall and sheet resistances (R_{sheet} and R_{Hall}) under gate electric fields $|E_G|$ up to 5 MV/cm and magnetic fields up to $|\mu_0 H|$ = 0.5 T. We determine p from the E_G dependence of R_{sheet} and T_C from R_{Hall} by making the Arrott plots. We obtain $\gamma \sim 1$ for (Ga,Mn)Sb, which is several times larger than that for (Ga,Mn)As. The result can be reproduced by adapted *p-d* Zener model with accumulation of holes at the interface of (Ga,Mn)Sb and gate insulator, opposing to depletion for (Ga,Mn)As. The hole accumulation at the interface is consistent with the Fermi energy pinning position of p-GaSb at the interface [7].

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