

Effect of Bi doping on the magnetic properties of (In,Fe)Sb ferromagnetic semiconductor

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Ferromagnetic semiconductors (FMS) are materials that possess the properties of both semiconductors and magnetic materials by doping magnetic atoms to semiconductor host. They have characteristics not found in conventional semiconductors, such as anomalous Hall effect (AHE). Recently, we have developed Fe-doped FMSs, such as (In,Fe)As, (Ga,Fe)Sb, and (In,Fe)Sb, which show Curie temperature (T_C) higher than room temperature [1-3]. Furthermore, T_C tends to increase with lowering the band gap [4]. Among them, (In,Fe)Sb has the smallest band gap, highest Curie temperature (385 K), and large AHE with possible applications to high sensitive Hall sensors [5].

In this work, we studied the effect of Bi doping on the magnetic properties of (In,Fe)Sb. Fig.1(a) shows the sample structure, which consists of InSb (2 nm) / $(\text{In}_{1-x}\text{Fe}_x)(\text{Sb}_{1-y}\text{Bi}_y)$ (20 nm) / AlSb (10 nm) deposited by molecular beam epitaxy on c-plane sapphire substrates. The 20 nm-thick $(\text{In}_{1-x}\text{Fe}_x)(\text{Sb}_{1-y}\text{Bi}_y)$ thin film was uniformly doped with Fe atoms at $x = 16\%$ and Bi at $y = 1 \sim 5\%$. Fig. 1(b) shows the reflection magnetic circular dichroism (MCD) spectra of (In,Fe)(Sb,Bi) samples with Bi concentrations of $y = 0\%$ and 3% , measured at 5 K under a magnetic field of 10 kOe. Although the MCD spectra show red-shift of the E_1 peak due to the large tensile strain effect from the sapphire substrate, they have a similar spectral shape, indicating that (In,Fe)(Sb,Bi) is an intrinsic FMS. Fig. 1(c) shows the change of T_C with increasing the Bi concentration, estimated from the Arrott plots of MCD intensity vs magnetic field characteristics. T_C tends to decrease with increasing the Bi doping concentration, which is against expectation since doping Bi reduces the bandgap.

References:

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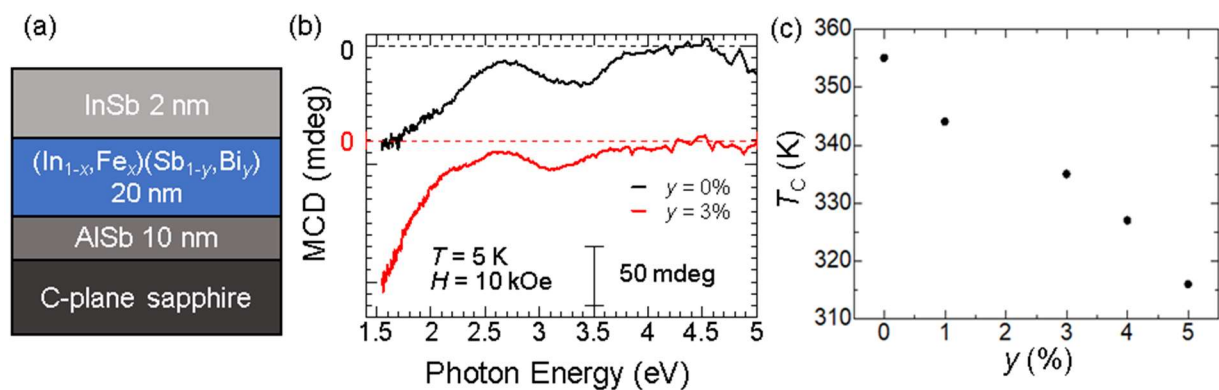


Fig. 1. (a) Schematic structure of our samples. (b) Reflection MCD spectra of $(\text{In}_{1-x}\text{Fe}_x)(\text{Sb}_{1-y}\text{Bi}_y)$ samples with $x = 16\%$, $y=0$ and 3% measured at 5 K. (c) Curie temperature T_C vs. Bi doping concentration y .