

p 型強磁性半導体 (Ga,Fe)Sb の電子構造: 価電子帯と不純物帯

Electronic structure of p -type ferromagnetic semiconductor (Ga,Fe)Sb:

Valence band and impurity band

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Ferromagnetic semiconductors (FMSs) are alloy semiconductors in which cations are partially replaced by magnetic impurities. FMSs have both the properties of ferromagnets and semiconductors and exhibit carrier-induced ferromagnetism, thereby attracting much attention as promising materials for semiconductor spintronics devices because one can control their magnetic properties by changing the carrier concentration. However, the Curie temperature (T_C) of III-V based FMSs was much lower than room temperature (RT) despite tremendous efforts for the past two decades. Recently, Tu *et al.*, have successfully grown p -type (Ga,Fe)Sb whose T_C is higher than RT [1,2]. Magnetic circular dichroism (MCD), magnetotransport, and magnetization measurements indicate that (Ga,Fe)Sb is an intrinsic ferromagnetic semiconductor [1,2].

Characterizing the valence-band (VB) structure, including the heavy hole (HH), light hole (LH) and split-off (SO) band, and the Fe $3d$ -related impurity band (IB) in (Ga,Fe)Sb is indispensable for unveiling the origin for the high- T_C ferromagnetism above RT. We conducted soft x-ray angle-resolved photoemission spectroscopy (SX-ARPES) measurements on $(\text{Ga}_{1-x}\text{Fe}_x)\text{Sb}$ with $x = 0.05$ and GaSb thin films to reveal the band structure. Based on the ARPES results, the VB band structure (HH, LH, and SO bands) of (Ga,Fe)Sb is similar to that of GaSb. Furthermore, we performed resonant ARPES (r-ARPES) at the Fe L_3 absorption edge and found that the Fe $3d$ -related IB is located on the Fermi level (E_F). The Fe $3d$ partial density of states (DOS) weakly depends on the wave number (k), suggesting that the IB hybridizes with the GaSb bands. In this talk, we discuss the origin of the RT ferromagnetism of (Ga,Fe)Sb by comparing the present results with the SX-ARPES results of (Ga,Mn)As [3].

References

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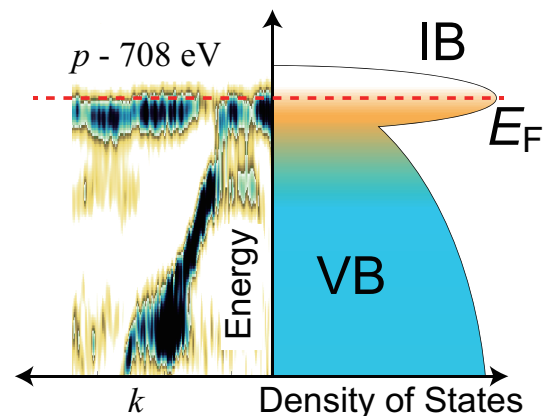


Fig. 1 : Schematic illustration of the DOS (right) and the VB and IB dispersion measured by resonant ARPES taken at a photon energy of 708 eV with p -polarization on $(\text{Ga}_{1-x}\text{Fe}_x)\text{Sb}$ with $x = 0.05$ (left).