Fe concentration dependence of the Fe 3*d* electronic states in p-type ferromagnetic semiconductor (Ga_{1-x},Fe_x)Sb

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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 temperatures (T_C) of III-V based FMSs were much lower than room temperature (RT) despite tremendous efforts for the past several decades. Recently, Tu *et al*., have successfully grown p-type (Ga_{1-x},Fe_x)Sb whose T_C is higher than RT [1-3]. Magnetic circular dichroism (MCD), magnetotransport, and magnetization measurements indicate that (Ga_{1-x},Fe_x)Sb is an intrinsic ferromagnetic semiconductor [1-3].

Knowledge of the Fe 3*d* electronic states in (Ga_{1-x},Fe_x)Sb is indispensable for unveiling the origin for the high-T_C ferromagnetism above RT. Using angle-resolved photoemission spectroscopy (ARPES), we have found that the ferromagnetism in (Ga_{1-x},Fe_x)Sb originates from double-exchange interaction [4]. In this study, we have conducted resonant photoemission spectroscopy (RPES) measurements at the Fe L_3 absorption edge on (Ga_{1-x},Fe_x)Sb thin films with x = 0.05, 0.15, and 0.25 to reveal the Fe concentration dependence of the Fe 3*d* states. By analyzing the RPES spectra, the Fe partial density of states (PDOS) can be decomposed into several components (α, γ, and impurity band), as shwon in Fig. 1. The results are consistent with the picture of double-exchnage mechanism [5]. Based on the observations, we have found that the Fe-3*d* states in the vicinity of the Fermi level owes to the high-T_C ferromagnetism in (Ga_{1-x},Fe_x)Sb.

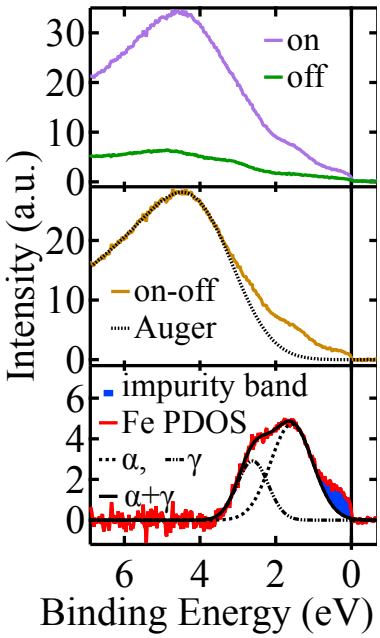

Fig. 1： Decomposition analyses of RPES spectra of ($Ga_{0.85}$,$Fe_{0.15}$)Sb by using symmetric and asymmetric Gaussian functions.

References
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