p 型強磁性半導体(In, Mn)As の不純物バンド及び価電子帯構造

Impurity Band and Valence Band Structure of p-type Ferromagnetic Semiconductor (In,Mn)As

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III-V ferromagnetic semiconductors (FMSs) are alloy semiconductors where the cations are partially replaced with magnetic impurities, and have been attracting much attention due to carrier-induced ferromagnetism (FM) which allows us to control both the charge and spin degrees of freedom. P-type (In,Mn)As is one of III-V FMSs showing hole-induced FM [1]. In order to use (In,Mn)As for spintronics devices, it is necessary to clarify the origin of FM. Although several models of FM have been proposed so far (e.g., [2, 3]), the mechanism of FM has been still under discussion [4, 5]. To understand the origin of FM, it is important to unveil the electronic band structure including the Mn 3*d* impurity band (IB) [6, 7].

In this study, we have performed angle-resolved photoemission spectroscopy (ARPES) with soft X-ray in order to observe the electronic structure of p-type (In,Mn)As. Soft X-ray ARPES reveals that the band structures are composed of the *s,p* bands of host InAs and IB from Mn impurities. Figure 1 shows the valence band (VB) dispersion and Mn IB near the Fermi level. The top of the VB is located near the Fermi level, consistent with the p-type nature of (In,Mn)As, and the Mn IB shows a peak below the VB maximum. By comparing these observations with previous ARPES measurements in (Ga,Mn)As [6] and in (In,Mn)As [7], we discuss the origin of FM in (In,Mn)As.

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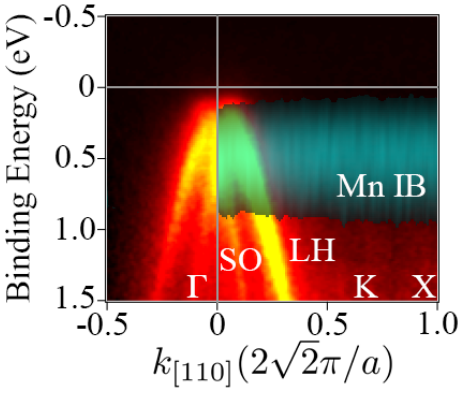

FIG. 1. Band dispersion along the Γ-K-X cut and the Mn 3*d* IB. LH, SO and IB denote the light-hole, split-off and impurity bands, respectively.