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Probing the Electronic Band Structure of Altermagnetic MnTe: An ARPES Study

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Altermagnetism is a recently recognized type of magnetism with vanishing net magnetization and a time-reversal symmetry broken electronic structure and have attracted much interest for their distinct magnetic characteristics and prospective applications [1]. As a canonical altermagnetic material, MnTe has garnered a lot of interest recently [2-6]. MnTe with a hexagonal NiAs-type structure is one of the few semiconductors among the 3d transition-metal compounds [3,4].

In this study, we investigated the electronic band structure of the hexagonal MnTe (0001) bulk single crystal using polarization dependent angle-resolved photoemission spectroscopy (ARPES). The samples were prepared by mixing stoichiometric amounts of finely powdered Mn and Te and sealed in evacuated quartz ampoule at 10^{-5} pa. We grew MnTe single crystal by solid reaction method and cut it to exhibit the (0001) plane. For getting clean surface we sputtered and annealed the sample. We used 2kV beam energy for sputtering and annealing temperature was 330 degree Celsius. By repeated cycles of sputtering and annealing, we could finally get a clean surface. The impurity of the surface was checked by the Auger electron spectroscopy and the long-range order was confirmed by the sharp hexagonal low-energy electron diffraction (LEED) spots. The polarization dependent ARPES experiments were done on HiSOR BL-9A equipped with an ASTRAIOS electron analyzer. We set the photon energy at 40 eV and the temperature at 200K. The polarization direction of the incident light was controlled by the undulator magnets configuration.

Figs. 1(a) and 1(b) show the k_x-k_y ARPES intensity map at the chemical potential taken with the s- and p-polarization geometries, respectively. Although MnTe is a semiconductor, due to the intrinsic hole doping, the chemical potential is located below the top of the valence band. The photoemission intensity is much intense taken at the s-polarization geometry indicating that the electron wave functions are odd with respect to the mirror plane. It indicates the observed valence bands are derived from Mn $3d_{xy}$, Mn $3d_{yz}$, and Te $5p_y$ states. The spectral intensity is strong around the $\bar{\Gamma}$ point and the ARPES intensity map along the $\overline{\Gamma K}$ direction in Fig. 1(c) suggests an existence of hole-like bands, which is consistent with the band-structure calculations [5,7]. The ARPES intensity mapping at the chemical potential in Fig. 1(a) is compatible with the hexagonal (0001) surface.

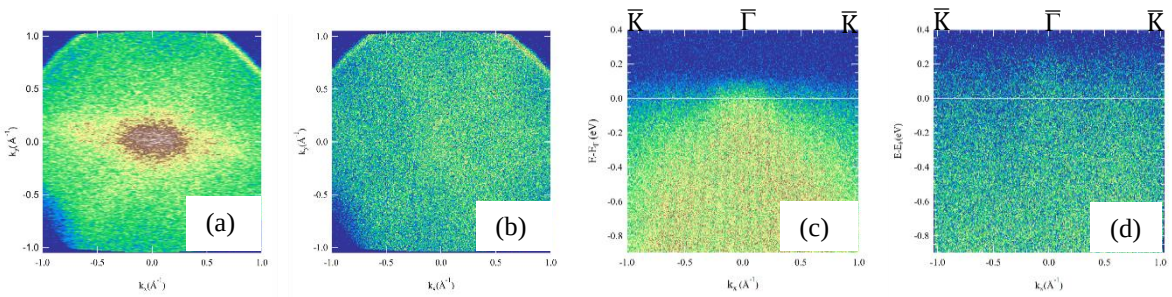

FIGURE 1. High-resolution ARPES results on MnTe (0001) single crystal taken at 200K and hν=40 eV. k_x-k_y mapping at the chemical potential with the s-polarization (a) and p-polarization (b) geometries. ARPES intensity map along the $\overline{\Gamma K}$ high symmetry line with the s-polarization (c) and p-polarization (d) geometries.

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