# Recent progress in the study of magnetic topological insulators of the $MnBi_2Te_4$-family by photoemission spectroscopy

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Representing almost a quarter of the materials known in nature, materials with topologically nontrivial electronic structure naturally attract considerable interest of condensed matter researchers. A special group among them are materials classified as magnetic topological insulators, which are defined by the coexistence of magnetism and the topological electronic structure in one compound [1]. This enables the realization of advanced quantum transport phenomena, including the quantum anomalous Hall effect, and, potential, the realization of Majorana particles, which could lead to the creation of topologically protected qubits for use in quantum computers.

Currently, the most promising in regard to practical application are magnetic topological insulators belonging to the $MnBi_2Te_4$-family [1,2]. The parent material of the family, $MnBi_2Te_4$, has a layered structure consisting of septuple-layer blocks [Te-Bi-Te-Mn-Te-Bi-Te] connected by van der Waals forces. It is characterized by the A-type antiferromagnetic interaction of magnetic moments of Mn atoms, which allows for the $Z_2$ topological classification of this compound [2]. A distinctive feature of the electronic structure is the presence of topological surface states within a bulk band gap, manifested as a Dirac cone with the band gap at the Dirac point, which is observable at temperatures below the Neel temperature ($T_N$ = 25 K for $MnBi_2Te_4$) [3]. The layered structure of $MnBi_2Te_4$ allows the incorporation of blocks exhibiting the same crystal symmetry, such as [$Bi_2Te_3$] block, between [$MnBi_2Te_4$] blocks, thereby modifying the electronic and magnetic properties [4]. Furthermore, element-by-element substitution of Mn, Bi, Te into appropriate elements is an effective method for controlling of the $MnBi_2Te_4$'s physical properties. For instance, Mn can be substituted with Ge, Sn, or Pb; Bi with Sb; and Te with Se [5]. Since the first works devoted to $MnBi_2Te_4$, significant progress has been made in the investigation of the electronic properties of $MnBi_2Te_4$-family compounds, with the active use of photoemission methods. However, a number of properties, including the band gap at the Dirac points, the presence and size of which determines the efficiency of quantum transport, have been found to be significantly smaller than predicted by theory [6]. Currently, efforts are being made to optimize the composition of the material with the aim of reducing the number of defects and modifying the transport and electronic properties.

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