THE INTERFACES OF BISMUTH-ANTYMONY BICRYSTALS: POTENTIAL APPLICATIONS OF DEVICES BASED ON THEM

F. M. Muntyanu[1,2*], A. Gilewski[2], A.J. Zaleski[3], V. Chistol [4], and K. Rogacki[2,3]
[1]*Ghitsu Institute of Electronic Engineering and Industrial Technologies, Academy of Sciences of Moldova, Chisinau, Republic of Moldova;*
[2] *International Laboratory of High Magnetic Fields and Low Temperatures,Wroclaw, Poland;*
[3] *Institute of Low Temperatures and Structural Research, Polish Academy of Sciences, Wroclaw, Poland;*
[4]*Technical University of Moldova, Chisinau, Moldova*
*E-mail: muntean_teodor@yahoo.com

The $Bi_{1-x}Sb_x$ (0 < x < 0.2) alloy system has long been studied in detail because of remarkable low-temperature properties and unique thermoelectric features below room temperatures. Recent investigations of these alloys have highlighted some important topics: first experimentally observed 3D Z_2 topological insulator, possible revelation of a three-dimensional Dirac semimetal, charge quantum Hall fractionalization, etc., which greatly expanded the field of application of these materials. Very interesting opportunities are foreseen when using bulk and low-dimensional combined structures of these materials because of large possibilities of studying various phenomena due to specific manifestations of Dirac electrons, Majorana excitations in the presence of magnetic fields, and unveiling novel effects with respect to spin and charge transport. In this context the bicrystals of 3D topological insulator Bi-Sb can play a special role given that the small crystallite disorientation angle (SDA) interfaces, which consist of a solitary central part (thickness of about 60 nm) and two similar adjacent layers (~20 nm) on both sides of it, exhibit two superconducting transitions with critical temperature T_c ~ (3.7 - 4.6) K and T_c ~ (8.3 – 21) K, while large crystallite disorientation angle (LDA) interfaces with a higher structural disorder show simultaneously ferromagnetic hysteresis loops and brings out specific characteristics of single superconducting layer with T_c ~ (3.7 - 4.6) K of the thickness comparable with the entire interface [1, 2]. Comparison the data on different disorientation angle interfaces we has revealed that the most significant changes occur in the higher superconducting critical temperature phase, where structural disorder in SDA interfaces considerable reduces T_c and generates weak ferromagnetic regions interacting with superconductivity. So, it prefigures a vast ability to manipulate the superconducting and magnetic states at crystallite interfaces by use the proximity effect and varying the spin splitting of the density of states which arises from the effect of magnetic field or the exchange field of a ferromagnetic insulator. In this regard, the crystallite interfaces as superconductor/ferromagnetic hybrid structures may exhibit the large thermoelectric effects, generation and propagation of highly spin polarized current. The potential development and applications of the devices based on interplay between superconductivity and weak magnetism in interfaces of 3D topological insulator $Bi_{1-x}Sb_x$ (0 < x < 0.2) such as spin-injection devices, superconductor/ferromagnet hybrid structures, thermoelectric devices will discuss.

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