Hydrostatic pressure induced band inversion in $Pb_{1-x}Sn_xSe$ substitutional alloys

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It has been shown theoretically and experimentally that topologically protected surface states appear in prototypical topological crystalline insulator SnTe [1,2]. These states are inevitably related to relativistic effects of bulk band theory and specific mirror symmetry of crystal unit cell. The energy gap in rock-salt SnTe is located at four equivalent L points of Brillouin zone and conduction and valence bands are in inverted order with respect to PbTe. In consequence, the $Pb_{1-x}Sn_xTe$ substitutional alloy exhibits gap closure and opening as a function of composition x [3], which in turn is equivalent to transforming system from topologically trivial to nontrivial band ordering.

Analogous situation takes place in $Pb_{1-x}Sn_xSe$. For a given composition x, band inversion can be reached either by temperature or pressure [4]. Here we report on transport study of two bulk $Pb_{1-x}Sn_xSe$ (x=0.14, x=0.20) monocrystals obtained by self selecting vapour growth method. The composition x=0.14 was chosen in order that the energy gap (E_g) does not vanish as a function of temperature but pressure only. On the other hand, the composition x=0.20 allows E_g=0 condition to be fulfilled by lowering temperature and applying pressure as well. Both samples were investigated in temperatures ranging from 4.2 K to 300 K and hydrostatic pressures up to 10 kbar. Each time the low-field Hall constant and Hall mobility were measured. The mobility data vs pressure and temperature were analysed within nonparabolic two-band Kane model [3] considering energy dependent relaxation time approximation for various scattering modes [5].

Work supported in part by the Polish National Science Centre Grant No. 2012/07/B/ST3/03607

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