Bi_2Te_2Se – promising material for topological insulators.

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Among Bi_2X_3 family compounds Bi_2Te_2Se crystals are the most promising material for topological insulators. These ternary crystals have a layered structure with the atoms layers sequence of: Te - Bi - Se - Bi - Te. They are characterized by high resistivity at low temperatures around 10K $\rho > 1\ \Omega$cm, [1,2] much higher than crystals of binary compounds as Bi_2Se_3 and Bi_2Te_3 - ($\rho \sim 10^{-3}\ \Omega$cm).

Bi_2Te_2Se is obtained by phase transformation in the solid state, which occurs as a result of long time heating the mixture of binary compounds Bi_2Se_3 + Bi_2Te_3 at a specific temperature [3,4,5].

The mixture is formed by Bi_2Te_3 – '*p* – type' material which properties are determined by high concentration of acceptor defects Bi_{Te} ($p = 2 \times 10^{19} cm^{-3}$) and Bi_2Se_3 – '*n*- type' material which properties resulting from the high concentration of donor defects V_{Se} ($n = 2 \times 10^{19} cm^{-3}$).

The resulting new structure quintuples has the following advantages over the binary compounds Bi_2Te_3 and Bi_2Se_3 [1].

- Generation of V_{Se} defects is suppressed because Se atom trapped between Bi atoms is less exposed to evaporation due to its stronger chemical binding with Bi,
- Formation of the anti-site defects is also suppressed because of the stronger bond between the Se - Bi than Te - Bi,
- Nature of bonds minimizes the additional disorder caused by random impact of Se / Te.

In this work we applied Vertical Bridgman technique (VB) for crystal growth. Crystallization was carried out for the charges compositions of a different ratio of Se / Te : $Bi_2\ Te_{1.95}\ Se_{1.05}$ to $Bi_2\ Te_{2.2}\ Se_{0.8}$. As the optimum composition Se $\approx$ 1.00 - 1.05 was determined. Specified conditions of heat treatment, resulting in the obtaining of crystals with resistivity $\rho \sim 7.5\ \Omega$cm at 10 K. After annealing under conditions of 500 °C/520h, we observe transition of conductivity type from *n* to *p*. Measurements of resistivity vs T have proved semiconductor behavior from the temperature $T \leq 200$ K. The crystals were characterized by the following methods: Hall measurements in the temperature range 300K – 8K, Scanning Electron Microscopy (SEM), Energy Dispersive X– ray Spectroscopy (EDS), Secondary Ion Mass Spectroscopy (SIMS).X-ray Difractometry (XRD)

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