TEMPERATURE-INDUCED EFFECTS AT Bi2Te3 SURFACE

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The bismuth telluride belong to the materials with the properties of 3D topological insulators (TI). The typical TIs have semiconducting properties in their volume, while the surface layers remain conductive. At the interface between TI and trivial insulator (e.g. vacuum), the bulk energy gap is closed by surface metallic states with linear dispersion relation (Dirac states). The practical use of these topological properties requires the fine tuning of the Fermi level with respect to gap in bulk electronic states. Except doping with foreign elements [1] or making   
a non-stoichiometric materials [2], this tuning might be also achieved by near-surface defects agglomeration or by creation of defects, as a result of thermal treatment of the sample. Therefore, the aim of our contribution is to determine the influence of thermal treatment on the samples’ stability, surface morphology, diffusion or creation of defects, which all can introduce changes into the surface electronic structure.

We present results of temperature-dependent study of surface morphology (by STM), local electronic structure (by STS), surface crystallographic structure (by LEED) and surface chemical composition (by AES) of single-crystalline Bi2Te3.

The temperature range in which the surface atomic and electronic structure does not change is determined. At high temperatures (above 430 K), diffusion of defects within a given atomic plane is observed, as well as their jumps between the planes. On this basis an activation energy for deffects diffusion is estimated. However, change of defects’ density near the surface with increasing temperature is not achieved. A further increase of temperature leads to the formation of a new phase of hexagonal symmetry at the surface of Bi2Te3. However, both the surface morphology and the electronic structure are permanently changed in comparison to the starting material. The new phase reveals dual character of its surface electronic structure; the linear relation is preserved only at some parts of the surface.

[1] Nowak, K., et al., Materials 2022, 15, 2083. <https://doi.org/10.3390/ma15062083>

[2] Netsou, A. M., et al., ACS Nano 2020, 14, 13172. <https://doi.org/10.1021/acsnano.0c04861>