Electron-phonon coupling in the copper intercalated Bi_2Se_3 hybrid devices.

M. Wiesner,[1] A. Zyuzin,[2] K. Koski,[3] A. Laitinen,[2] J. Manninen,[2] and P. Hakonen[2]

[1]*Faculty of Physics, Adam Mickiewicz University, Poland*

[2]*Low Temperature Laboratory, Department of Applied Physics, Aalto University, Finland*

[3]*Department of Chemistry, University of California Davis, Davis California USA*

We investigated charge and heat transport in copper intercalated Bi_2Se_3 topological insulator in temperatures ranging from 15 mK up to 250 K. Both superconducting aluminium leads and normal, golden leads were employed for contacting the samples. Measurements of magnetoconductivity of the Al-contacted sample were performed at temperature T = 100 mK using magnetic fields ranging from 0 T up to 5 T. Fitting results of the experiment with the HLN model[1] were consistent with weak localization, and it yielded the materials parameters: the coherence length (33 nm), mean-free path (12 nm), spin-orbit scattering length (19 nm) and mobility (593 cm^2/Vs). Weak localisation and electron-electron intercatios[2] were major processes contributing to the conductivity in the Au-contacted sample.

Disorder-related small unit cell deformation of the topological insulator enhanced separation of the in-plane and cross-plane processes. Such separation resulted in charge and phonon confinement in quintuple layers of the topological insulator. Shot noise measurements revealed that heat transport in the layered material is more sensitive to such an anisotropy than charge transport. The anisotropy was reflected in the heat flux investigated in three temperature ranges. The heat flux showed T^2 temperature dependence at $T < 7$ K, which changed to T^3 at $7 \text{ K} < T < 12$ K and to T^4 at $T > 12$K. A model of electron scattering on transverse acoustic phonons taking into account dynamic and static disorder as well as the Kapitza[3] resistance originating from the mismatch between acoustic phonons impedances of an investigated material and a substrate is found to be in accordance with the data.

References:

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