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Thermoelectric properties of ultrathin films of $\mathbf{Bi_{2-x}Sb_xTe_{3-y}Se_y}$
STEPHANE YU MATSUSHITA, Graduate School of science, Tohoku University, KHUONG KIM HUYNH, WPI-AIMR, Tohoku University, HARUKAZU YOSHINO, Graduate School of Science, Osaka City University, NGOC HAN TU, YOICHI TANABE, KATSUMI TANIGAKI, Graduate School of science, Tohoku University — The recent discovery of 3D-TIs showing the unconventional Dirac band on the surface provided an intriguing research platform to survey the new TE materials differently from the conventional electronic approaches. Here, we report our recent experimental studies on the thermoelectric (TE) properties of topological surface Dirac states (TSDS) in three dimensional topological insulators (3D-TIs) by employing $Bi_{2-x}Sb_xTe_{3-y}Se_y$ ultrathin films. We successfully obtained two nontrivial electronic surface states, a metallic TSDS (m-TSDS) and a gap-opened semiconducting TSDS (g-TSDS), in the ultrathin film limit of 8 and 4 quintuple layers, respectively. Important TE parameters (electrical conductivity (σ), thermal conductivity (κ) and thermopower (S)) were accurately determined. The state of m-TSDS gives S=-44 μVK^{-1}, which is more than an order of magnitude higher than those of the conventional metals and its value is enhanced to -212 μVK^{-1} for g-TSDS. From the viewpoint of σ and κ, the Wiedemann-Franz law seems to be broken due to the disordered topological surfaces, providing the future possibilities for highly efficient TE materials.

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