Insulating State in Topological Half Heusler compound TmPdSb

Shovan Dan,[1] A. Ptok,[2] O. Pavlosiuk,[1] Karan Singh,[1] P. Wiśniewski,[1] and D. Kaczorowski[1]

[1]*Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Okólna 2, 50-422 Wrocław, Poland*
[2]*Institute of Nuclear Physics, Polish Academy of Sciences, W. E. Radzikowskiego 152, PL-31342 Kraków, Poland*

Our study presents both theoretical and experimental evidence supporting the existence of a robust topological insulator state in TmPdSb, a half-Heusler compound. Typically, half-Heusler systems display topological features only in their semimetallic state and are topologically trivial in the insulating state. However, using a tight binding model to calculate the $\mathbb{Z}_2$ topological invariant, we found that TmPdSb has a (1; 000) invariant, which directly indicates it as a strong topological insulator. Furthermore, we observed the manifestation of topological features through unique surface states that extend across the entire Brillouin zone, independent of surface termination, and were confirmed in single crystal experimental results. TmPdSb exhibits insulating behavior at high temperatures, as evidenced by the temperature-dependent electrical resistivity. The transverse and longitudinal magnetoresistance behaviors display a linear in B trend at low temperatures and a quadratic B dependency at high temperatures. Despite being paramagnetic at 2 K, magnetic scattering was observed in the electrical transport, below 40 K. We also derived a large prefactor α and coherence length $L_\phi(0)$ using the Hikami-Larkin-Nagaoka model, based on the weak antilocalization behavior of conductance in weak magnetic fields. The relatively large value of $L_\phi(0)$ suggests the dominance of conducting surface states, which is typical of 2D topological sheets.

This work was supported by National Science Centre (NCN, Poland) under Project No. 2021/40/Q/ST5/00066 and 2021/43/B/ST3/02166.]