Large Anomalous Ettingshausen effect in a micron-sized magnetic Weyl semimetal on-chip cooler

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Solid-state cooling devices offer compact, quiet, reliable and environmentally friendly solutions that currently rely primarily on the thermoelectric (TE) effect. Despite more than two centuries of research, classical thermoelectric coolers suffer from low efficiencies which hampers wider application. In this study, the less researched Anomalous Ettingshausen effect (AEE), a transverse thermoelectric phenomenon, is presented as a new approach for on-chip cooling. This effect can be boosted in materials with non-trivial band topologies as demonstrated in the Heusler alloy Co_2MnGa. Enabled by the high quality of our material, in situ scanning thermal microscopy experiments reveal a record-breaking anomalous Ettingshausen coefficient in µm-sized on-chip cooling devices at room temperature. A significant boost of 44% of the effect by the intrinsic topological properties, in particular the Berry curvature of Co_2MnGa, emphasises the unique potential of magnetic Weyl semimetals for high-performance spot cooling in nanostructures.

Figures

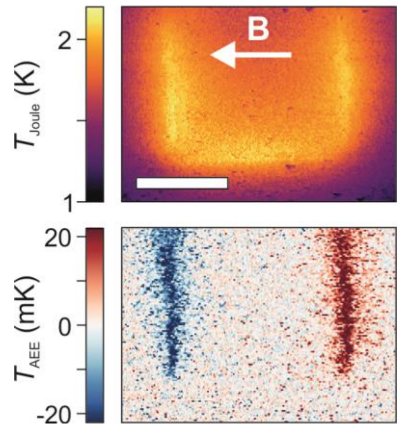

Figure 1: Anomalous Ettingshausen effect (bottom panel) and Joule heating (top panel) in "U"-shaped Co_2MnGa micro devices. Scale bar: 10µm.

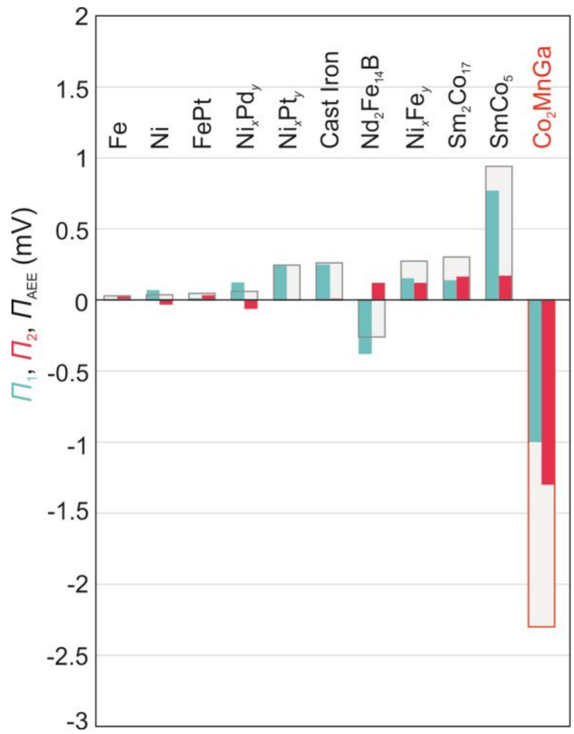

Figure 2: Total Ettingshausen coefficient Π_{AEE} (grey bars) and its contributions Π_1 (from Berry phase, blue bars) and Π_2 (from spin-orbit scattering, red bars).