**Large anomalous Hall angle in topological semimetal Co2MnGa thin films**

*Simon Granville A,B,\*, Yao ZhangA,B and Guy DubuisA,B*

ARobinson Research Institute, Victoria University of Wellington, Wellington, New Zealand; BMacDiarmid Institute for Advanced Materials and Nanotechnology, Wellington, New

Zealand

**Introduction**

Full Heusler ferromagnet Co2MnGa is predicted to be a magnetic Weyl semimetal having a large net Berry curvature near the Fermi energy associated with nodal lines and Weyl points (Sakai 2018, Guin 2019). Moreover, the anomalous Hall current can be nearly fully spin-polarized (Tung 2013, Manna 2018). These exotic electronic properties, along with the large Curie temperature TC ≈ 694 K, make Co2MnGa ideal for studying the interplay of topology and magnetism and realizing room temperature spintronics applications. Bulk Co2MnGa crystals have been recently shown to have Weyl-like transport properties, however so far there is little investigation of thin films.

**Methods**

Using magnetron sputtering from stoichiometric alloy targets, we have deposited thin films of various thicknesses of Co2MnGa onto MgO substrates at elevated temperatures. The thin films have been characterised using x-ray diffraction, magnetic and magnetotransport measurements.

**Results**

Thicker films (>20 nm) grow epitaxially on MgO, with all the diffraction lines expected from the Heusler L21 structure. Both anomalous Hall conductivity and longitudinal conductivity approach a constant 812 Ω-1cm-1 and 7250 -1cm-1, respectively, at low temperature. Thicker films have a large anomalous Hall angle (defined as ) =9.7%, matching the room temperature record for films of any material. Below 20 nm, the anomalous Hall angle becomes much smaller and is temperature independent due to a significantly lower anomalous Hall conductivity .

**Conclusions**

The magnetotransport properties of the thick films (above 20 nm) resemble those of bulk Co2MnGa, but for the sudden decrease in below 20 nm indicates size-dependent changes to the electronic properties. Our results indicate that magnetron sputtered Co2MnGa thin films show the same Weyl semi-metal characteristics as bulk crystals, however below a critical thickness the Weyl-like characteristics begin to disappear due to the dominance of surface effects.

**References**

Guin, S. N. *et al*. (2019). Anomalous Nernst effect beyond the magnetization scaling relation in the ferromagnetic Heusler compound Co2MnGa, NPG Asia Mater., 11, 16.

Sakai, A. *et al.* (2018). Giant anomalous Nernst effect and quantum-critical scaling in a ferromagnetic semimetal, Nat. Phys., 14, 1119–1124.

Manna. K. *et al*. (2018). From Colossal to Zero: Controlling the Anomalous Hall Effect in Magnetic Heusler Compounds via Berry Curvature Design, Phys. Rev. X, 8, 041045.

Tung, J. and Guo, Y. (2013). High spin polarization of the anomalous Hall current in Co-based Heusler compounds, New J. Phys., 15 033014.

\* simon.granville@vuw.ac.nz