Contribution ID : **9** Type : **Talk**

Investigating the perturbation to the spin ordering of the helimagnet Cu2OSeO3 upon doping

Monday, 4 November 2024 11:40 (20)

Magnetic Skyrmion lattices (SkL) are spin ordering which are topologically protected due to their quantised winding number. This, along with other helimagnetic orderings offer a plethora of fascinating phenomena for fundamental research and applications.[1] Cu2OSeO3 is an insulating multiferroic material that has shown to host SkL at specific conditions.[2] It possesses a magnetic structure with both ferromagnetic (FM) and antiferromagnetic (AFM) super exchange interactions being present and has a 3-up 1-down ferrimagnetic arrangement of Cu2+ ions.[3] The lack of inversion symmetry in the corner shared O-Cu4 tetrahedra lattice results in an appreciable DMI between Cu2+ sites; this competes with FM/AFM interactions leading to spin canting formation of helical/conical spin textures at different fields and temperature conditions.[2] Due to the absence of a crystallographic transformation throughout the temperature range alongside the formation of the magnetic phases, it has been commonly assumed that the structure plays a passive role in magnetic ordering.[3] Yet, published studies have challenged this assumption. The work by Wu et al. shows that internal expansion leads to a decrease in Tc for the helical to paramagnetic transition.[4] Furthermore, observation by Nishibori et al. shows that by applying a pressure, Tc increases as the unit cell volume contracts.[5]
In this work, we incorporated both magnetic and non-magnetic ions into the Cu2OSeO3 host. The inclusion of Te into the Se-sites and Co into the Cu-sites changed the crystal and magnetic structure, respectively. The skyrmion dynamics and spin interactions within these materials were then studied using synchrotron X-ray powder diffraction, neutron powder diffraction, small angle neutron scattering, and magnetometry. Using X-ray powder diffraction at the Australian synchrotron, we identify a structural anomaly where the Cu network distorts around the paramagnetic-helical ordering temperature. This alludes to the possibility that structure is also a contributing factor to the magnetic ordering of the material despite the lack of structural phase transition. Through neutron diffraction, we found that the magnetic response of the spin ordering is highly susceptible to chemical doping. This implies that the rigidity of the spin coupling might be affected by the both magnetic and non-magnetic dopants. Small angle neutron scattering of our samples confirmed the various helimagnetic ordering and their periodicity. Lastly, we also studied the magnetic interactions through magnetometry. These results give us insight as to the relationship between materials structure and magnetic ordering. This highlights the importance of the crystal structure and an avenue to design novel spintronic materials.

[1] S. Mühlbauer, et al., Science 323, 915 (2009).
[2] S. Seki, et al., Science 336, 198 (2012).
[3] J.-W. G. Bos, et al., Phys. Rev. B 78 (9), 094416 (2008).
[4] H. C. Wu, et al., J. Phys. D: Appl. Phys. 48, 475001 (2015).
[5] E. Nishibori, et al., Phy. Rev. B 102, 201106 (2020).

Topics

Magnetism and Condensed Matter

Primary author(s) : YICK, Samuel (University of Auckland)

Co-author(s) : VAS, Marco (PhD Student at The University of Auckland); Mr FERGURSON, Alexander (University of Fribourg); VELLA, Joseph (The University of Auckland); GILBERT, Elliot (ANSTO); ULRICH, Clemens (The University of New South Wales); SOEHNEL, Tilo (The University of Auckland)

Presenter(s) : YICK, Samuel (University of Auckland)

Session Classification : Talks