Ferrimagnetism in MnCoGe Thin Films

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Novel magnetic compounds known as inverse tetragonal Heusler alloys are proposed by density-functional theory (DFT) to permit magnetic skyrmions. Skyrmions are stable chiral arrangements of magnetic spins within a material, which may be used as bits in magnetic racetrack memory.

This work reports on the growth of Mn-Co-Ge thin films, proposed to crystalize into tetragonal structures which admit skyrmions. Amorphous films were synthesized with magnetron sputtering and crystalized post-deposition with rapid thermal annealing.

X-ray diffraction (XRD) was used to qualitatively determine crystal structure and magnetic measurements gave insight into the location of atoms in the structure. Unfortunately, the proposed tetragonal structure was not stabilized. The films crystalized into hexagonal phases, which do not possess the necessary symmetry to admit skyrmions. Magnetometry measurements led to the discovery of unexpected ferrimagnetic properties, due to an antiparallel arrangement of moments on Mn sublattices. Discrepancy with DFT calculated values was modeled by disorder of Mn and Co atoms within the crystal structure.

The work led to the investigation of another alloy, Mn3Ge, a hexagonal antiferromagnet in which the triangular arrangement of Mn moments exhibits geometrical frustration. These types of materials have recently been proposed as the active material in novel antiferromagnetic storage devices.