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Advanced Research Lab / Master Thesis

Anisotropic multicaloric properties of hot-compacted Ni-(Co)-Mn-X (X= Sn, Ti) Heusler alloys

With global temperatures being on the rise for the last nine consecutive years, the increasing global demand for cooling and refrigeration presents a critical challenge and signifies the necessity for the exploration of more energy-efficient solutions beyond the conventional vapor-compression technique. Magnetic cooling is seen as a promising alternative, as magnetic refrigeration systems show an increased energy efficiency.

In recent years, Ni-(Co)-Mn-X Heusler alloys have gained increased attention, as they show a large inverse magnetocaloric (MCE) and conventional elastocaloric effect (ECE), making them a promising candidate for magnetocaloric (MC) and multicaloric (MuC) cooling. The caloric effects arise from a first-order magnetostructural phase transition (FOMST) from a high-magnetic austenite phase to a low-magnetic martensite phase. To optimize the multicaloric performance of these materials, the FOMST needs to be tailored, which requires a comprehensive understanding of the influence of the microstructure.

In this work, we offer a systematic study on the influence of composition and microstructure on the first-order magnetostructural phase transition and the mechanical properties in Ni-(Co)-Mn-X (X = Sn, Ti) Heusler alloys. Heusler alloys will be synthesized from scratch by arc melting. Subsequently, using melt-spinning and hot-compaction, samples with anisotropic microstructures will be produced, which will be characterized by microstructural, chemical and magnetic analysis as well as by mechanical testing.

[1] O. Gutfleisch et al., *Phil. Trans. R. Soc*, (2016).
[2] F. Scheibel et al., *Energy Technol.*,*6* , 1397 (2018).
[3] T. Gottschall et al., *Nature Mater* 17, 929–934 (2018).

Experience to be gained:

- Learning about magnetic shape memory and magnetocaloric materials
- Experience on relevant synthesis routes → Arc Melting, Melt spinning, Hot compaction
- Microstructure analysis → Scanning Electron Microscopy (SEM), Energy dispersive x-ray analysis (EDX)
- Magnetic characterization → Vibrating Sample Magnetometer (VSM)
- Characterization of mechanical properties → Mechanical testing

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