The Exhausting Experimental Search for Alternative MSM-active Heusler Alloys

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The magnetic shape memory effect is a near-unique multiferroic property of the Ni_2MnGa Heusler alloy family (and it's off-stoichiometry or substituted derivatives). The effect relies on the synergistic combination of high magneto-crystalline anisotropy, high magnetic moment, and low energy required to move twin domain boundaries, known as the twinning stress [1]. Despite extensive searching, no alternatives to the Ni-Mn-Ga alloys have been found to have the required combination of properties. With the increasing libraries of computationally investigated materials, identification of promising alterative candidates, through appropriate property filtering should become easier.

We chose to use the results of several ab intio calculation papers, predicting the ground-state structure and resulting magnetic properties of a large list of potential Heusler alloys, to help shortlist and target our experimental efforts to identify alternatives to Ni-Mn-Ga [2,3]. The shortlisting used filters such as ground-state structure, effective moment, magneto-crystalline anisotropy, and tetragonality ratio, to predict the most likely candidate Heusler alloys. Synthesis of the potential candidates was then attempted using arc-melting, followed by compositional characterisation by SEM-EDX, and homogenisation heat-treatments. The most promising (phase pure) candidates were then investigated by magnetometry and structural analysis [4-6].

Despite the targeting using ab intio calculations, many of the predicted properties from the calculations were not realised in the experimentally prepared alloys, if a single-phase alloy could even be prepared. No promising alternatives to Ni-Mn-Ga have so far been identified. In this presentation we will summarise this exhausting search, highlighting the filtering parameters, preparation successes, and so-far identified magnetic properties of the prepared alloys.

References:

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