Improving the crystal growth of magnetic shape memory alloys using a slag.

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Magnetic shape memory alloys (MSMAs) are metals that show magnetic field induced reorientation, i.e. by applying a magnetic field, they can reorient their crystal structure and show a significant size change of the crystal [1]. These properties are nearly unique to the family of alloys based on Ni, Mn and Ga. The properties of MSMAs have been studied for ~30 years and are actively being looked at for applications in actuators, micropumps and switching devices.

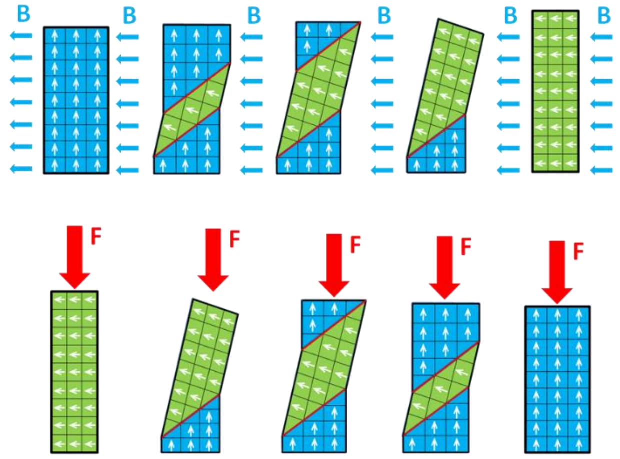

Figure 1*. Illustration of the reversible nature of sizable strain in single crystalline Ni-Mn-Ga, by twin boundary motion.* ***Upper****, the MIR effect by application of magnetic field,* ***lower****, recovery to the original shape by applied force .*

A setback for their applications is the necessity to have high quality single crystals to observe the best and most repeatable properties. We've recently patented an adaptation to the optical floating zone growth technique that reproducibly prepares reasonably high quality crystals, but defects and impurities (usually oxides) can still be included and act as pinning sites to reduce the MSMA properties [2].

A different team previously tested a growth technique that used a slag mixture to reduce oxide contaminants during the growth [3]. This project will attempt to implement the use of the slag into our current growth procedure. It will be tested at both: the pre-alloying stage, where we will use induction melting and quench casting to prepare the polycrystalline alloy rods; and during the growth stage, inside the optical floating zone furnace.

The resulting crystals will be examined by optical microscopy to search for impurities, and the mechanical properties will be tested. In order to do this, the crystals will also have to be oriented, cut and prepared for testing after the growth.

References:

[1] O. Heczko, Mater. Sci. Technol. **30**, 1559 (2014).

[2] R. H. Colman, PV 2019-337 (2019).

[3] K. Rolfs, A. Mecklenburg, J. M. Guldbakke, et al., J. Magn. Magn. Mater. **321**, 1063 (2009).