Phase Transformation in Ferromagnetic Shape-Memory Alloys

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Materials that can reversibly change their dimension upon the application of external fields, such as magnetic or electric fields, have been used as actuators or sensors in many applications. Among them are magnetic-driven shape-memory alloys (SMAs), which can be deformed by a magnetic field. The possibility of a magnetic-field control of the shape-memory effect has been demonstrated in the ferromagnetic Ni-Mn-Ga and Ni-Co-Mn-In alloys with a composition close to the Heusler structure [1-5]. Although considerable attention has been devoted to the processing of ferromagnetic materials for optimal performance properties, the underlying mechanism that controls the shape memory effect (SME) remains unclear. In particular, the interactions between crystallographic textures and stresses and their influences on the functional performance in polycrystalline SMAs are less understood.

High parallel X-ray beams at a synchrotron source with energies greater than 60 keV have significantly advanced the field of materials research. The X-ray diffraction technique based on synchrotron source, in combination of the neutron diffraction method, provides the ability to trace in-situ changes in detailed local and global information, such as stress and orientation of individual grains, under the application of temperature and high magnetic fields. Full information on crystallographic aspects during the phase transformation is essential for understanding the ‘memory’ characteristics in the ferromagnetic SMAs related to texture and stress. In this presentation, some new progresses on the in-situ investigations of phase transformation in the Ni-Mn-Ga and Ni-Mn-Ga-Co alloys [6] will be shown in all aspects, covering from the phase transformation kinetics of bulk samples and nano-particles, the influence of various stresses on the microstructural characteristics of SME, to the transformation behaviors under the stress and magnetic fields.

References


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