University of Central Florida

NanoScience Technology Center
Advanced Materials Processing & Analysis Center

GRADUATE RESEARCH SEMINAR SERIES

Friday
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12:15 PM

Research Pavilion
NSTC
Conference Room 475

Pizza and drinks will be provided

Microstructure, Crystallography and Mechanical Properties of NiMnGa Alloys

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NiMnGa Heusler alloys, functioning as either ferromagnetic shape memory alloys or mangetocaloric materials, have both practical applications and fundamental research value. The functional properties of NiMnGa alloys are closely related to the martensitic transformation from high temperature austenitic phase to low temperature martensitic phase. Alloys can be used for room temperature or high temperature applications, depending on the martensitic transformation temperature, which is compositional sensitive. The microstructure and crystallography of the martensites can be very complex but are crucial to the optimization of the material performance. In this study, solid-to-solid diffusion couples and various characterization techniques were carried out to fundamentally investigate the NiMnGa ternary alloys. Microstructural and crystallographic development, and mechanical properties of NiMnGa alloys were systematically examined by using scanning electron microscopy, transmission electron microscopy and nanoindentation.

Crystallographic variations in martensitic phase, including non-modulated (NM) martensite, modulated (5M or 7M) martensite, were found in the diffusion couples. All martensitic microstructure consists of twinned variants with different orientations that were documented using electron diffraction. The twinning relationship along with the tetragonality ratio (c/a) was correlated to martensitic transformation temperature. In addition, pre-martensitic state has been clearly observed in the cubic austenitic phase region, with distinctive tweed microstructure originating from the local lattice distortions. Mechanical properties including reduced elastic modulus (E_r) and hardness (H) as a function of composition were measured and analyzed. A decrease of E_r and H was observed with Mn or Ni substituting Ga, and Ni substituting Mn for the austenitic phase. However, an opposite trend was found for the martensitic phase. The softening of the elastic constants near the vicinity of martensitic transformation contributed to the sharp decrease in E_r and H near the phase boundary between austenite and martensite.