Title: Study of indium doped shape-memory alloy Ni_2MnGa

Author: Petr Cejpek

Department: Department of Condensed Matter Physics

Supervisor: RNDr. Milan Dopita, PhD., Department of Condensed Matter Physics

Abstract: The alloys related to Ni-Mn-Ga system exhibit effects connected to the magnetic shape-memory and martensitic transformation and therefore attract attention of researchers for their application potential. Properties and especially transformation temperatures are strongly dependent on composition, doping and also on external conditions as a magnetic field or pressure.

The main aim of the work was to prepare own single crystals of $Ni_2MnGa_{1-x}In_x$ and to study their properties with respect to the temperature and applied fields in dependence on a various indium doping. The transformation temperatures obtained from the measurement of electrical resistivity and magnetisation revealed the systematic decrease of martensitic transformation temperature T_M, pre-martensitic transformation temperature T_P and Curie temperature T_C. The martensitic transformation should vanish at indium concentration of $x \approx 0.10$. The decrease with indium content is much faster than in the study published previously on the polycrystalline samples (vanishing at $x \approx 0.20$). This discrepancy is probably caused by the residual stress remaining in polycrystalline samples from arc melting preparation. The measurements in various magnetic field revealed the increase of T_M and T_P in the order of 0.2-0.6 K/T.

The lattice parameters and the structure modulation were examined by X-ray diffraction. Indium increases unit cell volume and also increases the volume change during the martensitic transformation. Indium also influences modulation parameters - the increasing indium content increases the length of the modulation vector in the pre-martensitic phase and decreases its length in the martensite. It also decreases the pre-martensitic modulation amplitude.

The last part of the thesis was dedicated to the measurement of X-ray diffraction in-situ in tension on the off-stoichiometric $Ni_{50}Mn_{28}Ga_{28}$ with the martensitic phase at room temperature. When c axis (the shortest) is along the direction of the tension, the elongation of the sample is done primarily by the induced reorientation (creation of the new domains suitably oriented to the tension by twinning and increasing of their volume). When a or b axes lie along the direction of tension, the overall elongation happens primarily due to the change of the lattice parameters. This sample orientation also allows the tension to rapidly decrease the modulation amplitude with the applied tension.

Keywords: Ni-Mn-Ga alloys, shape memory, twinning, structure modulation, single crystal growth