Supervisor's report on the PhD. thesis "Study of indium doped shape-memory alloy Ni_2MnGa"

by

Petr Cejpek

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Thesis title: Study of indium doped shape-memory alloy Ni_2MnGa
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Submitted PhD thesis of Mr. Petr Cejpek, entitled "Study of indium doped shape-memory alloy Ni_2MnGa" deals with the preparation and detailed studies of physical properties, structure and microstructure of modern class of materials with a shape memory effect. Ni-Mn-Ga alloys are prototypes of magnetic shape-memory alloys showing magnetically induced reorientation and giant magnetic-field induced strain for which properties they attracted significant attention of scientific community in past years. An application potential of such high added value materials is very wide, covering the branches of their potential use in micro-pumps, precise actuators, micro-mechanics, or magnetic refrigerators. The basic research of those materials comprising their preparation, detailed studies, and tuning of their physical properties by alloying with additional elements, is very recent and actual.

The key and the first issue studied in this PhD thesis is the preparation of Ni_2MnGa and $Ni_2Mn(Ga,In)$ alloys with desired stoichiometry. Author used two methods, the Bridgman and the floating zone method with subsequent homogenization annealing for preparation of polycrystalline and single crystal samples. A series of specimen varying in composition (various In doping), depending on preparation procedure and homogenization annealing routes, was prepared and used for subsequent measurement of physical properties and microstructural studies. Prepared samples were consequently studied by whole variety of experimental techniques: the chemical composition was studied using energy dispersive X-ray spectroscopy (EDX) and X-ray florescence spectroscopy (XRF), the physical properties of samples were studied by differential scanning calorimetry (DSC), electric resistivity measurement by four-probe method and magnetisation measurements. The morphology of samples was studied by scanning electron microscopy and electron back-scattered diffraction. Finally, the structure, microstructure and the real structure of specimens were studied in detail by X-ray diffraction methods (XRD). The results of XRD measurements provided detailed information about the lattice parameters, domain structure, twinning and structure modulations of studied samples. Besides, the XRD measurements were performed in-situ at low temperatures and during in-situ deformation tests, as well. These results provided the information about the phase changes during the martensitic transformation, behaviour of the twin domain boundaries, their motion and reorientation as well as about the structure

modulation changes during the application of an external load. Obtained experimental results led to the construction of temperature versus composition phase diagram.

The PhD thesis is written in good English with a minimum of mistakes or typos. Graphics, language and formal level of the thesis is excellent. The work consists of seven chapters, has 105 pages, 67 figures, seven tables and one appendix chapter. The design of the figures is brilliant as well.

The author critically in detail discuss possible errors of measured results. The obtained original results are censoriously discussed, argued and compared with relevant published literature sources. The author rigorously cites 107 papers published in international journals. Outstanding scientific quality of this thesis is manifested by 10 original papers published in international journals with impact factor where Mr. Petr Cejpek is author or co-author and which contains results published in this thesis.

The results published in this thesis were presented on several international scientific conferences: 20th International Conference on Magnetism (ICM), Barcelona 2015; 29th European Crystallographic Meeting (ECM), Rovinj 2015; 62nd Annual Conference on Magnetism and Magnetic Materials (MMM), Pittsburgh 2017; 31st European Crystallographic Meeting (ECM), Oviedo 2018; 32nd European Crystallographic Meeting (ECM), Vienna 2019; 63rd Annual Conference on Magnetism and Magnetic Materials (MMM), Las Vegas 2019; 25th Congress of the International Union of Crystallography (IUCr), Prague 2021.

Relevance of materials studied in this thesis was supported by grant (grant number 244217) provided to Mr. Petr Cejpek by Grant Agency of Charles University, which was successfully solved in 2017 – 2019. Besides, Mr. Cejpek clearly demonstrated his expertise in X-ray scattering and diffraction theory and experimental work as a member of eight synchrotron experiments performed during his PhD. studies at top world synchrotron sources (ESRF, Grenoble, France; Spring-8, Japan; SOLEIL, Paris, France; Diamond, Didcot, United Kingdom; ANKA, Karlsruhe, Germany).

As a supervisor of Mr. Cejpek I would like to mention that besides the top level science, which is he doing, Petr Cejpek is young, noble, clever person and without any doubt extremely valuable member of our laboratory. He is any time ready to help and support other colleagues and students and in a good sense he is definitely the “team - player” and favourite person.

By writing and submitting of this thesis Mr. Petr Cejpek clearly demonstrated his diligence and abilities of independent, creative research work and critical thinking. The thesis fulfilled set goals, is of very high standard and after its successful defence I recommend to award Mr. Petr Cejpek by PhD. doctoral degree.

Place, date and supervisor signature:
V Praze, 1.9.2021 RNDr. Milan Dopita, PhD.