MM 42: Phase Transitions III

Time: Thursday 14:00–15:30 Location: H 0107

MM 42.1 Thu 14:00 H 0107

Stress Induced Martensite in Epitaxial Ni-Mn-Ga Films — •Michael Thomas[1,2], Jörg Buschbeck[1], Oleg Heczko[1], Ludwig Schultz[1,2], and Sebastian Fähler[1,2] — [1]IFW Dresden, P.O. Box: 270116, 01171 Dresden, Germany — [2]Institute for Solid State Physics, Department of Physics, Dresden University of Technology, 01062 Dresden, Germany

Martensitic epitaxial Ni-Mn-Ga films with a thickness of about 500 nm were deposited at different temperatures on MgO(001) substrates. Some films are in an orthorhombic martensite state at room temperature though their compositions suggest far lower martensitic transformation temperatures. The martensite transformation is stress induced which was confirmed by X-ray stress analysis. The film structure can be explained as having an austenite layer at the interface between film and substrate. A hierarchical twinned martensite phase is grown on this austenite layer separated by a (101)-habit plane. The distribution of the twin boundaries is controlled by the stress state arising from the substrate constraint. Additionally non-modulated Ni-Mn-Ga films with a tetragonal phase and a coexisting cubic austenite phase were grown. Peeling this films off the substrate leads to the vanishing of the residual austenite phase. The strongly acting stress during the peeling may induce a fully tetragonal non-modulated martensite phase.

MM 42.2 Thu 14:15 H 0107

Microstructure and mechanical properties of sputter deposited NiMnGa magnetic shape memory alloy thin films — •Guido J. Mahnke and S. G. Mayr — 1. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

While bulk magnetic shape memory alloys (MSMA) are well established - and even commerically available, miniaturization as thin functional films still remains an open issue. The relation of microstructure and mechanical properties is one of the key ingredients to understand the martensitic transformation behaviour as well as twin boundary movement in MSMA thin films. To achieve this, highly textured and epitaxial NiMnGa MSMA thin films were preprared on different substrates at variable temperature by ion beam sputtering from a multicomponent target, and charcterized with respect to phase, microstructure and growth stresses. While growth usully occurred in the austenitic phase, a twinned martensitic state usually could be obtained during cooling down, accompanied by changes in the stress state. The relation of mechanical properties and microstructure is discussed.

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MM 42.3 Thu 14:30 H 0107

Growth of epitaxial and highly textured FePd shape memory alloy thin films — •Lisa Kühnemund, Tobias Edler, and S.G. Mayr — I. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Thin films of the MSM alloy $Fe_{70}Pd_{30}$ are grown by e-beam evaporation. In order to achieve a maximum strain by the MSM effect, epitaxial or highly textured films are desirable. Depending on the substrate type (either MgO single crystals or amorphous SiO_2) key properties, including phase, microstructure, and magnetic characteristics have been determined. Since the stress state of a thin film is known to have a major influence not only on the matensitic transformation but also on the MSM effect itself, stress measurements on films grown by e-beam evaporation are compared to films grown by PLD. In order to influence the texture of polycrystalline films, methods of applying a magnetic field both during film growth and post-deposition annealing are evaluated. The implications of these structural and magnetic properties on the MSM effect and its possible applications are discussed.

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MM 42.4 Thu 14:45 H 0107

Intrinsic Properties and Growth of Iron Palladium Thin Films — •Iris Kock and S.G. Mayr — 1. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Iron Palladium alloys of a composition around $Fe_{70}Pd_{30}$ are among the most promising candidates for magnetic shape memory alloys. With regard to possible application in miniaturized devices the intrinsic properties of thin films prepared by electron beam evaporation were investigated and compared to those of splat quenched foils. The developement of mechanical stress and surface morphology during film growth were studied and linked to crystal structure, microstructure and magnetic properties to determine the growth mechanisms. It was found that deposition at room temperature leads to films in a bct structure with an out of plane magnetization. Transformation to the fcc austenite phase can be achieved by appropriate heat treatment. Splat quenching directly yields foils of about 60 microns thickness in the austenite phase that can transform into the martensite phase upon cooling.

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MM 42.5 Thu 15:00 H 0107

Structural, magnetic and phase transformation properties of Fe-Pd-X thin films — •Sven Hamann[1,2], Sigurd Thienhaus[1,2], Alan Savan[1], and Alfred Ludwig[1,2] — [1]Combinatorial Materials Science Group, Center of Advanced European Studies and Research (Caesar), Ludwig-Erhard-Allee 2, 53175 Bonn, Germany — [2]Institute for Materials, Faculty of Mechanical Engineering, Ruhr-University Bochum, 44780 Bochum, Germany

The topic of this work is the development of new ferromagnetic shape memory alloys (FSMA) within the Fe-Pd-X system (X=Co, Mn,...) with improved intrinsic properties (high transformation temperatures [MS > 100°C], high Curie temperature and high magnetocrystalline anisotropy). The advantages of Fe70 Pd30-based FSMA in comparison to Ni-Mn-Ga are higher Curie temperatures, saturation magnetization and transformation temperatures as well as potentially higher magnetocrystalline anisotropy. The Fe-Pd-X thin films were fabricated by co-sputtering from different elemental targets in a combinatorial magnetron sputter system. This method is used to create over 300 samples with different compositions on a 4" wafer substrate in one deposition process. The annealed Fe-Pd-X thin films were characterized by energy dispersive x-ray spectroscopy, electrical resistance versus temperature measurements, x-ray diffraction, vibrating sample magnetometry measurements and transmission electron microscopy. Results from several new Fe-Pd-X systems are presented, which show martensitic transformation temperatures above 100°C.

MM 42.6 Thu 15:15 H 0107

Microstructure of epitaxial films of the magnetic shape memory alloy Ni_2MnGa — •Tobias Eichhorn, Michael Kallmayer, Hans-Joachim Elmers, and Gerhard Jakob — Institut für Physik, Universität Mainz, Staudinger Weg 7, 55099 Mainz

Since the first discovery of the magnetic shape memory effect by Ullako et al. interest in this material group has increased continuously. By application of a magnetic field, length changes up to 10 % can be achieved in single crystals of martensitic Ni_2MnGa. However the microscopic mechanism is far from being completely understood. To improve this understanding, single crystalline thin films allow elaborate measuring techniques and form the basis for development of applications on a small length scale.

Thin epitaxial films of Ni_2MnGa and $Ni_{1.96}Mn_{1.22}Ga_{0.82}$ are grown by dc-magnetron sputtering onto heated $Al_2O_3(11\bar{2}0)$ and $MgO(100)$ substrates. To investigate the structural and magnetic properties of the samples we use temperature dependent x-ray diffraction and magnetometry. To get insight on microscopic magnetism and electronic structure x-ray absorption spectroscopy and magnetic circular dichroism measurements have been performed at the German synchrotron light source BESSY II (Berlin). Concerning technological applications free-standing single crystalline films will be needed. For that purpose water-soluble substrates and suitable sacrificial layers are investigated. To detect the magnetically induced shape memory effect in our films without removal of the substrate we build a setup to measure the magnetostriction by a capacitive method.