MM 6: Microstructure and Phase Transformations I - Martensitic phase transformations

Time: Monday 10:15–11:15 Location: IFW B

MM 6.1 Mon 10:15 IFW B

Nucleation and growth of martensite in epitaxial magnetic shape memory films — •Robert Niemann[1,2], Anja Backen[1], Hanuš Seiner[3], Sandra Kauffmann-Weiss[1,4], Christian Behler[1,2,4], Ulrich K. Rössler[1], Ludwig Schultz[1,2], and Sebastian Fähler[1,2,4] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]Technische Universität Dresden, Department of Physics, Institute for Solid State Physics, 01062 Dresden, Germany — [3]Institute of Thermomechanics, ASCR, Dolejškova 1402/5, 182 00 Prague, Czech Republic — [4]Technische Universität Chemnitz, Faculty of Natural Sciences, Institute of Physics, D-09107 Chemnitz, Germany

The complex martensitic microstructure of modulated magnetic shape memory alloys is beneficial for magnetic field induced reorientation or reversible field induced phase transition [1]. The big difference in mobility between type I and type II twin boundaries highlights the importance of a monoclinic description of the lattice. Hence it is important to understand the microstructure from the atomic up to the macroscale. As a model system we analyze the martensitic transformation in epitaxial Ni-Mn-Ga films. We perform temperature dependent SEM imaging during the phase transition and XRD as well as TEM in the martensitic state. We describe the observed stages of nucleation and growth using a crystallographic model based on the Wechsler-Lieberman-Read theory of martensites and finite element methods. [1] R. Niemann et al., Adv. Eng. Mat. 14, 562 (2012)

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MM 6.2 Mon 10:30 IFW B

Composition-dependent atomic positions in Ti-Nb martensites — •Matthias Bönisch[1,2], Mariana Calin[1], Lars Giebeler[1,3], Arne Helth[1,3], Annett Gebert[1], Werner Skrotzki[1,2], and Jürgen Eckert[1,3] — [1]IFW Dresden, D-01069 Dresden, Germany — [2]Technische Universität Dresden, Institute of Structural Physics, D-01069 Dresden, Germany — [3]Technische Universität Dresden, Institute of Materials Science, D-01069 Dresden, Germany

In this work the influence of Nb addition on the structural characteristics of martensitic phases in the Ti-Nb system is studied in detail. The orthorhombic martensite alpha" commonly observed in rapidly quenched beta-stabilized Ti-based alloys represents an intermediate structure between the hexagonal martensite alpha' found at low solute content and the bcc beta-phase present at high solute content. While the distortion of the orthorhombic unit cell by addition of beta-stabilizing atoms is well documented in literature, experimental data about the detailed atomic positions in dependence of chemical composition is missing. For this study we prepared a series of binary Ti-Nb alloys by casting techniques followed by homogenization treatment and water quenching. We used X-ray diffraction combined with Rietveld-based analyses to study the gradual structural changes of alpha' and alpha" martensites effected by addition of Nb and determined their compositional boundaries. In case of orthorhombic alpha" we found that besides the lattice parameters the locations of atoms on (002)alpha" planes very sensitively respond to the amount of Nb present.

MM 6.3 Mon 10:45 IFW B

Laser annealing of Fe7Pd3 ferromagnetic shape memory thin films — •Ariyan Arabi-Hashemi[1], Martin Ehrhardt[1], Pierre Lorenz[1], Dietmar Hirsch[1], Klaus Zimmer[1], and Stefan G. Mayr[1,2,3] — [1]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstraße 15, 04318 Leipzig, Germany — [2]Translationszentrum für regenerative Medizin, Universität Leipzig, 04103 Leipzig, Germany — [3]Fakultät für Physik und Geowissenschaften, Universität Leipzig, 04103 Leipzig, Germany

Fe7Pd3 is a magnetic shape memory alloy capable of performing strains of up to 5% by applying an external magnetic field. While the austenite phase of Fe7Pd3 is fcc, the martensite phases are fct, bct and bcc. The magnetic shape memory effect is only observed in the fct phase due to a high magnetocrystalline anisotropy and a high mobility of twin boundaries. We study phase transformation effects in Fe7Pd3 films annealed by 25 ns pulses of a KrF laser for various substrates: LaSrAlTaO, MgO and Si. The laser-solid interaction was simulated by finite element method. Laser annealing experiments are compared with thermal annealing experiments. Low temperature electron beam evaporation deposited samples reside in the bcc phase independently of the used substrate. Subsequent laser and thermal annealing of Fe7Pd3 films deposited on MgO reside in the bcc phase, while laser annealed Fe7Pd3 films on LSAT show a phase transformation from bcc to fcc. In thermally annealed Fe7Pd3 on LSAT fcc and fct is observed. Interdiffusion was studied by SIMS.

MM 6.4 Mon 11:00 IFW B

Mesoscopic twinning of nanotwinned martensites in epitaxial Ni-Mn-Ga films: A TEM study — •Christian Behler[1,2,3], Anja Backen[1], Hanuš Seiner[4], Robert Niemann[1,2], Sandra Kauffmann-Weiss[1,3], Ludwig Schultz[1,2], and Sebastian Fähler[1,2,3] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]Technische Universität Dresden, Department of Physics, Institute for Solid State Physics, 01062 Dresden, Germany — [3]Technische Universität Chemnitz, Faculty of Natural Sciences, Institute of Physics, D-09107 Chemnitz, Germany — [4]Institute of Thermomechanics, ASCR, Dolejškova 1402/5, 182 00 Prague, Czech Republic

Ni-Mn-Ga magnetic shape memory (MSM) alloys have attracted much attention due to the high reversible strains realized by reorientation of martensitic variants by applying external magnetic fields (MIR). To optimize this effect a detailed knowledge about the microstructure is beneficial, since the MIR effect depends on the martensitic phase and the type of mesoscopic twin boundaries connecting the different martensitic variants. As model system epitaxial Ni-Mn-Ga films are investigated which show two different microstructures at the surface. Several cross-sections of both structures were prepared by FIB milling and analyzed by means of (High-Resolution) TEM to gain a complete 3D information about the film structure. We apply a nucleation scenario based on WLR theory to explain the precession of the martensitic transformation for each microstructure. It results in the characteristic formation of mesoscopic twin boundaries we observe in thin films.