MM 8: Microstructure and Phase Transformations - Processing

Time: Monday 11:45–13:00 Location: IFW B

MM 8.1 Mon 11:45 IFW B

Crystalline-amorphous interfaces in high entropy alloy nanolaminates produced via high-pressure torsion — •Shabnam Taheriniya[1], Farnaz A. Davani[1], Sven Hilke[1], Harald Rösner[1], Marilena Tomut[2], Sergiy V. Divinski[1], and Gerhard Wilde[1] — [1]Westfälische Wilhelms-Universität Münster, Münster, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The intermixing possibilities of dissimilar high entropy alloys and the effect of co-deformation on microstructure evolution were investigated. High pressure torsion (HPT) was applied for bonding separate disks of equiatomic FCC single-phase CoCrFeMnNi and BCC HfNbTaTiZr alloys. The samples were processed for 5, 10 and 15 revolutions at ambient temperature under 9 GPa pressure. The resulting composite material showed enhanced mechanical properties as compared to either HEA systems processed under similar conditions. Scanning electron microscopy and energy-dispersive spectroscopy (EDS) revealed heterogeneous microstructures with relatively sharp chemical interfaces. After large strain, the BCC HfNbTaTiZr phase exhibited significant phase separation into Ta-rich and Ta-poor regions. Moreover, the processed samples possessed a nanolamellar microstructure and vortex-like regions. A partial amorphisation of the BCC phase was observed by transmission electron microscopy.

MM 8.2 Mon 12:00 IFW B

Dissolution of copper additions in aluminium by Friction Stir Processing — •Maximilian Gnedel[1], Amanda Zens[2], Ferdinand Haider[1], and Michael Friedrich Zäh[2] — [1]Chair for Experimental Physics I, Universitätsstraße 1, 86159 Augsburg, Germany — [2]Institute for Machine Tools and Industrial Management, Technical University of Munich, Boltzmannstraße 15, 85748 Garching, Germany

Friction Stir Processing (FSP) is an established method to modify the properties of materials such as aluminium. Furthermore, the composition of the alloy can be changed by this technique. Intermixing specific micrometer-sized metal powders as well as metal foils helps to optimize both the microstructural stability during subsequent heat treatment, as well as the mechanical properties in general. Dispersing copper with different morphologies inside a matrix of AA1050 aluminium by FSP can produce a homogenous solid solution of the two elements, if suitable processing parameters are used. A substantial hardening effect is shown, due to factors such as refinement of the grain structure, solid solution hardening and formation of early stage Al-Cu precipitates. By comparing the particle size distributions before and after FSP and including insights provided by transmission electron microscopy of the Al-Cu interface, a coherent understanding of the alloying process, a complex interplay between diffusion driven dissolution and mechanical fragmentation, can be obtained. The results can be used in future studies to evaluate the properties of such non-equilibrium alloys combined with the unique microstructure produced by FSP.

MM 8.3 Mon 12:15 IFW B

Epitaxial NiTi thin films: a 3D puzzle — •Klara Lünser[1,2], Stefan Schwabe[1,2], Moritz Döllgast[1,2], Kornelius Nielsch[1,2], and Sebastian Fähler[1] — [1]Leibniz IFW Dresden, Germany — [2]TU Dresden, Institute of Materials Science, Dresden, Germany

NiTi is the most widely used shape memory alloy. Its superelastic and shape memory properties are the result of a martensitic transformation from a cubic (B2) to a monoclinic (B19') structure. This transformation gives rise to a complex martensitic microstructure. To customize the material for a specific purpose, a thorough understanding of this microstructure is helpful. In polycrystalline materials, however, the microstructure is influenced by grain boundaries, which complicates an analysis substantially.

Here, we use epitaxial NiTi films as a model system to examine the martensitic transformation and microstructure. These single-crystalline films are grown with DC magnetron sputter deposition in different thicknesses and are probed with scanning electron and atomic force microscopy. Due to the well-defined orientation relation between substrate and film, we can identify the orientations of habit planes and Type I and Type II twin boundaries in the B19' martensite. With in-situ measurements, we additionally examine the nucleation and growth processes of the B19' martensite. Our results are the starting point to understand the three dimensional shape of martensitic nuclei in NiTi B19* martensite which results in a hierarchically twinned microstructure on different length scales.

Supported by DFG (FA 453/13).

MM 8.4 Mon 12:30 IFW B

Microstructural evolution of Mn_3Ga due to annealing in magnetic field — •Gloria Kirste, Christian G.F. Blum, Jens Freudenberger, Sabine Wurmehl, and Bernd Büchner — Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany

Due to its $D0_{22}$ structure Mn_3Ga can be described as a tetragonally distorted binary Heusler compound. The magnetic properties resulting from this crystallographic structure make the material an interesting candidate for application in spin torque devices or as a rare-earth-free permanent magnet. However, the Mn-Ga phase diagram is rather complex such that the $D0_{22}$ phase cannot be obtained by melting but needs further heat treatment. Moreover, the magnetic characteristics are affected by the material's microstructure and texture.

Within this study arc melted Mn_3Ga was deformed by rotary swaging to promote the phase transformation. After annealing for up to two weeks the change in microstructure was analysed. The results of X-ray diffraction provide information on the present crystallographic phases whereas microscopical methods revealed the grain size distribution. Some of the resulting magnetic characteristics were examined using SQUID magnetometry.

Several samples experienced annealing in a high static magnetic field as another aid to phase transformation and also in order to achieve a more pronounced texture. The value of magnetic field annealing as a tool for stimulating phase transformation and tuning microstructure will be discussed.

MM 8.5 Mon 12:45 IFW B

Phase selection and microstructural evolution of CoCrNi medium entropy alloy under cointernerless processing — •Angelo Fernandes Andreoli[1], Olga Shuleshova[1], Yuhao Wu[1,2], and Ivan Kaban[1] — [1]IFW Dresden, Institute for Complex Materials, Helmholtzstr. 20, 01069 Dresden, Germany — [2]Department of Applied Physics, Northwestern Polytechnical University, Xi'an, 710072, China

The CoCrNi alloy was cointainerlessly processed using a portable electromagnetic levitation device where in-situ X-ray diffraction and a high-speed camera were used to monitor the phase evolution and solidification behavior. At low undercoolings, the alloy nucleates the stable γ-fcc phase, which consequently grows until the solidification is over. Beyond a critical undercooling, it first nucleates the metastable δ-bcc phase, which completely transforms into the stable γ-fcc phase as solidification evolves. Crystal growth kinetics were determined and are comparable to Fe-Co binary alloys. The microstructural evolution exhibits a transition from a dendritic microstructure at low undercoolings to an equiaxed-refined structure at deeper undercoolings.