MM 52: Phase Transformations I

Time: Thursday 10:15–11:30 Location: H26

MM 52.1 Thu 10:15 H26

MELTING AND STRUCTURAL BEHAVIOUR OF INDIUM NANOPARTICLES EMBEDDED IN AN ALUMINIUM MATRIX — •Mostafa Mohamed, Martin Peterlechner, Tae Eun Song, and Gerhard Wilde — Institute of Materials Physics,Münster,Germany

The melting behaviour of small crystalline solid particles has attracted the interest of many researchers. In the present work, an alloy of Al-4 at % In with nanoparticles of Indium embedded in an Aluminium matrix was synthesized by rapid quenching using the melt-spinning technique. The melting point and freezing behaviour of the embedded nanoparticles were investigated using differential scanning calorimetry and transmission electron microscopy (TEM) including high resolution transmission electron microscopy (HRTEM). DSC experiments showed broad melting and crystallization peaks. The crystallization temperature of the embedded particles shifted to remarkable low temperature. The microstructure exhibited a homogeneous distribution of facetted In particles embedded in the Al-matrix. Analyses of HRTEM images were done to analyse the topology of the heterophase interfaces between Al and In in detail. The results are discussed with respect of the impact of the mismatch accommodation of interfaces on the thermodynamics of nanoscale systems.

MM 52.2 Thu 10:30 H26

Analysis of the melting point depression and the structure of Bi nanoparticles embedded in Zn matrix — •Tae-Eun Song, Martin Peterlechner, and Gerhard Wilde — Institute für Materialphysik, Wilhelm-klemm-straße 10, D-48149 Münster, Germany

The melting point depression of embedded Bi nanoparticles in a Zn matrix synthesized by rapid solidification was analyzed using Differential Scanning Calorimetry (DSC) and Transmission Electron Microscopy (TEM). TEM shows an elongated and faceted morphology of Bi nanoparticles. The elongated Bi particle (012) facet is arranged parallel to Zn (002). Upon heating in the DSC two Bi melting signals occur, one close to the bulk melting temperature and the other at a lower temperature. Subsequent cooling leads to two solidification signals. During repeated heating and cooling, some Bi particles are solidified at a small undercooling with a number of exothermic peaks, whereas other Bi particles are solidified with a broad exothermic peak at a larger undercooling. Thermal cycling below the bulk Bi melting temperature leads to a gradual decrease of the solidification enthalpy at larger undercoolings. The results are discussed in the framework of size confinement and interface control of phase transformations.

MM 52.3 Thu 10:45 H26

Investigation of solidification dynamics of Zr-based alloys — •Raphael Kobold[1,2] and Dieter Herlach[1,2] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, 51170 Köln, Germany — [2]Ruhr-Universität Bochum, 44780 Bochum, Germany

In contrast to experiments with most undercooled binary alloys the velocity of dendritic growth of a Cu50Zr50 alloy does not increase monotonically with undercooling but passes through a maximum and then decreases. To study this behaviour we investigate Zr-based alloys such as CuZr, NiZr and NiZrAl with Zirconium concentrations ranging from 36 to 64 at.% including eutectic and intermetallic phases. We use electrostatic levitation technique to melt and undercool samples with a diameter of 2-3 mm under ultra-high-vacuum conditions. Containerless processing is an effective tool for undercooling metallic melts far below their equilibrium melting temperatures since heterogeneous nucleation on container walls is completely avoided. During crystallisation of the undercooled melt the heat of crystallisation is released. The rapid increase of the temperature at the solid-liquid interface makes the solidification front visible. The velocities of the solidification front are recorded by using a high-speed camera with a maximum rate of 50.000 frames per second and are analyzed with a software for optical ray tracing. Furthermore, we try to model the growth velocity vs. the undercooling temperature and perform sample EBSD analysis with a scanning electron microscope. This project is funded by Deutsche Forschungsgemeinschaft, under grant HE1601/26-1.

MM 52.4 Thu 11:00 H26

investigation of nucleation in undercooled melts of pure Ni and Co100-xPdx alloy — •Reeti Singh[1,2], Gerhard Wilde[3], and Dieter Herlach[1,2] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, 51170 Köln, Germany — [2]Institut für Experimentalphysik IV, Ruhr-Universität Bochum, 44780 Bochum, Germany — [3]Institut für Materialphysik, Westfaälische Wilhelms-Universität Münster, 48149 Münster, Germany

Nucleation initiates the formation of a new phase within the environment of the parent phase. It is the phenomenon in nature and technology which is involved in a large variety of phase transformation. In the present work nucleation in undercooled pure Ni and Co80Pd20 is investigated. Levitation and calorimetry techniques were applied to undercooled melts of pure Ni and Co80Pd20. Each sample was undercooled several times (~ 80-100 cycles) and the distribution function of undercooling is determined. The evaluation of the undercooling distribution function in the frame work of the Skripov model yields information about the free energy barrier and the pre-exponential factor to distinguish between heterogeneous and homogeneous nucleation. The free energy barrier and pre-exponential factor was extracted from the measured nucleation rates obtained by using histogram method. The expected value of free energy barrier and pre-exponential factor for homogenous nucleation in case of pure Ni and Co80Pd20 are 74 kBT and 1039 m-3s-1 respectively.

MM 52.5 Thu 11:15 H26

Measurement of nucleation rates using fast scanning calorimetry on samples prepared by the Droplet Emulsion Technique (DET) — •Christian Simon, Joachim Bokeloh, and Gerhard Wilde — Westfälische Wilhelms-Universität, Institut für Materialphysik, Wilhelm-Klemm-Str. 10, 48149 Münster

The most difficult part in experiments on heterogeneous nucleation is the control of the heterogeneous nucleant. On one hand, parasitic nucleants like the container wall and impurities must be removed, and on the other hand the target nucleant phase must be kept at a constant potency. The DET is used to reduce the influence of impurities by dispersing a bulk volume to a fine dispersion of droplets. During the emulsification, a low-catalytic surface coating is applied to reduce the nucleation potency of the surface. The nucleation rate is evaluated by a statistical analysis that treats nucleation as a non-homogenous Poisson process and leads to model-free values of the nucleation rate. A fast scanning nano-calorimeter (10 K/s - 10000 K/s) is used to analyze the nucleation rate over a large number of repeated heating-cooling-cycles on a single droplet. We present experimental data on tin and a tin-bismuth alloy, which were both prepared by DET. Large values of undercooling were observed in tin. Indications of the formation of a metastable phase at large undercooling were observed in the tin-bismuth alloy. In additional experiments, the Sn-Bi alloys were only partially melted and the residual crystalline phase was used to act as heterogeneous nucleation-site.