MM 45: Topical Session Heterogeneous Nucleation II

Time: Friday 10:30–11:45 Location: IFW B

MM 45.1 Fri 10:30 IFW B

Grain refinement of TiAl-based alloys: experiments and model calculation — •Daniel Gosslar[1], Robert Günther[1], Christian Hartig[1], Florian Pyczak[2], Andreas Stark[2], Ulrike Hecht[3], and Rüdiger Bormann[1] — [1]Hamburg University of Technology, Institute of Material Science and Technology, 21073 Hamburg, Germany — [2]Helmholtz-Zentrum Geesthacht, Centre for Materials and Coastal Research, 21502 Geesthacht, Germany — [3]ACCESS e.V., 52072 Aachen, Germany

Turbine blades of TiAl-based alloys are on the verge of series production. The major advantages of these alloys are their good mechanical properties up to at least 800 °C and the relatively low density. Thereby it becomes possible to replace heavier Ni-based alloys in order to save weight and reduce fuel consumption of aircraft engines. Microstructure refinement of TiAl-based alloys is an important issue of concern. It can be achieved by several distinct ways, depending on alloy composition. One possible way offers particle inoculation of the melt using adequate boron / boride additions. Conventional casting experiments are used to study the effect of boride inoculation on the as cast microstructure. The boride phases are investigated by transmission electron microscopy and synchrotron diffraction experiments. For the first time a metastable monoboride is identified in a high boron containing (> 2 at.% B) Ti-45Al (at.%) alloy. The nucleation potency of this boride is evaluated by the crystallographic model of P.M. Kelly and M.-X. Zhang. The grain size evolution is analyzed using the free growth model of L.A. Greer for heterogeneous nucleation.

MM 45.2 Fri 10:45 IFW B

Peritectic solidification in Al-Ni alloys — •Hai-Lin Chen and Rainer Schmid-Fetzer — Institute of Metallurgy, TU Clausthal, Robert-Koch-Str. 42, D-38678 Clausthal-Zellerfeld, Germany

This work aims at a better understanding of the mechanism of peritectic solidification, including the four stages of heterogeneous nucleation, peritectic reaction, peritectic transformation and direct growth of the peritectic phase, and their roles in phase transformation and microstructure evolution. Directionally solidified, non-directionally solidified, quenched and specially heat treated alloys, relevant to the two peritectic reactions, L+NiAl->Ni2Al3 and L+Ni2Al3->NiAl3 in the Al-Ni model system, were investigated. A peritectic "reaction" is believed to occur instantly after a single nucleus of β forms on the primary phase α and result in a very thin peritectic rim, which may have different orientations. Generally, the primary phase α is mainly consumed during peritectic transformation and the amount of consumption may be defined as the "yield" of this step. It depends on the solid-state diffusion across the peritectic envelope and the composition relation between α and β. The diffusion, however, is hindered by the direct growth of β, which can become significant especially if β is located close to the peritectic liquid point and/or if the nucleation of β is difficult and the liquid is deeply undercooled. A new method is presented to tentatively predict the rate of a peritectic transformation according to phase diagram features, and it well accounts for the present experimental evidence that the transformation in L+NiAl->Ni2Al3 is extremely fast while that in L+Ni2Al3->NiAl3 extremely slow.

MM 45.3 Fri 11:00 IFW B

Homogeneous Nucleation and Crystal Crowth of Metallic Nanoparticle Superstructures — •Philip Born and Tobias Kraus — Leibniz-Institut for Neue Materialien (INM), Saarbrücken, Deutschland

The various interparticle interactions in nanoparticle suspensions lead to a phase diagram which is akin the thermodynamic phase diagram of atomic gases. In the atomic-gas-like state of colloidal suspensions, assembly is driven by the strength and directionality of the interparticle potentials, whose range is large compared to the particle size. The phase diagram alters drastically when the ratio between the particle size and the range of the interparticle forces increases. The liquid phase vanishes with increasing ratio, and the system eventually exhibits the temperature-independent jamming phase diagram of macroscopic granular media.

Here, we use sterically stabilized gold nanoparticles as a model system to explore experimentally the thermodynamic concentration-temperature (c-T) phase diagram of a colloidal suspension. We focus on the ordering of the emerging superstructures after quenching the system to the instable regime. By exchanging the capping layer of the gold particles the ratio between particle size and interaction potential range and the interactions among the ligand shells of particles can be changed. By systematically increasing the capping layer thickness, the transition from a rather atom-like to a granular media-like state can be observed. The interactions among the ligand shells of the particles change the interparticle friction and inhibit rearrangement.

MM 45.4 Fri 11:15 IFW B

Effect of production route on microstructural development during heat treatment of nanocrystalline NiTi and NiZr alloys — •Reeti Singh[1], Sergiy Divinski[1], Harald Rösner[1], Ruslan.Z Valiev[2], and Gerhard Wilde[1] — [1]Institut für Materialphysik, Westfälische Wihelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149, Münster, Germany — [2]Institute of Physics of Advanced Materials, Ufa State Aviation University, 12 K. Marx Street, 450000 Ufa, Russian Federation

A comparative study of an amorphous NiTi alloy, produced by severe plastic deformation via high-pressure torsion (HPT) and a NiZr alloy, produced by HPT, repeated cold rolling (RCR) and melt-spinning (MS), is presented. The microstructure evolution is investigated in dependence on the production route by differential scanning calorimetry (DSC), X-ray diffraction analysis and transmission electron microscopy. The DSC signals observed during continuous heating experiments indicate a large separation between the crystallization and growth stages in the amorphous NiTi and NiZr alloys. A detailed analysis of the evolution of the enthalpy release revealed reproducibly non-monotonous trends with the annealing temperature that cannot be explained solely with nucleation and growth of crystalline volume fractions. However, these results as well as detailed kinetics analyses indicate that a reverse amorphization process occurred during annealing around 523 K in the NiTi alloy. The vitrification and crystallization characteristics of NiZr amorphized by HPT, RCR and MS are analyzed for comparison.

MM 45.5 Fri 11:30 IFW B

Laser-induced condensation in model colloid-polymer mixtures: ultralow interfacial free energies between coexisting phases — •Tim Neuhaus[1], Richard L C Vink[2], and Hartmut Löwen[1] — [1]Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, Germany — [2]Institute of Theoretical Physics, Georg-August-Universität Göttingen, Germany

Laser-induced condensation occurs when a system with a bulk liquid-vapor transition is placed into a static external potential which is oscillating in one direction with a wavelength λ. The latter can be realized for colloidal particles by a standing laser field. It was shown previously [1], that for sufficiently large wavelengths λ, the bulk critical point splits into two critical points and a triple point with an intermediate "stacked fluid" phase which is partially condensed in sheets perpendicular to the oscillation direction. These results were obtained by using fundamental measure density functional theory for a colloid-polymer mixture within the Asakura-Oosawa model. Here, we use the same model and technique and calculate the interfacial free energy between all coexisting phases and compare the results with simulation data. We find that the "stacked fluid"-fluid and "stacked fluid"-vapor surface free energies are extremely small.

[1] I. Götze et al, Mol. Phys. **101**, 1651 (2003).