MM 5 Phase transitions II

Time: Monday 11:45–13:00 Room: IFW D

MM 5.1 Mon 11:45 IFW D

Formation of competing γ-Fe and ϕ-phase in undercooled Nd-Fe-B alloys investigated by in-situ diffraction experiments using synchrotron radiation — •Thomas Volkmann[1], Joern Strohmenger[2], Oliver Heinen[1], Dirk Holland-Moritz[1], Jianrong Gao[3], Sven Reutzel[2], and Dieter M. Herlach[1] — [1]Institut für Raumsimulation, Deutsches Zentrum für Luft- und Raumfahrt (DLR), D-51170 Köln, Germany — [2]Institut für Experimentalphysik IV, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [3]Key Lab of Electromagnetic Processing of Materials, Northeastern University, Shenyang 110004, P.R. China

Nd-Fe-B alloys are used for the development of advanced permanent magnets that are based on the $Nd_2Fe_{14}B_1$-phase (ϕ-phase). Under equilibrium solidification conditions of alloys near the stoichiometric composition the ϕ-phase is formed by a peritectic reaction from pro-peritectic γ-Fe. The electromagnetic levitation technique was combined with the diagnostic means at the European Synchrotron Radiation Facilitiy (ESRF) to study in-situ phase formation in the undercooled melt by energy dispersive diffraction experiments during solidification. It was found that the γ-Fe-phase crystallizes primarily in the undercooled melt even at temperatures below the peritectic temperature at which γ-Fe is metastable while the stable ϕ-phase solidifies in a subsequent step.

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MM 5.2 Mon 12:00 IFW D

Effect of melt convection on microstructure evolution of Nd-Fe-B alloys using a forced crucible rotation technique — •Kaushik Biswas[1], Regina Hermann[1], Joerg Acker[1], Gunter Gerbeth[2], Janis Priede[2], and Victor Shatrov[2] — [1]Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Germany — [2]Forschungszentrum Rossendorf e.V., Institut für Sicherheitsforschung, Germany

The forced crucible rotation technique has been applied to the solidification of Nd-Fe-B alloys. Specially sealed samples were subjected to well-defined forced rotation during induction heating and solidification. The resulting microstructure of the Nd-Fe-B alloys in consideration of melt convection has been investigated using scanning electron probe microscopy. The determination of the a-Fe volume fraction by measuring the magnetic moment in a vibrating sample magnetometer (VSM) resulted in a distinct reduction of the a-Fe volume fraction in samples with high crucible rotation frequencies. Furthermore, the investigation has been extended the peritectic Ti-Al system. It could be shown that the secondary dendritic arm spacing of the properitectic phase reduces with increasing forced sample rotation frequency.

MM 5.3 Mon 12:15 IFW D

Solute trapping during rapid solidification of alloys: A phase-field study — •Denis Danilov and Britta Nestler — Karlsruhe University of Applied Sciences, Karlsruhe, Germany

The effect of nonequilibrium solute trapping by growing solid under rapid solidification conditions is studied by a phase-field model. Considering a continuous steady-state concentration profile across the diffuse solid-liquid interface, a new definition of the nonequilibrium partition coefficient in the phase-field context is introduced. This definition leads to a better description of the available experimental data, especially at high growth velocities, in comparison with other diffuse-interface and sharp-interface predictions.

MM 5.4 Mon 12:30 IFW D

Experimental and Theoretical Studies of Solidification in Undercooled Fe-Ni and Fe-Co Droplets — •T.G. Woodcock, H.-G. Lindenkreuz, R. Hermann, and W. Loeser — IFW Dresden, PO Box 270116, D-01171 Dresden, Germany

Fe-Ni and Fe-Co based alloys have important applications as soft magnetic materials. The solidification of such alloys is therefore of interest. Droplets of Fe-Ni and Fe-Co alloys were electromagnetically levitated enabling very high melt undercooling (maximum approx. 300 K). The temperature of the samples was monitored during the solidification process using a two-colour pyrometer and a Si diode with a very fast reaction rate. The recalescence during solidification showed a transition from single step to double step at a critical value of undercooling. The double step recalescence was caused by formation of a metastable bcc phase and subsequent transformation to the equilibrium fcc phase in both Fe-Ni and Fe-Co alloys. A thermodynamic database was used to generate values of the enthalpy of formation for the fcc and bcc phases in three different Fe-Co alloys. Based on classical nucleation theory, the free energy of formation of a spherical nucleus was calculated. Calculation of the nucleation rate of these two phases showed that below a critical undercooling, the metastable bcc phase can have a higher nucleation rate than the equilibrium fcc phase.

MM 5.5 Mon 12:45 IFW D

Primary crystallization of the hypoeutectic Ni-17at.% P alloy by ASAXS — •Rainer Kranold[1], Dragomir Tatchev[2], Günter Goerigk[3], and Stephan A. Armyanov[2] — [1]Institut für Physik, Universität Rostock, D-18051 Rostock, Germany — [2]Institute of Physical Chemistry, Bulgarian Academy of Sciences, Sofia 1113, Bulgaria — [3]Institut für Festkörperforschung, Forschungszentrum Jülich, PF 1913, D-52425 Jülich, Germany

During the primary crystallization of a hypoeutectic Ni-P alloy, according to the equilibrium phase diagram, crystallites of pure Ni should be precipitated until the matrix reaches the eutectic composition with 19 at.% P. However, several authors assume that the precipitating Ni particles contain a certain P amount. We investigated with anomalous small-angle X-ray scattering (ASAXS) the primary crystallization of Ni(P) particles in the amorphous hypoeutectic Ni-17 at.% P alloy. Using the maximum entropy method, the particle size distribution, the size dependence of the particle composition and the amorphous matrix composition could be found simultaneously. The size distribution consists of a peak at particle radius of 1 nm and a tail spanning from 2 to 15 nm. The composition of the particles of the peak changes from 14 to 2 at.% P as their radius grows from 0.7 to about 3 nm. The particles in the tail of the size distribution (2-15 nm) have nearly constant P content in the range of 0-2 at.%. The matrix composition tends to the eutectic one at the end of the primary crystallization process. Our experimental results comply the predictions of a new nucleation theory developed recently [1]. [1] D. Tatchev et al., J. Appl. Cryst. 38 (2005) 787