MM 23 Phasenumwandlung III

Zeit: Samstag 14:45–16:30 Raum: TU H1058

MM 23.1 Sa 14:45 TU H1058

Phase-field study of the cellular bifurcation in dilute binary alloys — •Mathis Plapp and Esteban Meca — Laboratoire PMC, Ecole Polytechnique, 91128 Palaiseau, Frankreich

In the directional solidification of dilute binary alloys, a planar interface becomes unstable at a critical speed of the solidification front that depends on the alloy concentration and the applied temperature gradient. We investigate the microstructures that form closely above this instability threshold using phase-field simulations in both two and three dimensions. In particular, we study the so-called 'node' or 'pox' structures that consist of regular hexagonal arrays of 'holes' (local depressions of the solidification front) and compare their properties to the ones of the well-known hexagonal cell patterns. The results are compared to the predictions of weakly nonlinear amplitude expansions as well as to experimental findings.

MM 23.2 Sa 15:00 TU H1058

In-situ Determination of Phase Selection Sequences and Short-Range Order in Undercooled Ti-Fe-Si-O Melts — •Oliver Heinen, Dirk Holland-Moritz, Thomas Volkmann, Jörn Strohmenger, and Dieter M. Herlach — DLR, Inst. für Raumsimulation, D-51170 Köln

The alloy system Ti-Fe-Si-O shows a great variety of complex stable and metastable phases. Depending on composition and undercooling different solidification pathways are found. The large number of alloy phases in Ti-Fe-Si-O leads to a strong competition of phase selection during rapid solidification of undercooled melts. In order to determine the phase formation sequence as function of composition and to examine possible dependencies on the short-range order (SRO) of the undercooled liquid, in situ investigations of SRO and solidification pathways were performed. The containerless processing technique of electromagnetic levitation was combined with energy dispersive diffraction of synchrotron radiation at the European Synchrotron Radiation Facility. This enables us to directly determine the crystal structure of the solid phases formed during rapid solidification and to study the SRO of the liquid in the same experiment. Depending on the undercooling different solidification sequences were found. In addition the SRO was also investigated using neutron diffraction at the Institut Laue-Langevin. The complementary results on the SRO obtained by neutron and x-ray diffraction are discussed in terms of the effects of topological and chemical SRO.

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MM 23.3 Sa 15:15 TU H1058

In-situ Determination of Phase Formation in Undercooled Nd-Fe-B-melts – Identification of a Metastable Phase with Synchrotron Radiation — •Jörn Strohmenger[1], Thomas Volkmann[1], Jianrong Gao[2], Sven Reutzel[3], Dirk Holland-Moritz[1], Oliver Heinen[1], and Dieter M. Herlach[1] — [1]Institute of Space Simulation, German Aerospace Center (DLR), D-51170 Cologne — [2]Key Lab of Electromagnetic Processing of Materials (EMP), Northeastern University, Shenyang 110004, China — [3]Institute of Experimental Physics IV, Ruhr-University Bochum, D-44780 Bochum

Nd-Fe-B alloys are of special interest due to the excellent hardmagnetic properties of the intermetallic compound $Nd_2Fe_{14}B_1$ (Φ-Phase). Competitive crystallisation of stable and metastable phases in undercooled Nd-Fe-B melts was investigated using electromagnetic levitation combined with in-situ X-ray diffraction experiments at the ESRF. Under equilibrium conditions for alloys near the stoichiometric composition the Φ-phase is formed by a peritectic reaction from pro-peritectic γ-Fe. For Nd-contents between 10 and 18at% at the ratio $\frac{\mathrm{Nd}}{\mathrm{B}} = \frac{2}{1}$ it is shown that the crystallization of primary phase is affected by undercooling, e.g a metastable phase can be directly observed which initiates the formation of the Φ-phase. It can be identified as a ternary extension of the rhombohedral Nd_2Fe_{17} phase being stable in binary Nd-Fe alloys. A phase selection diagram showing the different solidification pathways as a function of undercooling and alloy composition will be analysed within theories of nucleation and crystal growth. This work was supported by DFG under contract No. HE1601/14.

MM 23.4 Sa 15:30 TU H1058

Phase-field simulations of solidification structures in multicomponent (Ni-Cu-Cr) and multiphase (Al-Cu) alloys — •Denis Danilov and Britta Nestler — Karlsruhe University of Applied Sciences, Karlsruhe, Germany

Phase transformations in multicomponent and multiphase (e.g. eutectic) systems play a major role during solidification processes of a variety of alloys. Using a general phase-field model we investigate growth microstructures and their dependence on solidification conditions in such systems. In ternary Ni-Cu-Cr alloy a morphological transition from dendritic to globular growth is found by varying the alloy composition at a fixed underccoling. The dependence of the growth velocity and of the impurity segregation in the solid phase on the composition is analyzed and indicates a smooth type of transition between the dendritic and globular structures. The stability of lamellar eutectic structure in Al-Cu alloy is investigated and two possible types (regular and oscillatory) of the growth structures have been found depending on the lamellar spacing and on the off-eutectic composition. The work was supported by DFG under project No. Ne 882/2.

MM 23.5 Sa 15:45 TU H1058

Die Entstehung dendritischer Mikrostruktur in einem metallischen Glaskomposit — Y.-L. Huang[1], •T. Niermann[1], M. Seibt[1], S. Schneider[1], B. Nestler[2] und D. Danilov[2] — [1]IV. Physikalisches Institut der Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Fachhochschule Karlsruhe, Moltkestrasse 30, 36133 Karlsruhe

Wir präsentieren die Ergebnisse unserer Untersuchungen der Mikrostruktur eines massiven Glas-Komposits. Die Untersuchungen wurden mittels Transmissionselektronenmikroskopie (TEM), energiedispersiver Röntgenanalyse (EDX) und Elektronenenergieverlustspektroskopie (EELS) durchgeführt. Dabei beobachten wir eine in der Glasmatrix eingebettete dendritische BCC-Phase, die während der Abkühlung einer Schmelze der Zusammensetzung $Zr_{59}Ti_{14}Nb_5Cu_7Ni_6Be_{12}$ entsteht. Die Verteilungen der Elemente (Zr, Ti, Nb, Cu, Ni und Be) im Volumen der beiden Phasen sowie an der Grenzfläche zwischen Dendrit und Matrix konnten experimentell bestimmt werden. Die experimentellen Ergebnisse werden mit numerisch simulierten Konzentrationprofilen verglichen. Zur Durchführung der Simulationen des dendritischen Wachstums wird ein pseudo-ternäres Phasendiagramm mit 3 Komponenten A=(Zr,Ti,Nb), B=(Ni,Cu) und Be betrachtet. Wir verwenden eine allgemeine Formulierung eines multikomponentigen Phasenfeldmodells zur Beschreibung des Phasenübergangs von der Schmelze zum Dendriten.

MM 23.6 Sa 16:00 TU H1058

Solidification of Undercooled Si, Si-Co and Si-Ge Melts — •C. Panofen[1], R.P. Liu[2], and D.M. Herlach[1] — [1]DLR Köln, Institut für Raumsimulation — [2]Yanshan University, Qinhuangdao, China

We undercooled and solidified pure Si, dilute Si-Co and Si-Ge melts in a high purity environment containerlessly by electromagnetic and electrostatic levitation techniques. Without surrounding crucible walls and thus reducing heterogeneous nucleation sites we achieved large melt undercoolings of up to 330K.

Crystallization at the desired undercooling was initiated by triggering with a silicon wafer. The velocity of the solidification front as a function of undercooling was directly determined with a high speed camera.

We analyzed the growth behavior within current theories of crystal growth in undercooled melts. Special emphasis was placed to a microstructure transition from faceted to dendritic growth. The results of the growth measurements were correlated to microstructure formation upon undercooling prior to solidification.

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MM 23.7 Sa 16:15 TU H1058

SANS Untersuchungen an unterkühlte Schmelze — •O. Perroud[1], A. Wiedenmann[1], D. Holland-Moritz[2] und D. Herlach[2] — [1]Hahn-Meitner Institut Berlin, Glienickerstr.100, D-14109 Berlin — [2]DLR, Institut für Raumsimulation, Linder Höhe, D-51147 Köln

Über die Natur möglicher Nahordnung in unterkühlten Schmelzen ist bisher wenig bekannt. Theoretische Arbeiten [1] postulierten eine ikosaedrische Nahordnung, die kürzlich durch eleastische Neutronenstreuexperimente im Großwinkelbereich bestätigt wurde [2]. Wir berichten über Untersuchungen an unterkühlten Schmelzen von reinem Ni und von Cu-Co Legierungen mit Hilfe der Neutronen-Kleinwinkelstreuung. Die Proben wurden in einem elektromagnetischen Levitationsofen geschmolzen und in-situ auf dem SANS Instrument V4 am HMI, Berlin untersucht. Durch den tiegelfreien Prozess der Schmelze unter hochreinen Bedingungen wurde heterogene Keimbildung unterdrückt, wodurch Unterkühlungen bis zu 300°C erreicht wurden. Im Verlauf der Unterkühlung tritt neben der inkohärenten Flüssigkeitsstreuung ein Kleinwinkel-Streusignal auf, das auf Dichte-Fluktuationen im Nanometerbereich hindeutet. [1] F.C. Frank, R. Soc. A215(1952) 43. [2] T. Schenk, D. Holland Moritz, V. Simonet, R. Bellissent and D.M. Herlach, Phys. Rev. Lett. 89 (2002) 075507.