

MM 14 Wachstum

Zeit: Freitag 14:45–16:15

Raum: TU H2038

MM 14.1 Fr 14:45 TU H2038

Auf der Suche nach einem Modellsystem zum Verständnis der Korrelationseffekte beim normalen Kornwachstum — ●ANNE-CATHERINE PROBST¹, DMITRI MOLODOV², RAINER BIRINGER¹ und CARL E. KRILL³ — ¹FR 7.3 Technische Physik, Universität des Saarlandes, Postfach 151150, 66041 SAARBRÜCKEN — ²Institut für Metallkunde und Metallphysik, R.W.T.H. Aachen, Kopernikusstr. 14, 52056 AACHEN — ³Abt. Werkstoffe der Elektrotechnik, Universität Ulm, Albert-Einstein-Allee 47, 89081 ULM

Die physikalischen Eigenschaften polykristalliner Materialien hängen in hohem Maße von der Größe der Kristallite ab. Dementsprechend ändern sich diese Eigenschaften, wenn Kornwachstum durch Anlassen bei hinreichend hohen Temperaturen induziert wird. Bisher gibt es keine Theorie, die das Kornwachstum einphasiger Materialien – sog. normales Kornwachstum – vollständig beschreibt. Insbesondere können analytische Modelle wie die mean-field-Theorie von Hillert die lognormale Form experimentell gefundener Korngrößenverteilungen überhaupt nicht erklären. Um dieses Defizit zu beheben, formulierte Wu eine neue, auf einem nicht-mean-field-Ansatz beruhende Wachstumstheorie, die explizit die Existenz einer Korngrößenkorrelation zwischen benachbarten Körnern berücksichtigt. Es wurde ein Modellsystem für normales Kornwachstum gesucht, welches zur experimentellen Überprüfung des Wuschen Ansatzes dienen sollte.

MM 14.2 Fr 15:00 TU H2038

The size distribution induced by normal grain growth is lognormal in shape—fact or fiction? — ●CARL E. KRILL III¹, MAX ZIEHMER², and LUKAS HELFEN³ — ¹Materials Division, Albert-Einstein-Allee 47, University of Ulm, D-89081 Ulm — ²FR 7.3 Technical Physics, Geb. 43B, University of the Saarland, D-66123 Saarbrücken — ³ESRF, BP 220, F-38043 Grenoble Cedex

Experimental investigations of normal grain growth invariably find that the distribution of grain sizes can be approximated by a lognormal function. Computer simulations of the same process, however, predict a far more symmetrical distribution shape, regardless of the underlying algorithm used to model the migration of grain boundaries. One possible explanation for this discrepancy arises from the manner in which the grain size is determined: in experiment, one generally relies on the cross-sectional area evident in a two-dimensional section passing through the grain, whereas one has access to the full three-dimensional grain volume during a simulation. By applying 2-D and 3-D grain-size analyses to identical polycrystalline microstructures, we have attempted to assess the extent to which stereological factors contribute to the apparent shape of the size distribution generated by normal grain growth. Results obtained using experimental coarsening data are compared to those of a large-scale grain-growth simulation, with the goal of determining whether the size distribution really differs in the two cases.

MM 14.3 Fr 15:15 TU H2038

Dendritic structure and solidification kinetics of undercooled Ni-Zr alloys — ●PETER GALENKO, DIETER HERLACH, GANDHAM PHANIKUMAR, and OLIVER FUNKE — Intitut fuer Raumsimulation, DLR, 51170 Koeln, Deutschland

Ni-Zr droplets have been melted and undercooled in electromagnetic levitation facility. After controlled triggering of solidification, measurements of solidification velocity have been provided by capacity sensor technique and high-speed camera technique. Novel experimental results on the kinetics of solidification of undercooled Ni-Zr alloys are found. The velocity-undercooling relationship have been plotted for three contents of diluted Ni-Zr alloys and metallographic investigations of a crystalline structure have been performed. The microstructure of all samples is found to be a dendritic like. The microstructural features as a function of undercooling are attributed to morphological transitions, viz., from grain refined (GR) equiaxed microstructure to a coarse grained (CG) dendritic microstructure and to a grain refined (GR) equiaxed microstructure. The kinetics of dendritic growth in undercooled droplets are analysed using the local nonequilibrium solidification model [1]. The experimental values of critical undercoolings for the GR-CG-GR transitions are compared with the modeling predictions. The disagreement of the theoretical predictions are attributed to the influence of convective flow, especially, at small and moderate undercoolings.

The work was supported by DFG under contract No. He 1601/13.

[1] P.K. Galenko and D.A. Danilov, Phys. Lett. A 235 (1997) 271; J. Cryst. Growth 197 (1999) 992.

MM 14.4 Fr 15:30 TU H2038

Growth kinetics of dendrites in Ni and Ni-Zr systems: Simulations and experiments — ●DENIS DANILOV¹, PETER GALENKO², and BRITTA NESTLER¹ — ¹Karlsruhe University of Applied Science, Karlsruhe, Germany — ²German Aerospace Center, Cologne, Germany

The morphologies and the kinetics of dendritic microstructures in pure Ni as well as in Ni-Zr alloys are modeled using the phase-field simulations. The simulation results are compared with experimental data on solidified samples processed by electromagnetic levitation facility and with the solutions of a sharp-interface model. In particular, we consider the velocity-undercooling relations for different thermophysical data and for different compositions in 2D and 3D. We use a phase-field model for non-isothermal solidification in multicomponent systems consistent with the formalism of classic irreversible thermodynamics to perform the numerical simulations of the dendritic growth structures. 3D morphology transitions are obtained for variations in surface energy and kinetic anisotropies at different undercoolings. In computations, we investigate the convergence behaviour of a standard phase-field model and of its thin interface extension at different undercoolings and at different ratios between the diffuse interface thickness and the atomistic capillary length. The influence of the grid anisotropy is accurately analyzed for a finite difference method and for an adaptive finite element method in comparison. The work was supported by DFG under contracts No. Ne 882/2 and He 1601/13.

MM 14.5 Fr 15:45 TU H2038

Controlling of symmetry and fractal dimension of Xe dendrites by heating — ●MARCO FELL, HERMAN M. SINGER und JÖRG H. BILGRAM — Laboratorium für Festkörperphysik, ETH, CH-8093 Zürich, Switzerland

Xenon dendrites, grown in supercooled melt ($\Delta T \sim 100 - 200$ mK), show characteristic sidebranching frequencies depending on supercooling. They are statistically symmetric and the contours' outlines have a characteristic fractal dimension, depending on morphologies: dendrite, seaweed and dendritic doublon.

We experimentally perform periodical heating of the melt close to the melting point and observe a change in the growth morphology of the crystal: The whole dendrite stops growing or even begins to melt, depending on power and duration of heating. After stopping the heating, the liquid xenon cools down and growth restarts. Interestingly four absolutely symmetrical lobes start to grow at the main tip.

This process is found to form crystals with a lower fractal dimension as well as a lower curvature of the contour than known in the morphologies for free growth.

MM 14.6 Fr 16:00 TU H2038

Interacting Xenon Dendrites — ●OLIVER WITTEWIT und JÖRG BILGRAM — Laboratorium für Festkörperphysik, ETH, CH 8093 Zürich, Switzerland

In our experiments we investigate in situ three dimensional pattern formation of xenon crystals during free growth. Well known morphologies are dendrites, doublons and seaweed. We also observe triplons and quadruplons. The transition from dendrite to doublon has gained interest since it has been discovered in metallic samples [1]. Transitions between these morphologies can be initiated in our experiments by changing the temperature distribution in the environment of a growing crystal [2].

In this communication we report on periodic oscillations in growth velocity induced by the interaction of two dendrites growing close to each other. The amplitude of these oscillations is in the range of 20% of tip velocity and increasing with time. These oscillations have to be compared with the growth velocity of a freely growing isolated dendrite where fluctuations in growth rate (mainly due to pixel noise) are below $\pm 1.5\%$ of tip velocity at the same experimental conditions.

[1] K. Dragnevski, R. F. Cochrane, and A. M. Mullis, Phys. Rev. Lett. **89**, 215502 (2002)[2] I. Stalder and J. H. Bilgram, Europhys. Lett. **56**, 829 (2001)