MM 12: Growth

Time: Monday 16:15–17:45 Location: H6

MM 12.1 Mon 16:15 H6

Growth History of Single Grains in 3D Normal Grain Growth — •Dana Zöllner and Peter Streitenberger — Otto-von-Guericke-Universität Magdeburg, Institut für Experimentelle Physik, Abteilung Materialphysik, PF 4120, D-39016 Magdeburg

A 3D grain growth model is presented, which allows the prediction of the growth history of single grains. The model is based on a generalised mean-field approach resulting in an analytic grain size distribution function that represents the data of three dimensional grain growth - simulated with a large 3D Monte Carlo Potts model algorithm - very well. The parameters from the obtained grain size distribution are then used to calculate an analytic function representing the further growth history by showing the temporal development of the grain radius for a fixed but selectable initial grain size. The results are compared with the 3D Monte Carlo simulation giving very good agreement. Furthermore, the life spans of single grains are calculated as a function of their size showing again a good agreement with the simulation results.

MM 12.2 Mon 16:30 H6

Abnormal grain growth of nanocrystalline materials: In situ investigation in the SEM — •Michael Marx, Andreas Noll, and Horst Vehoff — Saarland University, Materials Science, Building D22, 66041 Saarbrücken, Germany

To develop nanocrystalline (NC) and ultra fine grained (UFG) materials to secure operating construction materials, it is essential to stabilize the microctructure. So far the different mechanisms of grain growth and recrystallization were often investigated however a final description through all stages of grain growth is missing. Therefore in this work NC und UFG materials which were produced by different procedures were imaged in a SEM during heat treatment. The materials investigated were pulse electro deposited (PED) nickel, severe plastic deformed (SPD) aluminium by equal channel angular pressing for 2 and for 8 passes and an AlMgSi-alloy produced by accumulative roll bonding also for 2 and for 8 passes. No significant difference in the development of the microstructure between PED and SPD materials was found. In every case there is abnormal grain growth which results in an UFG matrix with some large grains of more than 100 um, the ratio of matrix grains and larger grains varies with the heat treatment. The growth of the large grains was monitored and the growth kinetics measured. By focused ion beam combined with orientation imaging microscopy, the growing grain boundaries could be identified as (100)-planes. So far the investigations are not finished however it will not be easy to find a heat treatment to produce a mono-modal ultra fine grained microstructure which is stable at moderate temperatures.

MM 12.3 Mon 16:45 H6

In situ investigation of Ostwald ripening in Al-Cu alloys by x-ray microtomography — •Mehdi Lalpoor[1], Lukas Helfen[2], and Carl Krill[1] — [1]Institute of Micro and Nanomaterials, Ulm University, D-89081 Ulm — [2]Institut für Synchrotronstrahlung (ISS/ANKA), Forschungszentrum Karlsruhe, D-76021 Karlsruhe

Conventional methods for studying Ostwald ripening in multiphase alloys rely on the characterization of planar sections, which provide access to statistically averaged microstructural parameters but not to local quantities, like the actual 3D shapes of individual particles. Serial sectioning can capture the 3D microstructure of solid specimens, but it destroys them in the process, rendering the procedure unsuitable for *in situ* coarsening studies. In contrast, x-ray microtomography delivers 3D microstructural data in a nondestructive manner, thus providing a way to track sample evolution over time. We report a first application of this approach to Ostwald ripening occurring in the model system Al-6.7 wt% Cu above its eutectic temperature. A temporal sequence of absorption-contrast tomographic images reveals the growth/shrinkage of solid α-Al particles embedded in a liquid phase richer in Cu. Microstructural evolution is found to be a superposition of coarsening-driven migration of phase boundaries and gravity/thermal gradient-driven vertical displacement. Quantitative values for local and global coarsening rates are extracted via image segmentation and combined with the results of conventional 2D studies to obtain additional insight into the influence of the volume fraction of the coarsening phase on the kinetics of Ostwald ripening in this system.

MM 12.4 Mon 17:00 H6

Modeling of equiaxed solute-controled dendrites which interact via a temperature* field — •Matthias Jurgk[1], Heike Emmerich[2], and Ricardo Siquieri[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Dresden, Germany — [2]Institut für Gesteinshüttenkunde, Rheinisch-Westfälische Technische Hochschule, Aachen, Germany

A fundamental challenge in the modeling of solidification processes arises from the many different length scales, on which important subprocesses take place.

We discuss a model for dendritic microstructures in the solidification of binary alloys. For most alloys the transport scales of solute diffusion and heat diffusion differ by several orders of magnitude. The two-scale model, which we discuss, includes both these transport scales in an efficient manner and enables us to study a whole array of equiaxed dendrites, whose microstructure morphology is controled by the slow solute transport but which interact with each other via the fast temperature transport.

One crucial parameter of the model is the ratio of both transport scales. Our numerical investigations of the model indicate the existence of two different growth regimes of the dendrites in dependence on the ratio of the transport scales. Another important parameter in the model is the density of the dendritic nuclei in the considered domain. We will also discuss the influence of this density on the growth dynamics of the dendritic microstructures.

MM 12.5 Mon 17:15 H6

Recrystallisation phenomena of HPT-processed 99.99% iron. — •Kejing Yang[1], Ralf Theissmann[2], Julia Ivanisenko[2], and Hans-Jörg Fecht[1,2] — [1]Materials Division, University of Ulm, 89091 Ulm, Germany — [2]Institut für Nanotechnology, Forschungszentrum Karlsruhe, 76021 Karlsruhe, Germany

The understanding of mechanisms governing the recrystallisation of nanocrystalline metals and alloys is important for fundamental materials science, but also for practical applications of such materials, because it can help to find out the routs for improvement of their thermal stability. We conducted a comprehensive investigation of microstructure evolution upon annealing in the temperature range between 100°C and 400°C of high purity (99.99%) iron processed by severe plastic deformation using transmission and orientation imaging microscopy, and XRD analysis. The as-processed microstructure was typical of severely deformed metals consisting of grains with a mean size of 160 nm, and subgrains with a mean size of 90 nm. The grain boundaries originated from plastic deformation are in non-equilibrium state, which is manifested in presence of steps and facets in their structure, and a high level of micro stresses of 0.2 %. After annealing at 200°C for 1 hour, a growth of both grains and subgrains was observed, and after 400°C the microstructure was completely recrystallised. The mechanism of recrystallisation of as-processed iron was of continuous type. Surprisingly, a very high dislocation density was observed in grains after recrystallisation. Presumably, these dislocations appeared as a result of migration of grain boundaries with steps.

MM 12.6 Mon 17:30 H6

Kinetics of grain growth in nanocrystalline Fe at low annealing temperatures — •Heiko Paul and Carl Krill — Institute of Micro and Nanomaterials, Ulm University, D-89081 Ulm

At low annealing temperatures the rate of grain growth observed in nanocrystalline materials can be orders of magnitude smaller than would be expected from an extrapolation of high-temperature growth recorded in coarse-grained counterparts. One possible explanation for this observation rests on the drag force exerted on moving grain boundaries by triple junctions (TJ), the migration rate of which is independent of the average grain size $\langle R \rangle$ [1]. Since the curvature-driven speed of a grain boundary (GB) varies inversely with $\langle R \rangle$, there must be a critical grain size below which TJ migration becomes the rate-controlling step for grain growth. Likewise, if the activation enthalpy for triple-junction migration is higher than that of grain boundaries, then low annealing temperatures should favor TJ-controlled growth. We have searched for the latter by carrying out long-term *in situ* investigations of coarsening in high-purity nanocrystalline Fe at temperatures as low as 470°C. Grain growth was measured in a laboratory