MM 7: Microstructure and Phase Transformations II

Time: Monday 11:45–13:00 Location: H 0106

MM 7.1 Mon 11:45 H 0106

Shake, rattle and roll! Direct measurement of grain rotations during Ostwald ripening in semisolid Al-5 wt% Cu — Jules Dake[1], Jette Oddershede[2], Thomas Werz[1], Henning Osholm Sørensen[3], Søren Schmidt[2], and •Carl Emil Krill III[1] — [1]Ulm University, Germany — [2]Technical University of Denmark, Denmark — [3]University of Copenhagen, Denmark

Materials scientists studying the coarsening of crystalline solids have long speculated that individual crystallites can undergo rigid-body rotation while shrinking or growing by the usual mechanism of boundary migration. The driving force for such grain rotations would be a reduction in interfacial energy: if two grains rotate toward each other's orientation, the boundary between them will become smaller in angle or even vanish, thereby lowering the free energy of the system. Investigations of spherical grains placed on single-crystalline substrates have lent credibility to this hypothesis; however, it remains to be determined whether grain rotation also takes place under technically relevant conditions, such as the sintering of closely packed powders or the Ostwald ripening of a two-phase material. Employing the recently developed technique of three-dimensional x-ray diffraction (3DXRD) microscopy, we have obtained direct evidence for the occurrence of grain rotations in a bulk, semisolid Al-Cu alloy undergoing Ostwald ripening. Not only did we find that the magnitude of grain rotations increases with relative volume of the liquid phase (as one might naively expect), but we also discovered that the orientation dependence of the interfacial energy biases the direction of rotation.

MM 7.2 Mon 12:00 H 0106

Anomalous Grain Growth in Friction Stir Welded Aluminium — •Michael Kreissle[1], Janina Diessenbacher[1], Sahin Sünger[2], and Ferdinand Haider[1] — [1]Univ. Augsburg, Inst. f. Physik, 86135 Augsburg — [2]TU München, Inst. f. Werkzeugmaschinen und Betriebswissenschaften, 85748 Garching

Friction Stir Welding is a solid state joining technique using a rotating, forward moving tool, which plastifies and locally mixes the joining parts. Due do the extreme plastic deformation during the process, considerable changes in the microstructure in and around the weld seam take place. Normally this results in a very fine grained material, but in certain aluminium alloys like e.g. Al2195 subsequent heat treatments, sometimes only in combination with a precedent low temperature deformation can cause extreme anomalous grain growth. In this presentation results from metallographic analysis of samples showing such anomalous grain growth are shown. The onset can be controlled by the degree of precedent deformation, but also by welding parameters and by addition of further elements into the weld seam.

MM 7.3 Mon 12:15 H 0106

Influence of the heat treatment on the precipitation behavior on age-hardenable commercial Al-based alloys AA2195. — •Muna Khushaim[1], Judith Seibert[2], Ferdinand Haider[2], and Talaat Al-Kassab[3] — [1]Physical Sciences and Engineering Division, King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Kingdom of Saudi Arabia. — [2]University Augsburg, Inst. f. Physics, D - 86159 Augsburg, Germany. — [3]D-37077, Göttingen, Germany.

Many aluminum age-hardenable alloys have a good combination of strength and formability and exhibit an attractive enhanced strength/weight ratio. The enhancement of the mechanical properties has largely been attributed to the formation of different precipitates such as: T_1 (Al_2CuLi), θ' (Al_2Cu), δ' (Al_3Li) and β' (Al_3Zr).The object of this work is to investigate the dependency of the precipitation kinetics on the performed heat treatment conditions. Aluminum-Lithium - copper alloy AA2195 was selected as a model system in the present study. Common industrial heat treatments such as: T8 temper, T4 temper and T6 temper have been examined. Results are obtained by utilizing transmission electron microscopy (TEM), micro-hardness Vickers measurement, differential scanning calorimetry (DSC) and atom probe tomography (APT). In this contribution a detailed analysis of the correlation between the microstructure developments owing to the respective treatment condition and the hardening process will be presented.

MM 7.4 Mon 12:30 H 0106

Coherency and coarsening behavior of Al3(Sc,Zr) precipitation in aluminum alloys subjected to severe plastic deformation — •Vladislav Kulitckii[1], Sergey Malopheyev[1], Rustam Kaibyshev[1], Sergiy Divinski[2], and Gerhard Wilde[2] — [1]Laboratory of Mechanical Properties of Nanoscale Materials and Superalloys, Belgorod State University, Pobeda 85, Belgorod 308015, Russia — [2]Institute of Materials Physics, University of Münster, Wilhelm-Klemm-Str. 10 Münster, Germany

The coarsening behavior of the Al3(Sc,Zr) particles in Al-5.4Mg-0.4Mn-0.2Sc-0.09Zr (alloy 1) and Al-4.6Mg-0.35Mn-0.2Sc-0.09Zr (alloy 2) alloys was investigated using transmission electron microscopy (TEM). The alloys were subjected to equal channel angular pressing (ECAP) in the temperature range of 300-450°C and up a to total strain of ϵ~12. In the initial state, homogeneously distributed round nanoscale Al3(Sc,Zr) precipitates with average size ~9 nm were observed. Some of these particles featured a characteristic coffee-bean contrast, reflecting their coherence with the matrix. The severe plastic deformation of alloy 1 does not lead to significant coarsening of the Al3(Sc,Zr) particles, their average size was ~11 nm after ECAP at 300, 350, 400 and 450°C. Moreover, the coffee-bean TEM contrast was retained indicating the coherence between particles and matrix. In alloy 2, the Al3(Sc,Zr) precipitates demonstrated a different behavior. After deformation at 300-450°C, no significant change of the size of these precipitates was observed; however, some fraction of the particles lost their coffee-bean contrast and appeared as black circles.

MM 7.5 Mon 12:45 H 0106

Cluster model for precipitation in Al-alloys — •Tobias Stegmüller and Ferdinand Haider — Universität Augsburg, Inst. f. Physik, 86135 Augsburg

Precipitation processes in modern aluminum alloys are due to their signifance for mechanical properties of great technical interest. Proper choice of alloying elements in precipitation hardened alloys as well as an appropriate heat treatment allows to reach middle to high strength and to control corrosion resistance.

Despite the fact, that most of these processes are well understood both qualitatively and quantitatively, there is still a lack in a precise correlation between process parameters the resulting material properties. A key role for such a correlation can be formed by a precise model allowing to simulate the kinetics of a precipitation reaction.

One approach to model unmixing in binary alloys is the so-called dynamic cluster model. The basic idea is to describe the temporal evolution of the precipitate size distribution, starting from a supersaturated homogeneous solid solution. Mathematically, this means to solve an initial value problem: taking n as number of solute atoms in one particular cluster, c_n the concentration of clusters of size n, the temporal evolution is given by a master equation in terms of the respective probabilities for cluster growth and shrinkage of clusters containing n atoms.

In this work we present first results for an extended model for alloys with more than two components and with more complicated sequences of precipitate phases, as they occur in e.g. Al-Zn-Mg or Al-Cu alloys.