# MM 18 Materials Design

Time: Tuesday 14:45–16:00 Room: IFW B

MM 18.1 Tue 14:45 IFW B

**Three-dimensional analysis of globular microstructures by means of phase sensitive Synchrotron Tomography** — •Simon Zabler[1], Andreas Lohmüller[2], Alexander Rack[3], Astrid Haibel[1], Heinrich Riesemeier[4], Jürgen Goebbels[4], John Banhart[1], and Antonio Rueda[1] — [1]Hahn-Meitner-Institut Berlin, Abteilung Strukturforschung — [2]Neue Materialien Fürth GmbH — [3]Forschungszentrum Karlsruhe - ANKA — [4]Bundesanstalt für Materialforschung und -prüfung Berlin

We investigate materials with globular microstructure as used in Thixocasting processes like A356, A357 and AZ91D alloys. Phase sensitive synchrotron tomography is the ideal non-destructive tool for the analysis of such materials. The effects of growth and coarsening are analysed as well as the dynamics of the semi solid melt.

The aim of our work is to use 3D image processing in order to reveal the correlation between the alloys microstructure and its rheological properties (e.g. viscosity) in the semi solid state. Because all the samples under test represent alloys that are built from neighbouring elements with similar densities (e.g. Aluminium and Silicon) standard absorption tomography lacks any visible contrast in the images. We apply phase contrast imaging yielding a contrast up to three orders of magnitude superior to absorption contrast rendering the microstructure of all the alloys under test visible. Tomography data is available in form of phase sensitive 3D images or holotomographic data sets when the tomographic reconstruction is combined with a direct phase retrieval algorithm.

MM 18.2 Tue 15:00 IFW B

**Synchrotron Tomography on Complex Material Systems** — •A. Rack[1], L. Helfen[1], I. Manke[2], S. Zabler[2], C. Knabe[3], H. Riesemeier[4], M. Stiller[3], J. Goebbels[4], T. Baumbach[1], and J. Banhart[2] — [1]Forschungszentrum Karlsruhe – ANKA — [2]Hahn-Meitner-Institut Berlin, Bereich Strukturforschung — [3]Charité Berlin — [4]Bundesanstalt für Materialforschung und -prüfung, Berlin

High resolution synchrotron-tomography investigations on metal foams, commercial batteries and novel rapidly resorbable bone substitutes (ceramics like Bioglass, Cerasorb) are reported. The measurements were performed with high spatial resolutions at the synchrotrons ESRF (ID19), BESSY (BAM*line*) and ANKA (TOPO-CT). The use of monochromatic radiation and the application of subsequent 3d image analysis [1] enables us to separate different material phases in the volume data sets, e.g. solid matrix and blowing agents' particles in metal foams or tissue and ceramics in a reshaping jawbone. This provides the basics for *ex situ* and *in situ* imaging on materials and devices. Firstly, the pore formation process in early stages (1% to 10% porosity) of aluminium foams could be studied *ex situ*. Secondly, the time and spatial dependence of a commercial batterie's zinc powder decay was quantified *in situ*. Finally, quantitative determination of the formation and structural changes of the bony tissue in a given defect plus the biodegradation of the bone substitute materials within animal and human biopsies 3, 4 and 6 months after implantation were performed *in vitro*.

[1] J. Ohser and F. Mücklich, *Statistical Analysis of Microstructures in Materials Science*, John Wiley & Sons, 2000

MM 18.3 Tue 15:15 IFW B

**Beating the Miscibility Barrier Between Magnesium and Iron Group Metals (Fe, Ni, Co) by High-Pressure Alloying** — •Leonid Dubrovinsky[1], Natalia Dubrovinskaia[2], Igor A. Abrikosov[3], and Levente Vitos[4] — [1]Bayerisches Geoinstitut, Universität Bayreuth, Germany — [2]Physikalisches Institut, Universität Bayreuth, Germany — [3]Department of Physics and Measurement Technology, Linköpings University, Sweden — [4]Department of Materials Science and Engineering, Royal Institute of Technology, Sweden

It is now generally recognized that all metals and compounds show some solubility in the solid or liquid state, but the extend of solid solubility is different in different cases. Fe and Mg are almost immiscible at ambient pressure. Though two close chemical analogues of iron, namely nickel and cobalt, form intermetallic compounds with magnesium, solubility of Mg in these metals is also negligibly low. The low solubility of Mg in Fe is in complete agreement with well-known Hume-Rothery rule for metallic alloys. However, compressibility of Mg is much higher than that of Fe, and therefore the difference in atomic sizes between these two elements decreases dramatically with pressure. Based on the predictions of ab initio theoretical calculations, we demonstrate in series of experiments in a multianvil apparatus and in electrically- and laser-heated diamond anvil cells, that high pressure promotes solubility of magnesium in iron and at megabar pressure range more than 10 at% of Mg can dissolve in Fe, and then quenched to ambient conditions. Up to 4 at% of Mg could be dissolving in Ni or Co at 20 GPa and 2200 K.

MM 18.4 Tue 15:30 IFW B

**Synthesis and properties of new materials in the B-C system** — •Natalia Dubrovinskaia[1,2], Georg Eska[1], Grigorii A. Sheshin [1,3], Leonid Dubrovinsky[2], and Hans F. Braun[1] — [1]Physikalisches Institut, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Bayerisches Geoinstitut, Universität Bayreuth, 95440 Bayreuth, Germany — [3]B. Verkin Institute for Low Temperature Physics and Engineering, 61103 Kharkov, Ukraine

Synthesis of a series of bulk samples of B-doped diamonds was realized in a wide spectrum of pressures and temperatures (up to 20 GPa and 2700 K) using a 5000 tonne multianvil press. The properties of the samples were characterized using X-ray diffraction, SEM, TEM, and microprobe analysis. Electrical resistance of the samples was measured at the temperature range between 300 K and 10 mK. It was found that the samples exhibit semiconducting an superconducting behavior at different temperature intervals. A bulk sample (˜7.5 mm3) of heavily boron-doped diamond containing 2.6(0.6) at.% B was synthesized by means of direct reaction between boron carbide and graphite. Electrical resistance measurements revealed a transition to superconducting state at 2.4 K to 1.4 K. Sharpening of the temperature interval of the transition to superconducting state in magnetic field suggests that superconductivity in our samples may arise from filaments of zero-resistant material. Crystallographic aspects in explanation of the observed electrical properties will be discussed.

MM 18.5 Tue 15:45 IFW B

**The evolution of the structure of liquid aluminium foams: comparison between in-situ X-ray observations and numerical calculations.** — •Oliver Brunke and Stefan Odenbach — TU Dresden, Professur für Magnetofluiddynamik, 01062 Dresden

Drainage is one of the driving forces for the temporal instability of liquid metal foams. For usual aqueous foams this phenomenon is very well examined and understood on both, the experimental as well the theoretical side. The situation is different for metallic foams. Due to their opaque nature, the observation of drainage is just possible by either measuring the density distribution of solidified samples ex-situ, or by x-ray or neutron radioscopy. We will report on the drainage behaviour of Al foams grown by a powder-metallurgical production route. The changes of the structure during the ageing of the foam have been observed in-situ by means of a tabletop x-ray radioscopy system. This method allows us to get direct information about the temporal density redistribution and therefore the drainage behaviour of liquid metallic foams. A direct comparison of the experimental data to numerical results obtained by solving the foam drainage equation shows that this theory, which has proved to be successful for the theoretical description of aqueous foams, can in principle also be used to model the material redistribution in metallic foams.