MM 13: Microstructure and Phase Transformations - Processing and Imaging

Time: Monday 15:45–16:45 Location: IFW B

MM 13.1 Mon 15:45 IFW B

High-gravity processing of metals at elevated temperatures — •Štefan Stanko, Mihai Stoica, Josef Hecht, Erwin Fischer, and Jörg F. Löffler — Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, 8093 Zurich, Switzerland

Research into ultracentrifugation is generally limited to molecular biology, biochemistry and polymer science. To investigate the behavior of metals at ultrahigh gravity, a unique centrifuge was designed and built in-house. The apparatus is capable of achieving an acceleration of more than 50,000 *g* together with a temperature of up to 1,200 °C. At this acceleration, the sedimentation of atoms in solid solution is expected to play an important role, and the pressure gradient within the sample has an effect on the thermodynamics of the system. Under ultrahigh gravity, more phases may be observed than predicted by the Gibbs phase rule due to the effect that the chemical potentials of the various phases become gravity dependent. The processing method can also be used to explore eutectic compositions in complex multicomponent alloys. In this work, we investigate the effect of acceleration on the crystallization of pure metals such as aluminum and tin. The metals were molten and slowly cooled to room temperature at an acceleration of 26,000 *g*. They were then characterized via metallurgical methods as well as scanning and transmission electron microscopy. The results on the sedimentation and nanoscale microstructure obtained via this high-temperature centrifugal processing are presented and discussed.

MM 13.2 Mon 16:00 IFW B

Silicon Highly Enriched in 28Si: Probing Artificial Crystals for the Dissemination of the Mole and Kilogram — •Axel Pramann and Olaf Rienitz — Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

The revision of the SI units mole and kilogram has been enabled by the exact realization of the Avogadro constant by the the X-ray-crystal-density (XRCD) method *counting* silicon atoms in single-crystalline silicon spheres [1] and the complementary realization of the Planck constant using a Kibble balance [2]. For the XRCD method applied by PTB, a pool of few unique silicon single crystals highly enriched in 28Si has been produced and characterized. Using a high-resolution MC-ICP mass spectrometer and a tailored analytical methodology in a key experiment, the isotopic composition (the molar mass M) of these crystals has been determined with associated uncertainties of u(M) < 1 x 10-9, which is unique in chemistry up to now. After developing and improving this method during the last decade, the uncertainties u(M) were reduced by almost three orders of magnitude. The way how to disseminate the amount of substance and kilogram after the revision of the SI is outlined [1, 3]. [1] K. Fujii et al., Metrologia, 53, A19 (2016). [2] I. A. Robinson, S. Schlamminger, Metrologia, 53, A46 (2016). [3] B. Güttler, O. Rienitz, A. Pramann, Annalen der Physik, 1800292 (2018)

MM 13.3 Mon 16:15 IFW B

Random walks on images - statistical analysis and Hurst component calculation — •Tomasz Blachowicz[1], Fjora Mance[2], David Fetter[3], Alexander Friesen[3], Axel Dreyer[4], Artur Kasza[1], and Andrea Ehrmann[3] — [1]Silesian University of Technology, Institute of Physics - Center for Science and Education, 44-100 Gliwice, Poland — [2]Polytechnic University of Tirana, Faculty of Mechanical Engineering, Tirana, Albania — [3]Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, 33619 Bielefeld, Germany — [4]Bielefeld University, Department of Physics, 33615 Bielefeld, Germany

Pictures of diverse structures can be investigated by image processing, followed by mathematical methods, to derive geometrical or other properties of these objects. Especially irregular samples, such as fibrous materials [1], can be examined by a random-walk algorithm, enabling calculation of the so-called Hurst exponent [2].

Here we show the analysis of drying processes of different polymer pre-cursors on varying surface by grey-channel dependent Hurst exponent calculations, performed on microscopic images of the drying traces. Our results allow for quantifying the differences between drying marks of diverse fluids and thus classifying various crystallization processes.

[1] T. Blachowicz, A. Ehrmann, K. Domino, Physica A: Statistical Mechanics and its Applications 452, 167-177 (2016)

[2] A. Ehrmann, T. Blachowicz, K. Domino, S. Aumann, M. O. Weber, H. Zghidi, Textile Research Journal 85, 2147-2154 (2015)

MM 13.4 Mon 16:30 IFW B

Hidden charge order in an iron oxide square-lattice compound — •Darren C. Peets[1,2,3], Jung-Hwa Kim[1], Manfred Reehuis[4], Peter Adler[5], Andrey Maljuk[1,6], Tobias Ritschel[3], Morgan C. Allison[3], Jochen Geck[3], Jose R. L. Mardegan[7], Pablo J. Bereciartua Perez[7], Sonia Francoual[7], Andrew C. Walters[1], Thomas Keller[1,8], Paula M. Abdala[9], Philip Pattison[9,10], Pinder Dosanjh[11], and Bernhard Keimer[1] — [1]MPI-FKF, 70569 Stuttgart — [2]NIMTE, CAS, Ningbo, 315201 China — [3]IFMP, TU Dresden, 01069 Dresden — [4]HZB, 14109 Berlin — [5]MPI-CPfS, 01187 Dresden — [6]IFW, 01171 Dresden — [7]DESY, 22603 Hamburg — [8]MLZ, 85748 Garching — [9]ESRF, 38042 Grenoble, France — [10]EPFL, 1015 Lausanne, Switzerland — [11]UBC, Vancouver, V6T 1Z1 Canada

We report Fe^{3+}–Fe^{5+} charge order in square-lattice $Sr_3Fe_2O_7$. The charge order is nearly invisible to state-of-the-art diffraction probes, despite its simple checkerboard structure, large amplitude, and high critical temperature $T_{CO} \sim 330\,K$. This arises from the highly-symmetric lattice structure of $Sr_3Fe_2O_7$, combined with frustration of interlayer Coulomb interactions. We point out parallels to electronic nematicity and hidden order in *d*- and *f*-electron compounds with frustrated interactions.