# MM 61: Liquid and Amorphous Metals V - Structure and structure formation

Time: Thursday 15:45–17:15 Location: IFW A

MM 61.1 Thu 15:45 IFW A

**Crystal growth behavior of undercooled silicon melts** — •Daniel Simons[1], Pierre-Yves Pichon[1,2], and Dieter Herlach[1] — [1]DLR, Institut für Materialphysik im Weltraum, 51170 Köln — [2]RGS Development B.V., Bijlestaal 54 A 1721 PW, Broek op Langedijk, Netherlands

Electromagnetic levitation technique is used to containerless undercool and solidify pure silicon melts. Due to the avoidance of heterogeneous nucleation on container walls large undercoolings up to 320 K below the melting temperature of pure Si, 1685 K, are achieved. The velocity of the crystal growth is measured as a function of undercooling by recording the propagation of the solidification front with a high speed camera. Maximum velocities of 12 m/s are measured at largest undercooling. The high speed video frames give also information of the morphology of the growth front. Plate-like crystals, isolated dendrites, and smaller dendrites at low, moderate and high undercooling temperatures are observed. The plate like crystals morphology is the result of the faceting of the solid-liquid interface at low undercooling. By increasing the undercooling, the solid-liquid interface roughens at the atomic scale, and metallic-like dendrite growth becomes occurs. This effect is identified as kinetic roughening of a smooth solid-liquid interface.

MM 61.2 Thu 16:00 IFW A

**Dynamics of wetting and solidification for silicon droplet impacting a cold substrate** — •Pierre-Yves Pichon[1,2], Daniel Simons[1], Dieter Herlach[1], and Axel Schönecker[2] — [1]DLR, Institut für Materialphysik im Weltraum, Köln, Germany — [2]RGS Development B.V., Bijlestaal 54 A 1721 PW, Broek op Langedijk, The Netherlands

The topic of this work is to examine the wetting dynamics of liquid silicon droplet during the impact on a cold substrate under well controlled conditions. This is motivated by the unusual behavior of the silicon-mold interaction during the crystallization of silicon wafers in the ribbon-growth-on-substrate (RGS) silicon casting process. Silicon droplets were melted in an electromagnetic levitation tool and released so as to impact a cold substrate with a defined amount of kinetic energy. The substrate temperature, wetting properties and roughness were controlled. During the spreading of the droplet on the substrate, the contact line velocity and the dynamic contact angle were recorded with a high speed camera. After the experiment, the interface between the solidified drop and the substrate was analyzed by microscopy. It was found that solidification and wetting strongly interact at the moving contact line. For example at lower substrate temperature, solidification prevents the system to reach the steady state wetting angle, because attachment kinetics of the atoms to the substrate is diffusion limited: solidification blocks the progression of the contact line. This can explain the behavior of the silicon in the RGS system and gives directions for further improvement of the process.

MM 61.3 Thu 16:15 IFW A

**Spatial Distribution of Icosahedra in a Cu-Zr metallic glass** — •Jérôme Zemp[1], Massimo Celino[2], Bernd Schönfeld[1], and Jörg F. Löffler[1] — [1]Laboratory of Metal Physics and Technology, Department of Materials, ETH Zurich, Switzerland — [2]ENEA, C. R. Casaccia, Rome, Italy

Topological order in $Cu_{64}Zr_{36}$ metallic glass was studied by Molecular Dynamics simulations. Structure-specific nearest-neighbor histograms were used to highlight the unique role of Cu-centered icosahedra as compared to other types of Voronoi polyhedra: In both, the glassy and supercooled liquid temperature regime, only icosahedra show a distinct tendency to form superclusters, which is expressed by the strength of the first peak in the Cu-Cu nearest-neighbor histogram. The spatial distribution and interconnectivity of icosahedra were studied as a function of cooling rate and compared to a homogeneous icosahedra distribution. Thermal vibrations were avoided by considering the corresponding inherent structures. Chemical short-range order and potential energy will be discussed as possible reasons for clustering.

MM 61.4 Thu 16:30 IFW A

**ASAXS on NiPB amorphous nanograined material** — •Sören Gayer[1], Ulla Vainio[1], Vikram Raghuwanshi[2], Armin Hoell[2], Andreas Schreyer[1], and Jixiang Fang[3] — [1]Helmholtz-Zentrum Geestacht, Geesthacht, Germany — [2]Helmholtz-Zentrum Berlin, Berlin, Germany — [3]Xi'an Jiaotong University, Xi'an, China

An exhaustive understanding of new materials includes a description of the internal structure. As for the class of amorphous nanograined metals, this structure includes inhomogeneities both in density and chemistry. They are produced by compressing nanometer-sized armorphous particles with high pressures. To investigate their structure (anomalous) small-angle X-ray scattering, (A)SAXS, is a good method, sensitive to density and, in the case of ASAXS, chemistry differences.

The nanoparticles for the investigated samples were created by chemical reduction of compounds containing Ni, P and B in solution. The then dried precipitates were compressed with pressures ranging from 0.5 to 4.0 GPa to form thin disks. Due to the chemical reduction, interfaces were already formed within the relatively large particles during their synthesis.

Measurements were performed at the ASAXS station (7T-MPW-SAXS) at the synchtrotron source BESSY II. The measured SAXS curves were fitted with different models to determine sizes and density differences of the substructures. The structural models were then tested with the Akaike information criterion to select the best of them.

MM 61.5 Thu 16:45 IFW A

**In-situ XRD studies of Cu-Zr alloys in amorphous, liquid and crystalline state** — •Olga Shuleshova[1], Ivan Kaban[1,2], Jozef Bednarcik[3], Dirk Holland-Moritz[4], Jan Gegner[4], Fan Yang[4], Junhee Han[1], Norbert Mattern[1], and Jürgen Eckert[1,2] — [1]IFW Dresden, Institute for Complex Materials, 01171 Dresden, Germany — [2]TU Dresden, Institute of Materials Science, 01062 Dresden, Germany — [3]DESY Photon Science, 22607 Hamburg, Germany — [4]DLR, Institut für Materialphysik im Weltraum, 51170 Köln, Germany

Structure and phase formation in the glass-forming Cu-Zr alloys have been studied in situ by high energy synchrotron X-ray diffraction. Heating of the glassy ribbons was carried out with a Linkam hotstage, while the equilibrium and undercooled liquid alloys were studied with electrostatic levitation technique. Depending on the initial state (either amorphous of liquid), different sequences of crystalline phase formation have been observed. Analysis of the total pair distribution functions revealed larger differences between the crystalline and parent liquid phase for the alloys with relatively simple (cubic) phase nucleating from the melt, comparing to those where complex crystalline structures are formed. This is thought to indicate distinctions in crystal nucleation and/or growth rates depending on alloy composition, implying different mechanisms that govern glass formation in Cu-Zr system.

MM 61.6 Thu 17:00 IFW A

**Surface tension of liquid Al-Au alloys** — •Gerhard Kolland and Jürgen Brillo — Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt, Köln, Germany

Wire bonding of gold with conducting substrates such as aluminum is a widely used industrial technique. To understand the formation of the Al-Au interface, it is crucial to study the thermophysical properties of the binary Al-Au system in the liquid state. We measured the surface tension of liquid Al-Au alloys in a wide temperature and concentration range. The measurements have been performed containerlessly by electromagnetic levitation using the oscillating-drop technique. We compare the obtained experimental data with theoretical predictions from the Butler- and multilayer model.