MM 25: Liquid and Amorphous Metals - Structure

Time: Tuesday 11:45–13:00 Location: IFW D

MM 25.1 Tue 11:45 IFW D

TEM in-situ investigation of local dynamics in amorphous alloys — •Katharina Spangenberg, Sven Hilke, Martin Peterlechner, and Gerhard Wilde — Institute of Materials Physics, University of Münster, Germany

The investigation of the amorphous atomic structure in metallic glasses (MGs) is essential for production and design of MGs as engineering materials. Unlike crystals, MGs have no long-range order, but may consist of distinct atomic structures often summarized as medium-range order (MRO). The degree and type of MRO in amorphous materials can be measured by fluctuation electron microscopy (FEM) using the evaluation of spatial fluctuations in diffraction from nanoscale volumes or intensity variations in dark field images. It has been experimentally shown that the dynamics of MGs in terms of atomic mobility are related to their mechanical properties and connect to the underlying mechanisms of plastic deformation. Therefore, spatial maps of atomic fluctuations can be evaluated to give insight into typical time and length scales of these rearrangements. In this sense, electron correlation microscopy (ECM) is able to investigate dynamics and relaxation phenomena at the atomic scale. The focus of the presented study is the atomic structure of nanostructured MGs using the techniques of ECM in TEM. The dynamics of nanostructured MGs are analysed at different temperatures. Different sample preparation routes are presented and the possibilities of in-situ sample analysis, which enables an observation of the microstructure and reactions at the atomic level upon e.g. heat or mechanical treatment, are discussed.

MM 25.2 Tue 12:00 IFW D

Uncovering β-relaxations in amorphous phase-change materials — •Shuai Wei[1], Si-xu Peng[2], Yudong Cheng[1], Julian Pries[1], Hai-bin Yu[2], and Matthias Wuttig[1] — [1]RWTH Aachen University — [2]Huazhong University of Science and Technology

Relaxation processes are decisive for many relevant physical properties of amorphous materials. For amorphous phase-change materials (PCMs) employed in non-volatile memories, relaxation processes are, however, difficult to characterize due to the lack of bulk samples. Here, instead of bulk samples, we use powder mechanical spectroscopy for powder samples to detect the prominent excess wings– a characteristic feature of β-relaxations – in a series of amorphous PCMs at temperatures below the glass transition. By contrast, β-relaxations are vanishingly small in amorphous chalcogenides of similar composition, which lack the characteristic features of phase-change materials. This conclusion is corroborated upon crossing the border from PCMs to non-PCMs, where β-relaxations drop significantly. Such a distinction implies that amorphous PCMs belong to a special kind of covalent glasses whose locally fast atomic motions are preserved even below the glass transitions. These findings also suggest a correlation between β-relaxation and crystallization kinetics of PCMs, which may have technological implications for phase-change memory functionalities.

MM 25.3 Tue 12:15 IFW D

Controlling the Effective Cooling Rate upon Magnetron Sputter Deposition of Glassy Ge15Te85 — •Julian Pries[1], Shuai Wei[1], Felix Hoff[1], Pierre Lucas[2], and Matthias Wuttig[1,3] — [1]Institute of Physiks IA, RWTH Aachen — [2]Department of Material Science and Engineering, University of Arizona — [3]PGI-10, Forschungszentrum Jülich

A reduction of the enthalpy state is accompanied by a desirable stabilization of the glass. In this study, we demonstrate the relationship between the voltage applied in the sputtering process and the resulting enthalpy state. Due to this correspondence, it is possible to assign an effective cooling rate to the sputtering process, which decreases by about three orders of magnitude when the voltage is increased by ~100 V. This shows that the sputtering voltage as a new and decisive parameter can manipulate the fictive temperature of a glass, which opens the door to the design of ultra-stable, but also ultra-unstable glasses.

MM 25.4 Tue 12:30 IFW D

Correlating transmission electron microscopy data to study dynamics in amorphous structures — •Martin Peterlechner, Sven Hilke, Katharina Spangenberg, and Gerhard Wilde — Institute of Materials Physics, University of Münster, Wilhelm-Klemm-Str. 10, D-48149 Münster

The method of transmission electron microscopy (TEM) is well suited to study atomistic structures and their dynamics. However, due to the quantum-mechanical interference of electrons with matter, the arising contrast is not straight forward to interpret. Moreover, any quant can alter the observed object, generally termed beam damage in the TEM community. Thus, either correlations of image simulations with individual experimental micrographs are used, or, more recently time autocorrelations of signals obtained by TEM. In the present work, the choice of signals for time correlations is elucidated and experimental limitations are discussed. To link the experiments to physical quantities the relaxation of an amorphous structure is analysed.

MM 25.5 Tue 12:45 IFW D

Pure Néel-type Spin Textures in Ferrimagnetic Alloys — •Boris Seng[1,2,3,4], Daniel Schönke[1], Nico Kerber[1,3,4], Fabian Kammerbauer[1], Jean-Loïs Bello[2], Daniel Lacour[2], Robert Reeve[1], Michel Hehn[2], Stéphane Mangin[2], and Mathias Kläui[1,3,4] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, 55128 Mainz, Germany — [2]Institut Jean Lamour, 2 allée André Guinier, 54011 Nancy Cedex, France — [3]Max Planck Graduate Center, Staudingerweg 9, 55128 Mainz, Gemany — [4]Graduate School of Excellence Materials Science in Mainz, Staudingerweg 9, 55128 Mainz, Germany

Magnetic skyrmions are topologically stabilized spin textures that have been suggested for next generation spintronics devices. Recent studies confirmed the current-driven skyrmion dynamics in ultrathin ferromagnets. However, the Magnus effect leads to a transverse motion of ferromagnetic skyrmions for spin structures with a non-zero topological winding number. Antiferromagnetically exchange-coupled skyrmions or compensated ferrimagnets are expected to suppress this effect owing to an overall zero topological charge. Especially at the angular momentum compensation temperature skyrmions dynamics is predicted to be collinear with the current[1]. Here, we explore GdFeCo ferrimagnetic alloy-based multilayer stacks where a strong Dzyaloshinskii-Moriya interaction is present. In our samples, we observe chiral spin textures such as magnetic skyrmions. The spin distribution of their internal domain walls is imaged and found to be a pure Néel-type.

[1] Barker et al., Phys. Rev. Lett. 116, 147203 (2016)