Neutron scattering experiments on Zr-based melts processed by electrostatic levitation

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We have developed a compact electrostatic levitator as a sample environment for high quality neutron scattering experiments on melts [1]. This containerless technique allows to process even chemically reactive melts at high temperatures. Moreover, the containerless process under high vacuum conditions gives access to the metastable regime of an undercooled liquid below the melting temperature. The avoidance of crucible materials in the vicinity of the freely suspended sample results to an excellent signal to background ratio in scattering experiments.

The utilization of the electrostatic levitator allowed us to investigate the structure and the atomic dynamics of different stable and undercooled Zr-based melts by elastic- and quasielastic neutron scattering as a function of the temperature.

Quasielastic neutron scattering studies have been performed on the time-of-flight spectrometer TOFTOF at the FRM II. For liquid $Zr_{64}Ni_{36}$ the Ni self-diffusion coefficient shows deviations from an Arrhenius-type temperature dependence at an undercooling of 167 K below the melting point, as observed in also for bulk metallic glass forming alloys.

Elastic neutron diffraction experiments were performed on the high flux diffractometer D20 at the ILL. The structure factors measured for $Zr_{50}Cu_{50}$, Zr_7Cu_{10} and Zr_2Cu revealed large nearest neighbor coordination numbers of $Z_{NN} > 13$. While it is widely assumed in literature that the good glass forming ability of Zr-Cu is related to an icosahedral short-range order prevailing in the melt, our investigations demonstrate that liquid Zr-Cu is not characterized by a dominant icosahedral short-range order.

References

[1] T. Kordel, D. Holland-Moritz, F. Yang, J. Peters, T. Unruh, T. Hansen, and A. Meyer, Phys. Rev. B, **83**, 104205 (2011)