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Dynamical and structural properties of undercooled Cu-Ti melts

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Cu-Ti alloys feature a large, undercooled liquid region and a high glass-forming ability (GFA) and thus, provide the possibility to obtain two component bulk metallic glasses (BMGs). Such behavior is unusual and could be due to the special properties of the Cu-Ti system: In the melt, it shows a positive excess volume, whereas it still features a negative enthalpy of mixing.
Even though, the scientific interest in Cu-Ti-based BMGs increased, the relevant atomic mechanisms responsible for such good GFA are still to be explored. Here we discuss the temperature-dependent dynamical and structural properties of Cu-Ti melts, within a compositional range of 24 to 69 at% Ti. To obtain accurate data about viscosity, density, and atomic structure, the Cu-Ti samples have been processed without any container using the electrostatic levitation technique. We found a non-monotonous trend of the viscosity, with the highest values at intermediate Ti contents. Surprisingly, this dynamical trend is not reflected by the macroscopic packing fraction, meaning a high viscosity does not necessarily correlate with a dense packing. However, on the atomic scale, x-ray and neutron diffraction measurements reveal a denser, local packing density and a pronounced chemical short-range order, which is based on attractive interactions between Cu and Ti. These short-range interactions can explain the high viscosity, while the macroscopic packing fraction is rather governed by long-range interactions.

Primary author: KREUZER, Lucas (MLZ (FRM II, TUM))

Co-authors: Prof. MEYER, Andreas (Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Materialphysik im Weltraum); Prof. HOLLAND-MORITZ, Dirk (Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Materialphysik im Weltraum); YANG, Fan (Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institut für Materialphysik im Weltraum); Dr BLANKENBURG, Malte (DESY); Dr HANSEN, Thomas (ILL); PETRY, Winfried (FRM II - TUM)

Presenter: KREUZER, Lucas (MLZ (FRM II, TUM))

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