Physical Properties and Processing of Undercooled Metallic Glass Forming Liquids

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The High Vacuum Electrostatic Levitation (HVESL) technique as developed by Rhim and collaborators at Jet Propulsion Laboratory provides a method of levitating metallic alloy droplets of size ranging up to several mm under high vacuum conditions with relatively quiescent conditions. The levitated sample can be heated and melted using either a focused quartz lamp or a laser. When combined with non contact temperature measurements, such a system provides an ideal platform for the study of liquid metals and alloys under ultraclean and containerless conditions. The HVESL method has been initially applied to the study of the undercooling behavior and thermophysical properties of metallic glass forming liquids in both the equilibrium liquid and undercooled states. Studies of crystal nucleation and growth kinetics in undercooled glass forming liquids have enabled direct measurements of the CCT and TTT-diagrams throughout the undercooled liquid range for a number of bulk metallic glass forming systems. As a representative example, technique has been used to directly quantify the influence of low level impurities (e.g., oxygen) on the crystal nucleation kinetics in a bulk metallic glass forming system. Combined with high resolution imaging methods, the method has allowed determination of the volume thermal expansion coefficient of the liquid and glassy states. Preliminary experiments, suggest that it is feasible to implement an AC modulation calorimetry measurement on the HVESL platform. We are examining the potential use of the HVESL platform in studying heterogeneous nucleation in liquids containing second phase solid particles.