AC Calorimetry and Thermophysical Properties of Metallic Glasses and Undercooled Liquids

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AC modulation calorimetry (ACMC) has been applied to study the heat capacity and thermal conductivity of glass forming metallic alloys in the undercooled liquid state using the TEMPUS facility under microgravity conditions. The ACMC method utilizes rf power modulation to a heating coil, which couples to liquid sphere contained by a separate positioning field. Non contact temperature measurement using two separate pyrometers is used to detect temperature modulations about the mean temperature of the sphere. From these data, one can deduce the ratio of the heat capacity of the drop to the total hemispherical emissivity (THE). Analysis of the coupling of the heating coil power to the sphere at the melting point enables a separate determination of the THE and direct evaluation of the heat capacity of the sample. The technique and is implementation in flight experiments carried out during the recent First Materials Science Laboratory (MSL-1) mission will be described. Data were obtained on a series of liquid metals (alloys) including Zr-metal, binary Zr-Ni alloys, and multicomponent bulk metallic glass forming alloys. Related experiments carried out by other members of the TEMPUS PI group on the same samples were used to obtain data on the surface tension, viscosity, and thermal expansion coefficient of the liquid alloys. Taken in combination, these data are being used to develop a better understanding of the thermodynamics and kinetics of crystal nucleation in the undercooled glass forming liquids.