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Thermodynamics and Statistical Mechanics of Bulk Metallic Glasses

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A survey of the mechanical, rheological, and thermodynamic properties of bulk metallic glasses and glass forming liquids will be presented. The experimental data reveal striking systematic correlations among linear elastic constants, plastic yielding of the glass and its dependence on temperature, the glass transition temperature, and rheological properties of the glass forming liquid. A Cooperative Shear Model will be presented while predicts that physically relevant features of the Potential Energy Landscape of the glass/liquid obey simple scaling relations. The model predicts the yield criterion and its dependence on temperature in the glass. It also leads to natural expressions for the Newtonian and Non-Newtonian viscosity law for the liquids, as well as the fragility of the liquid. The model is found to be in remarkable agreement with a variety of experimental observations including variations in ductility and toughness among metallic glasses. It predicts that all metallic glasses exhibit universal behavior based on a small number of measurable parameters.