# Abstract

A rheological law based on the concept of cooperatively sheared flow zones is presented, in which the thermodynamic state variable controlling flow is identified to be the isoconfigurational shear modulus of the liquid. The law captures Newtonian as well as non-Newtonian viscosity data for glass-forming metallic liquids over a broad range of fragility. Acoustic measurements on specimens deformed at constant strain rates correlate with the measured steady-state viscosities. This correlation verifies that viscosity has a unique functional relationship with the isoconfigurational shear modulus.

The equilibrium and non-equilibrium viscosity and isoconfigurational shear modulus of $Pt_{57.5}Ni_{5.3}Cu_{14.7}P_{22.5}$ are evaluated using continuous-strain-rate compression experiments and ultrasonic measurements. This data is fit using the cooperative shear model.

Viscosity and isoconfigurational shear modulus data, $G$, from the literature and current experiments, were analyzed for strong and fragile liquids. The effects of "elastic" and "cooperative volume" fragility indices were observed to be equivalent in relation to the softening of the shear flow barrier. This equivalence gives rise to a factor of $G^2$ in the softening of the shear flow barrier used in the Cooperative Shear Model.

The change in the configurational enthalpy of metallic-glass-forming liquids induced by mechanical deformation and its effect on elastic softening is assessed. The acoustically measured shear modulus is found to decrease with increasing configurational enthalpy by a dependence similar to that obtained by softening via thermal annealing. This establishes that elastic softening is governed by a unique functional relationship between shear modulus and configurational enthalpy.

The relaxation processes of metallic glasses are investigated by observing the changes in material properties associated with the transient stress strain responses of specimens subjected to isothermal deformation. The properties studied include the isoconfigurational shear modulus, configurational enthalpy, and the anelastic strain of the material. Conventional glass relaxation processes and Eshelby stresses are applied to the description of the relaxations observed in the transient response of the specimens. Additionally, the criteria for shear localization and the barrier height controlling flow are investigated using steady-state flow properties of the material at different strain rates.