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Beta relaxations and their correlations to plasticity in metallic glasses and soft disordered systems

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Focusing on metallic glasses as model systems, we show that mechanical properties and deformation mechanisms of glassy materials are closely related to a kind of dynamical process inherent in glasses, i.e., the so-called Johari-Goldstein beta relaxations. Microscopically, we demonstrate that beta relaxations and the basic deformation units of glasses have the same activation energy, and this activation energy correlates with the deformability of metallic glasses. Macroscopically, we illustrate that metallic glasses with pronounced beta relaxations around room temperature could have outstanding tensile plasticity, and the transition from brittle to ductile in tension and the beta relaxations follow a same temperature-time relationship. We will also show how to tune the beta relaxations by the understanding of chemical influence to get desirable properties [1]. Atomic signatures of beta relaxations in metallic glasses will be addressed based on recent computer simulations.

[1] See also review papers, H.B. Yu, W.H. Wang, H.Y. Bai and K. Samwer, National Science Review 1, 429-461 (2014); H.B. Yu, W.H. Wang and K. Samwer, Materials Today 16,183 (2013)