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An invited talk

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THE PRIMARY AND SECONDARY RELAXATION BEHAVIORS IN SEVERAL INORGANIC GLASS FORMERS

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By applying the hyperquenching – annealing – calorimetry approach, we study both primary and secondary relaxation behaviours of inorganic glasses with different fragilities. To do so, we choose the following three glass formers as objects of this study: GeO_2 glass (strong system), basaltic glass (intermediately fragile system) and La-based metallic glass (fragile system). We demonstrate the fundamental differences in enthalpy relaxation between the three glass systems. We show that the manner of enthalpy relaxation in hyperquenched (HQ) glasses (glasses far from equilibrium) is linked to the α- and β-relaxations. The correlative degree between the secondary and the primary relaxations is closely associated with the liquid fragility. We have found that, unlike the HQ basaltic and metallic glasses, the HQ GeO_2 glass relaxes in a manner that all the secondary relaxation units contribute to the primary relaxation. By analyzing dynamic properties of the secondary relaxation, we have identified the typical feature of the Johari-Goldstein (JG) relaxation in the HQ GeO_2 glass, i.e., the relationship observed between the activation energy E_β and the glass transition temperature T_g well agrees with that typical for the JG relaxation. Besides, the characteristic secondary relaxation time of the GeO_2 glass at T_g is found to be about 10 seconds, larger than that of relatively fragile glasses. These results imply that the JG peak in strong glasses is hidden by the α peak in the dielectric loss curves. The close relationship between E_β and T_g is also observed in the secondary relaxation in hyperquenched $La_{55}Al_{25}Ni_{20}$ ribbons. By a survey of experimental data related to sub-T_g relaxation dynamics of other metallic glass systems, the general correlation E_β=26.1RT_g is found, which indicates that JG relaxations are intrinsic in metallic glass formers. By analyzing on the average relaxation time of JG motion, τ_{JG}, and the crossover time in the coupling model, t_c, we discuss why the excess wing, rather than the JG peak (or shoulder), is generally present in metallic glass systems.

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