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Hu, Lina; Yue, Yuanzheng

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Abnormal three-steplike sub-Tg enthalpy relaxation pattern in hyperquenched metallic glasses

Hu, Lina[2]; Yue, Yuanzheng[1]
(1) Section of Chemistry, Aalborg University; (2) Key laboratory of Liquid Structure and Heredity of Materials (Ministry of Education), Shandong University

Our recent work observed a quite different relaxation pattern, i.e., the abnormal three-steplike sub-T_g relaxation in CuZrAl GRs[1]. However, the generality and the origin of this remarkable thermodynamic anomaly remain enigmatic. By hyperquenching strategy, the present work investigated the dependence of thermal history on the sub-T_g enthalpy relaxation pattern (ERP) of $Cu_{46}Zr_{46}Al_8$ glasses, as well as $La_{55}Al_{25}Ni_{20}$ for comparisons. It has been found that the presence of the three-steplike sub-T_g ERP of $Cu_{46}Zr_{46}Al_8$ closely relates to the fictive temperature T_f, whereas no such anomaly is observed in $La_{55}Al_{25}Ni_{20}$ GRs. However, the correlation between T_f and the activation energy for initiating the energy releasing during thermal scanning is three-steplike for $La_{55}Al_{25}Ni_{20}$, revealing the similar phenomenon with the abnormal ERP of $Cu_{46}Zr_{46}Al_8$. These unexpected phenomena have been well explained by the models based on the competitions between the low-temperature and high-temperature clusters used in the terms of the fragile-to-strong (F-S) transition. By analysis on the different chemical feature between $Cu_{46}Zr_{46}Al_8$ and $La_{55}Al_{25}Ni_{20}$ alloys, it is believed that such anomaly of thermodynamic evolution exists generally in metallic glass-forming liquids, and corresponds to the different extent of the F-S transition.

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[1]. Lina Hu & Yuanzheng Yue, APL **98**(2011) 081904