Sub-Tg enthalpy relaxation in unstable oxide glass formers: insights into the structural heterogeneity

An Invited Talk

Yue, Yuanzheng; Zhang, Yanfei

Invited talk

TP-GT-9

Sub-Tg enthalpy relaxation in unstable oxide glass formers: insights into the structural heterogeneity

Yue, Yuanzheng[1]; Zhang, Yanfei[2]
(1) Aalborg University; (2) Shanong Polytechnic University

The structural heterogeneity in liquid has a strong impact on both glass stability and functionality of glass. Exploring the structural heterogeneity is crucial for understanding the glass transition and glass formation. However, one of the challenges for such exploration is lack of an effective method for detecting the structural heterogeneity in liquid. Here, we introduce a promising approach for detecting the structural heterogeneity in unstable oxide glass formers. This approach takes advantage of abundant features of the sub-T_g enthalpy relaxation in hyperquenched (HQ) unstable oxide glasses. We conduct the present study on the two unstable model glasses (towards crystallization): $65SiO_2$-$35Al_2O_3$ (SA) and $57SiO_2$-21CaO-22MgO (SCM) (mol%). This is done by hyperquenching the liquids via fiberization, annealing the HQ samples below T_g, and then upscanning the annealed samples in a differential scanning calorimeter (DSC). For SA, we find that both sub-T_g annealing and repeated dynamic heating to T_g can greatly enhance structural ordering, and facilitate crystal growth upon further heating to well above T_g. The results indicate that highly heterogeneous structure already exists in the liquid state. For SCM, we observe two exothermic sub-peaks in sub-T_g relaxation region during the first DSC upscan, implying that two types of structural domains occur already in the liquid state before HQ. The existence of the two types of structural domains is verified by direct transmission electron microscopy imaging. By performing sub-T_g annealing, we find that one type of structural domain is fragile, whereas another is strong. In addition, the sub-T_g annealing can be used as a sensitive tool for determining the glass forming ability.