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Glass Transition and Relaxation in Pressure-Quenched Borate and Borosilicate Glasses.

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Glass transition and relaxation continue to be an intensively explored topic in condensed matter science, since numerous key problems still remain unsolved. For instance, how is a thermodynamic response to glass transition associated with a structural one? How do structure and properties of a pressure-quenched glass relax prior to and during the glass transition? Recently we have, at least partly, answered these questions by looking at the relaxation in both borate and borosilicate glasses. These glasses were chosen because they possess rich structural features, e.g., boron speciation and superstructure, which are sensitive to composition, temperature and pressure. Considering these features we clarify the origin of thermodynamic and property changes of the pressure-quenched glasses prior to and during the glass transition. When soda-lime-borate (SLB) glass or boroaluminosilicate glass were isostatically compressed under load up to 0.6 GPa around T_g , we detected a pronounced increase in the ratio of the 4- to the 3-coordinated borons in the SLB glass, as well as in its macroscopic properties such as hardness, density and elastic modulus [1-3]. When the compressed SLB glass was annealed around T_g for a given duration, the pressure-induced 4-coordinated borons did not relax back to the 3-coordinated ones, but the macroscopic properties relaxed towards the values of the uncompressed glass [1]. We analyze the origin of this phenomenon considering structural and thermodynamic aspects. To explore the structural origin of the isobaric heat capacity jump (ΔC_p) during glass transition, we substitute B_2O_3 for SiO_2 in glass to observe the change of ΔC_p [3]. The results show a striking non-linear ΔC_p enhancement with substitution. Here we discuss the reason of this enhancement by examining the network connectivity, bond strength, bond constraint, superstructure and diversity of structural.

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