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Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

Understanding the sub-T_g relaxation in mechanically excited chalcogenide glasses by comparison with hyperquenched glasses

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We investigate the sub-T_g enthalpy relaxation in a milling derived, i.e., mechanically excited (ME) chalcogenide glass (Ag_3PS_4 glass) by comparing with the hyperquenched (HQ) (>10^5 K/s) oxide and metallic glasses. This has been done using differential scanning calorimetry (DSC). We have found that two distinct, but also correlated peaks of sub-T_g energy release with similar intensity occur in the ME glass during DSC upscanning. Such relaxation pattern is in strong contrast to the asymmetric peak observed in the HQ oxide and metallic glasses. The low-temperature relaxation peak of the ME glass is attributed to β-relaxation. β-relaxation originates from the local motion of mobile silver ions from unstable to relatively stable sites. The high-temperature peak is a result of the α-relaxation associated with the recovery of the distorted covalently bonded PS_4 units. However, for the HQ glasses, the low-temperature peak is manifested as a shoulder superimposed on the main peak. The HQ glasses lie significantly higher on potential energy landscape than the ME glass. This work implies that the ME glass is of higher structural heterogeneities than the HQ ones.