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Energy release in isothermally stretched silicate glass fibers

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Glass annealed near the glass transition temperature (T_g) shows no energy release behavior below T_g during reheating in a differential scanning calorimeter (DSC) at a heating rate (q_h) equal to prior cooling rate (q_c). However, when the glass is annealed near T_g and cooled under a mechanical force, an energy release peak occurs during DSC measurements at $q_h = q_c$. This behavior is similar to that of a hyperquenched glass, cooled at $q_c >> q_h$. Here we show the energy release behavior of the isothermally stretched silicate fibers. The results suggest that the energy stored in glass fiber during spinning processes consists of two parts, i.e. the thermal quenching induced part and the mechanical stretching induced one. The latter part should be taken into account in calculating the average fictive temperature and the cooling rate of fibers, especially in the case of slowly drawn thick fibers. Until recently this part has been supposed to be insignificant in estimating the fictive temperature and the cooling rate of the hyperquenched fibers. The impact of annealing temperature, mechanical load, and composition on the mechanically induced energy release behavior are investigated by doing systematic experiments on glass fibers with different chemical compositions. The results show a clear dependence on both load and annealing temperature. The higher mechanical strength of fibers in comparison to that of a bulk glass of the same compositions could be attributed partly to the observed effect. Therefore, measurements on mechanical properties of the fibers have also been carried out, as well as calculations of the rheology based on the isothermal stretching experiments.