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How Mechanical Deformation of Polymers during Vitrification Alters the Subsequent Stability of the Glass LAURA A. G. GRAY, CONNIE B. ROTH, Dept. of Physics, Emory University, Atlanta, GA — How stress and mechanical deformation impart mobility to polymer glasses have been studied primarily for materials where the glassy state was formed stress free. Here, we investigate the stability of polymer glasses where a constant stress is applied during the formation of the glassy state (thermal quench). Previously we found that physical aging is strongly dependent on the conditions during glass formation, including cooling rate and (often unintended) stress [Macromolecules 2012, 45, 1701]. We constructed a unique jig to apply a known stress to free-standing films during the thermal quench. We used ellipsometry to measure the physical aging rate of polystyrene films by quantifying the time-dependent decrease in film thickness that results from an increase in average film density during aging. As the magnitude of stress during vitrification increases, the physical aging rate quickly transitions over a small range of stresses to a faster aging rate, indicating the resulting glass is less stable [Soft Matter 2014, 10, 1572]. To explore this unique finding, we have constructed a computer-controlled apparatus to measure and apply stress and strain to polymer films during vitrification in order to characterize the temperature-dependent stress build up.

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