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Fiber Formation From the Melting of Free-standing Polystyrene, Ultra-thin Films: A Technique for the Investigation of Thin Film Dynamics, Rheological Properties and Confinement Effects JEREMY M. RATHFON, University of Massachusetts Amherst, ROBERT W. COHN, University of Louisville, ALFRED J. CROSBY, JONATHAN P. ROTHSTEIN, GREGORY N. TEW, University of Massachusetts Amherst — The processes of fiber formation from the melting of ultra-thin films are explored in high detail and produce a new technique for the investigation of rheological properties, confinement effects, and the dynamics of thin films and polymer chains. Ultra-thin films of polystyrene are suspended atop micro-arrays of pillars. Films are then annealed above the T_g and studied via optical microscopy. Hole nucleation is quantified with a free energy barrier based on a simple capillary model. Holes then grow exponentially in a shear thinning, high shear strain regime. These holes impinge upon each other to form suspended fibers which thin according to a model for elasto-capillary thinning of fluid filaments. Monitoring fiber thinning allows for the acquisition of rheological properties as well as the apparent extensional viscosity. The breakup of the fiber network indicates the effects of confinement on chain entanglements in ultra-thin films. A transition below a critical film thickness, comparable to the dimensions of a polymer chain, shows reduced interchain entanglements and a remarkably faster breakup of fibers.

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