Hole Nucleation and Growth in Free-standing Polystyrene Ultra-thin Films

Jeremy M. Rathfon[†], Robert W. Cohn[‡], Alfred J. Crosby[†] and Gregory N. Tew[†]*
[†]*Department of Polymer Science and Engineering, University of Massachusetts Amherst, 120 Governors Drive, Amherst, Massachusetts 01003*
[‡]*ElectroOptics Research Institute and Nanotechnology Center, University of Louisville, Louisville, Kentucky 40292*
*Corresponding Author: Gregory N. Tew, E-mail: tew@mail.pse.umass.edu

Supporting Information

Figures S1 through S4 are included to show exponential hole growth curves for all samples tested. Curves are generated from an average of hole data from at minimum five representative holes. The data was fit to the exponential growth equation, $R_{hole}(t) = Ae^{t/\tau}$, to obtain the characteristic growth time, τ. The data is then plotted as $\ln[R(t)/R(\tau)]$ versus t/τ, to normalize data such that long time regions of data overlap, where exponential growth occurs. Exponential growth curves yield viscosity values at the hole edge. Curves of varying molecular weights (Figures S3 and S4) condensed onto single plots cannot be compared directly due to varied conditions for experiments affecting their corresponding shear strain rate.

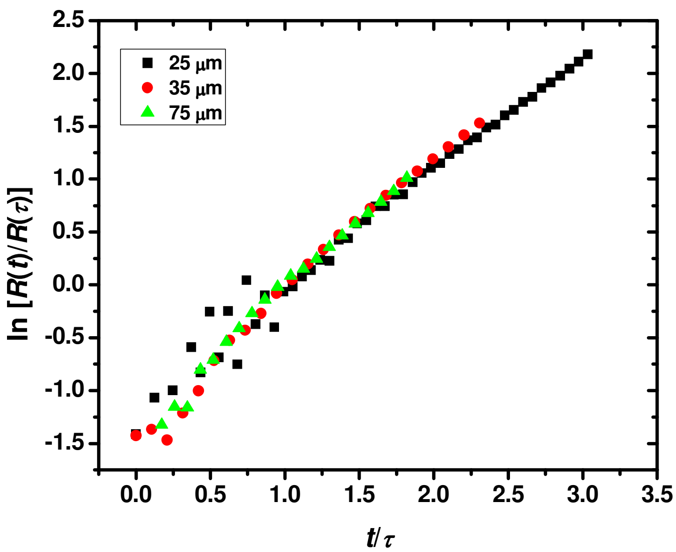

Figure S1. Normalized radius, $\ln[R(t)/R(\tau)]$, versus time, t/τ, for exponentially expanding holes with varying pillar spacings (h = 65 nm, M_w = 400 kDa), showing no correlation of pillar spacings on hole growth rates.

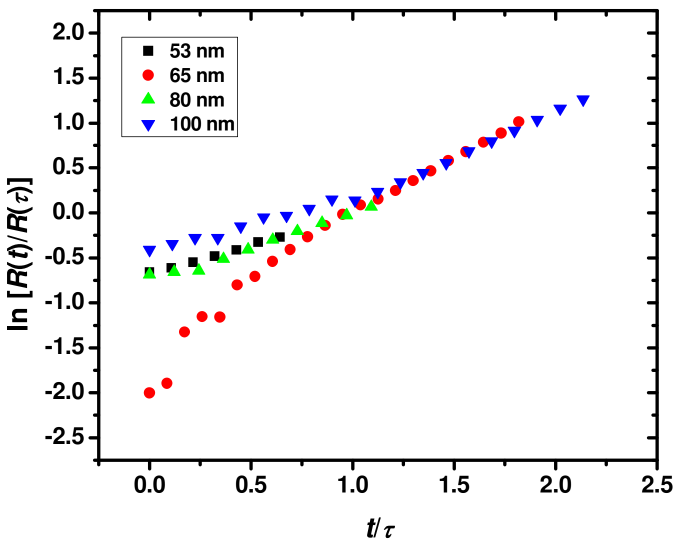

Figure S2. Normalized radius, ln[$R(t)/R(\tau)$], versus time, t/τ, for exponentially expanding holes with varying parent film thicknesses and pillar spacings of 75 μm, M_w = 400 kDa.

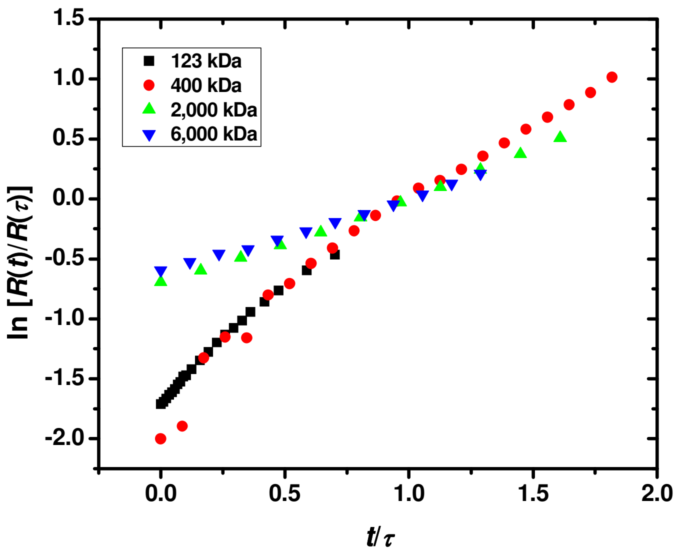

Figure S3. Normalized radius, ln[$R(t)/R(\tau)$], versus time, t/τ, for exponentially expanding holes with varying M_w and pillar spacings of 75 μm, h = 65 nm.

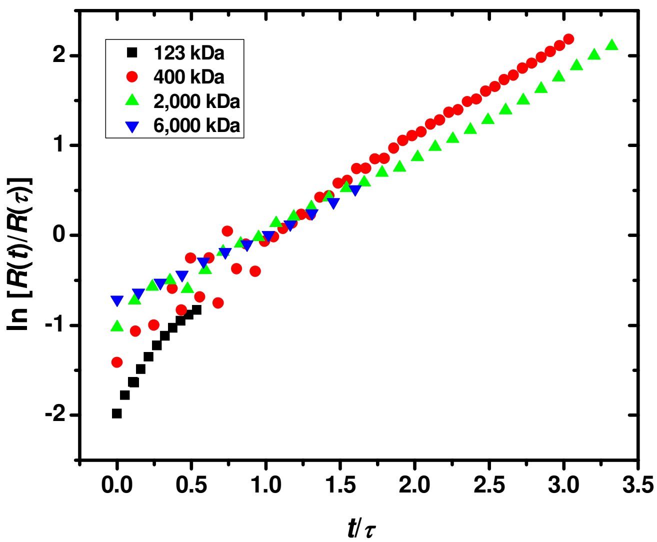

Figure S4. Normalized radius, ln[$R(t)/R(\tau)$], versus time, t/τ, for exponentially expanding holes with varying M_w and pillar spacings of 25 μm, h = 65 nm.

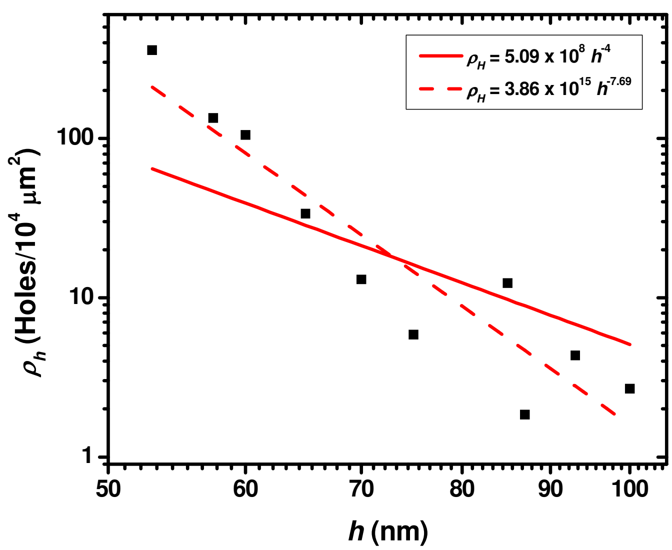

Figure S5. Hole density as a function of film thickness, for 400 kDa PS samples, showing the -4 power law and a fit obtained allowing the power to vary, both determined using least-squares-regression.