IRG-C: Coarsening Phenomena in Electrohydrodynamic Lithography of Thin Polymer Films

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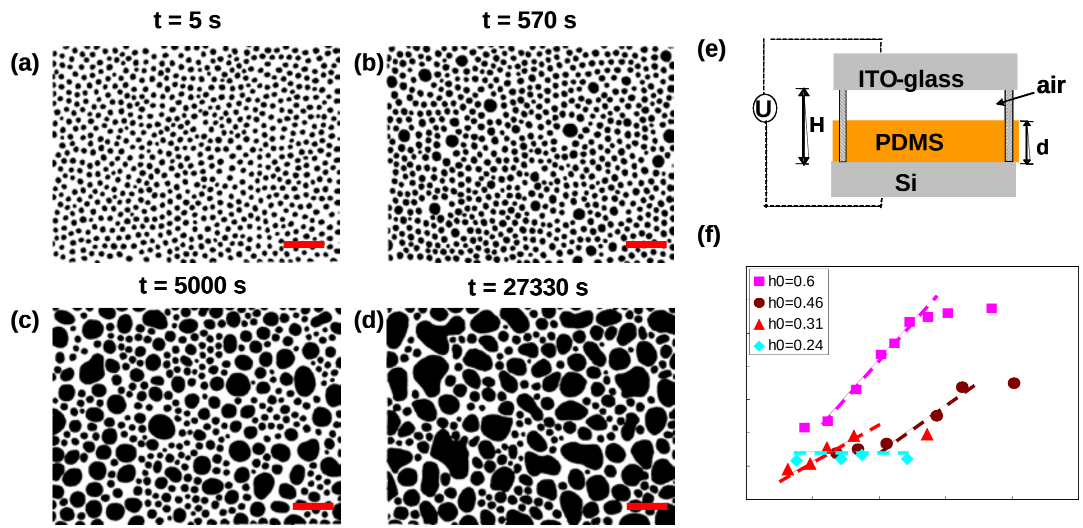
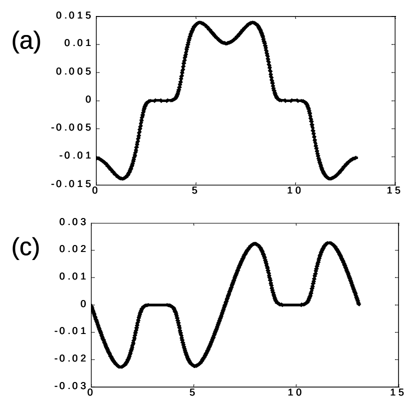
An electric field normal to a thin polymer film initiates an instability that generates pillars, often in ordered patterns, spanning a sub-micron gap between silicon wafers. Those patterns, however, are metastable leading to coarsening over several decades in time with a characteristic logarithmic time dependence (top right). And thicker films coarsen faster than thinner films.

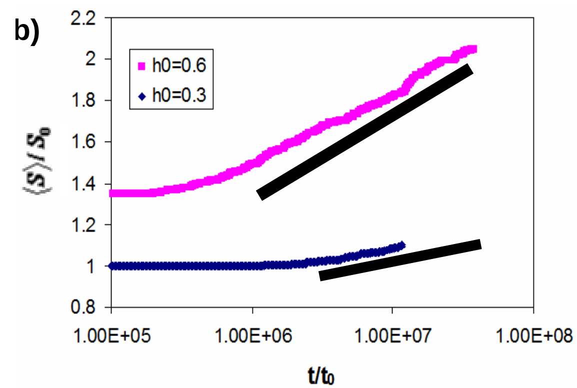
Linear stability analyses of the initial metastable states produce eigenfunctions (bottom left) that identify two mechanisms also seen experimentally: collision (upper) and Ostwald ripening (lower). Reducing the original PDE into a pair of ODEs governing the separation between pillars enables a simulation that reproduces the logarithmic time dependence (bottom right). Note that coarsening is dominated by Ostwald ripening in the thicker film (magenta) and by collisions in the thinner film (blue)



Right: (a)-(d) Optical images illustrating different stages for the coarsening of 160 nm PDMS (600 Pa-s) film at 17V. The scale bar indicates 10 microns. **Left:** (e) The schematic of experimental set-up under an optical microscope. (f) Coarsening data for PDMS films (100 Pa-s) with different fill ratios ($h_o=D/H$).



Eigenfunctions: Ostwald ripening (top) and collisions (bottom)



Simulations (black) of coarsening dominated by Ostwald ripening (thick film magenta) and collisions (thin film blue).