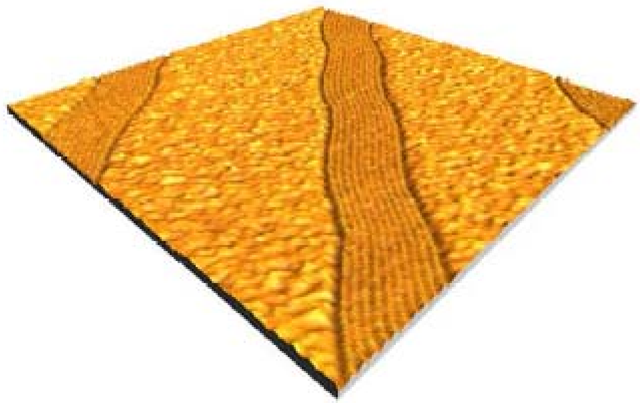
Guided Hierarchical Self-Assembly of Aligned Polymer Nanodomains (IRG 2)

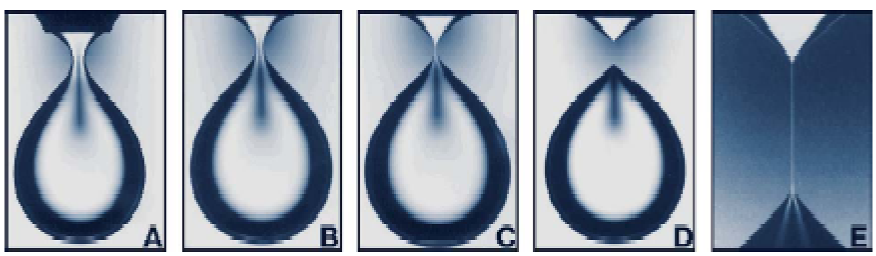


Researchers in the Chicago MRSEC, led by Steven J. Sibener, in collaboration Argonne National Laboratory, developed a novel hierarchical method to achieve near-perfect alignment of polymeric nanostructures [1]. Top-down and bottom-up assembly approaches are fused by lithographically patterning a substrate with channels that, in turn, direct the self-organization of diblock copolymer ultrathin films. Aspect ratios of 5000:1 have been demonstrated, and ordering likely can be extended to arbitrary lengths. Depending on preparation, alignment can be confined to etched channels (the above atomic force microscopy image shows confinement in 270 nanometer wide channels) or extended both above and beyond the channel volumes to cover large areas of the substrate. This type of nano-phase separated film can then used as a template to create hybrid hard/soft matter systems via the spatially selective adsorption of functional inorganic materials such as nanoparticles, either due to innate selectivity or by designed lock and- key chemistry. Potential applications include nanostructured magnetic, electronic, optical, and catalytic materials.

[1] "Guiding Polymers to Perfection: Macroscopic Alignment of Nanoscale Domains", D. Sundrani, S. B. Darling, and S. J. Sibener, Nano Letters **4**, 273-276 (2004).

Hanging By a Thread: Persistent Memory in Droplets (IRG 1)

MRSEC researchers Wendy Zhang and Sidney Nagel, together with collaborators at Harvard and Purdue, discovered a new class of drop fission dynamics which is distinct from the selfsimilar behavior first uncovered at Chicago. In general, fluids breaking up into droplets exhibit universal dynamics near the region of break-up. One can typically superimpose the structures of different fluid systems observed at this point, once appropriate scaling factors are considered. However, when an effectively zero-viscosity fluid breaks up into droplets while surrounded by a much more viscous exterior fluid, a unique new situation arises [1], involving the production of a long thin thread. The length and shape of the thread retain a memory of both initial and boundary conditions. Because this process is highly tunable, and easily controlled, this method can eventually be used to manufacture long, thin, threads with microscopic dimensions.
Solidification of these threads into filaments or wires is facilitated by the slow rate of thread formation.



A water drop drips through silicone oil. The area around the neck of the drop is initially parabolic (images A to C). After time, the neck forms a long and thin thread (images D and E). In image E, this neck is two millimeters long but only eight microns wide.
Images courtesy of Itai Cohen, Harvard University, and Sidney R. Nagel, University of Chicago

[1] "Persistence of Memory in Drop Breakup: The Breakdown of Universality", Pankaj Doshi, Itai Cohen, Wendy W. Zhang, Michael Siegel, Peter Howell, Osman A. Basaran, Sidney R. Nagel, Science **302**, 1185-1188 (2003).