

High-fidelity patterns form spontaneously when solvent evaporates

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Resembling neatly stacked rows of driftwood abandoned by receding tides, particles left by a confined, evaporating droplet can create beautiful and complex patterns. The natural, pattern-forming process could find use in fields such as nanotechnology and optoelectronics.

“A lot of work in nanotechnology has been directed toward the bottom-up imposition of patterns onto materials,” said Steve Granick, a professor of materials science, chemistry and physics at the University of Illinois at Urbana-Champaign. “We found that beautiful patterns of high fidelity and regularity could form naturally and spontaneously, simply by allowing a drop to evaporate in a confined geometry.”

Granick and former postdoctoral research associate Zhiquan Lin (now a professor of materials science at Iowa State University) describe their work in a paper that has been accepted for publication in the *Journal of the American Chemical Society*, and posted on its Web site. Funding was provided by the U.S. Department of Energy.

To produce the patterns, Granick and Lin began by gluing two small mica sheets to cylindrical mounts. With the cylinders at right angles, a droplet of volatile solution containing small polymer chains was inserted between the curved mica sheets. The sheets were then brought into contact and left undisturbed until evaporation was complete.

Because evaporation in this geometry is restricted to the edge of the droplet, the process results in hundreds of concentric rings with regular

spacing, very much resembling a miniature archery target. Each ring – composed of polymer chains abandoned as the solvent receded – is several nanometers high and several microns wide.

The droplet evaporates in a jerky, stick-slip fashion, said Granick, who also is a researcher at the Frederick Seitz Materials Research Laboratory and at the Beckman Institute for Advanced Science and Technology.

“While the droplet is sticking to the surface, a ring of polymer is deposited,” he said. “As evaporation continues, tension builds in the droplet. Eventually the droplet jerks to a new position, the tension is temporarily relieved, and another ring is deposited.”

The simple evaporative process could be used to form patterns with many other materials, such as electrically conducting polymers, nanoparticles and proteins. Pattern formation could be controlled by altering the size of the material, changing the solvent, or modifying the surfaces.

“The pattern emerges spontaneously from the geometry in which we put the droplet,” Granick said. “This means we could make other kinds of patterns by using different geometries or surfaces with tailored wettability.”

Source: University of Illinois at Urbana-Champaign

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