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The nano world of Shrinky Dinks

August 13 2010

The magical world of Shrinky Dinks -- an arts and crafts material used by children since the 1970s -- has taken up residence in a Northwestern University laboratory. A team of nanoscientists is using the flexible plastic sheets as the backbone of a new inexpensive way to create, test and mass-produce large-area patterns on the nanoscale.

"Anyone needing access to large-area nanoscale patterns on the cheap could benefit from this method," said Teri W. Odom, associate professor of chemistry and Dow Chemical Company Research Professor in the Weinberg College of Arts and Sciences. Odom led the research. "It is a simple, low-cost and high-throughput nanopatterning method that can be done in any laboratory."

Details of the solvent-assisted nanoscale embossing (SANE) method are published by the journal Nano Letters. The work also will appear as the cover story of the journal's February 2011 issue.

The method offers unprecedented opportunities to manipulate the electronic, photonic and magnetic properties of nanomaterials. It also easily controls a pattern's size and symmetry and can be used to produce millions of copies of the pattern over a large area. Potential applications include devices that take advantage of nanoscale patterns, such as solar cells, high-density displays, computers and chemical and biological sensors.

"No other existing nanopatterning method can both prototype arbitrary patterns with small separations and reproduce them over six-inch wafers for less than $100," Odom said.

Starting with a single master pattern, the simple yet potentially transformative method can be used to create new nanoscale masters with variable spacings and feature sizes. SANE can increase the spacing of patterns up to 100 percent as well as decrease them down to 50 percent in a single step, merely by stretching or heating (shrinking) the polymer substrate (the Shrinky Dinks material). Also, SANE can reduce critical feature sizes as small as 45 percent compared to the master by controlled swelling of patterned polymer molds with different solvents. SANE works from the nanoscale to the macroscale.

Biologists, chemists and physicists who are not familiar with nanopatterning now can use SANE for research at the nanoscale. Those working on solar energy, data storage and plasmonics will find the method particularly useful, Odom said.

For example, in a plasmonics application, Odom and her research team used the patterning capabilities to generate metal nanoparticle arrays with continuously variable separations on the same substrate.

SANE offers a way to meet three grand challenges in nanofabrication from the same -- and a single -- master pattern: (1) creating programmable array densities, (2) reducing critical feature sizes, and (3) designing different and reconfigurable lattice symmetries over large areas and in a massively parallel manner.

More information: DOI: 10.1021/nl102206x

Provided by Northwestern University