Molecular "Stencils" Open Up New Possibilities for Solar Energy

Self-assembled nanomaterials provide a promising approach to fabricating more efficient and less expensive solar energy systems.

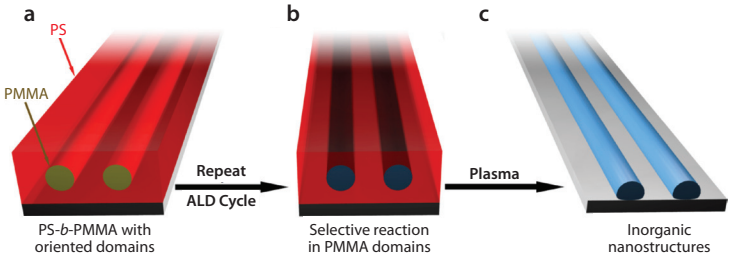
The Challenge

Nanofabrication techniques such as electron beam lithography and block copolymer self-assembly can be effective, but in many cases these approaches are either too costly or do not yield materials with the desired combination of nanostructure and physical properties.

The Solution

Researchers from Argonne's Center for Nanoscale Materials and Energy Systems Division have developed a new technique known as sequential infiltration synthesis (SIS), which involves the growth of inorganic materials within polymeric templates. In one embodiment, SIS relies on the creation of self-assembled nanoscale chemical domains into which other materials can be grown. A film composed of block copolymers acts as a template for the creation of a highly-tunable patterned material.

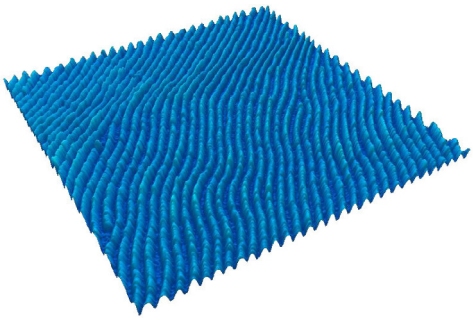
SIS is an extension of atomic layer deposition (ALD). But instead of just layering two-dimensional films of different nanomaterials on top of one another, SIS allows scientists to construct materials that have much more complex geometries.



This diagram shows the scheme for patterning inorganic nanoscale features onto the substrate by applying SIS onto a self-assembled PS-b-PMMA block copolymer film template.

The Results

SIS enables the creation of materials that weren't possible with ALD or block copolymers alone. By providing the ability to control the geometry of a material as well as its chemical composition, SIS opens the door to new nanomaterials that could potentially find their way into future generations of solar cells, catalysts, and photonic crystals. Argonne researchers are continuing work to optimize this methodology for specific applications and to test its limits.



Atomic force micrograph depicting titanium dioxide nanowires fabricated using SIS. The total image area is 2×2μm.

> ***"Our solar energy future does not have a one-size-fits-all solution,"*** **said Argonne chemist Jeff Elam. "*We need to investigate the problem from many different angles with many different materials, and SIS will give researchers many new routes of attack.*"**

For more information, contact: Seth Darling, darling@anl.gov or Jeff Elam, jelam@anl.gov

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