Polymers & Soft Materials (/core/journals/mrs-bulletin/topics/polymers-and-soft-materials)

New polymer brush patterning method streamlines adding functionality to surfaces

By Kendra Redmond 07 October 2016

Polymer coatings can add protection, functionality, and properties to materials. They are used in a variety of scientific and industrial applications, from aiding the body in accepting biomedical devices to making flame-retardant textiles and water-resistant paint.

Researchers from the University of California, Santa Barbara have now developed a streamlined, cost-effective technique for applying multiple polymer coatings to a surface. Their modular design, reported in a recent issue of *Advanced Materials*, can be used to coat and functionalize many different materials including silicon, Teflon, and cellulose fibers.

Traditionally, materials have been sprayed, dipped, or spin-coated with polymer films. These methods do a good job of coating a material uniformly and giving it one particular property or function. However, even more properties or functions can be added by applying different coatings in a pattern formation.

The new research simplifies an approach to patterning that is based on polymer brushes. Similar to the bristles in a hair brush, polymer brushes are composed of long polymers fixed to the surface at one end that stretch outward. Brushes can be patterned topographically, by growing polymers in certain areas and not others, as well as chemically, by growing a polymer brush in a pattern and then growing one or more other brushes in the gaps.

Chemically patterned brushes are formed by first depositing initiators on the surface in a desired pattern. Then a monomer solution is added and a polymer grows out from the initiators in the presence of a catalyst. The brushes are deactivated and the cycle is repeated for each new type of coating. Patterns can also be created by first growing a polymer brush uniformly, irradiating it with a particle beam into the desired pattern, redepositing initiators, and growing the second polymer.

The new technique simplifies the growth process by combining elements of photolithography with stop-flow techniques, in which reactants are inserted into a closed mixing cell containing the substrate. Unlike conventional methods, the substrate is coated with initiators just once, according to Christian Pester, lead author of the article. This happens before it is placed in the cell. In traditional patterning methods each type of polymer brush requires its own initiator deposition step, as well as rinsing and cleaning. The new method is more time-efficient and decreases the risk of related chemical contamination.

The setup consists of a light source mounted above an array of lenses. The array projects a photomask onto the substrate, which is totally enclosed in the stop-flow cell. “We can perform a variety of reactions with nearly infinite complexity and high spatial fidelity with our setup,” Pester says.

First, a monomer solution is injected into the cell and the light is turned on. The mask blocks the light from reaching selected areas, so the polymers only grow on the exposed areas of the substrate. While the photomask stays in position, the solution is drained and a new one flows in to functionalize the polymers. After this, the desired pattern can be achieved by changing the reactants, light source, position of the substrate, or position of the photomask.

“With our new method we can exchange solutions on the fly without ever moving the photomask or the substrate. This way we can access patterns which were previously inaccessible,” Pester says.

According to Christopher Ober, a materials scientist with expertise in polymers and surface structures who is director of the Cornell Nanoscale Facility, “The ability to spatially control surface functionality using a rather straightforward stop-flow process is the major breakthrough in this paper.” He adds, “Patterned brushes are being used in a large number of applications, particularly for controlled cell-surface studies, in a variety of sensors, and for anti-fouling surfaces, and that is just the biological applications. The new technique will make this work easier and broaden the use of patterned brushes.”

Read the abstract in *Advanced Materials* (http://onlinelibrary.wiley.com/doi/10.1002/adma.201602900/abstract).

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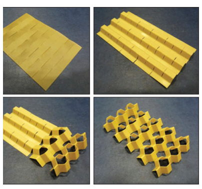

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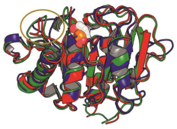

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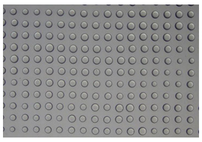

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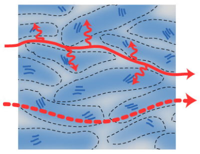

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