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Engineers Find A New Wrinkle in Research

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North Carolina State University researchers in the Department of Chemical and Biomolecular Engineering are exploring the possible benefits of wrinkles – how to create them, how to control them and how to use them.
Wrinkles, or buckles, in surfaces are typically considered a major design flaw that destroys the usefulness of the surface. In silicon chips, for example, wrinkled surfaces are a defect that sends a chip to the trash. But in the laboratory of Dr. Jan Genzer, associate professor of chemical and biomolecular engineering, the wrinkle has become the object of exploration for possible uses.

The inspiration for the research came as an added benefit to another experiment. The researchers were attempting to harden a sample of silicon rubber but created instead a hardened wrinkly surface.

"What we found when we examined the surface," Genzer says, "was that our surface was decorated with multiple generations of self-similar wrinkles, with each new generation 'carrying' the old one. Basically, the wrinkles have their 'infant' wrinkles, which have their 'infant' wrinkles, and so on."

The researchers were able to observe five distinct generations of wrinkles that span six orders of magnitude in dimensions ranging from tens of nanometers to millimeters.

Genzer and senior research associate at NC State, Dr. Kirill Efimenko, collaborated with scientists from Harvard University and Pennsylvania

State University to uncover the mechanisms that lead to the formation of multigeneration wrinkles. A paper describing the research, "Nested Self-similar Wrinkling Patterns in Skins," was published in the journal *Nature Materials*.

"We can control the creation and wavelength of the wrinkles by manipulating the surface," Genzer says. "We stretch a flexible elastomeric surface, convert the top-most part of the specimen into a more rigid skin by exposing it to ultraviolet/ozone treatment, and then gradually release the tension."

Now that they know how to form the multigeneration wrinkles consistently, Genzer and colleagues are exploring ways of utilizing this phenomenon.

"That is the challenge we face right now," Genzer says. "Now that we know how to create such complex surface topologies repeatedly, we have to establish how we put them to use. We have already used them to sort tiny beads by size. The next most logical application would involve controlling surface wettability through adjusting surface roughness (related to the so-called 'lotus leaf' effect) and explore the possibility of generating cheap and effective antifouling coatings for ships. We have recently started working on the latter application and our first results are very encouraging."

Source: North Carolina State University

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