CNMS Staff Science Highlight

Spontaneous Wrinkling in Functional Polymer Thin Films

Scientific Achievement

Azlactone-containing polymers wrinkle spontaneously upon deposition and solidification on a substrate without applying any external strain to the substrate, with the mode of deposition defining the direction of the wrinkles. This simple, one-step process is shown to be advantageous for nanoscale large-area patterning on 2D and 3D surfaces.

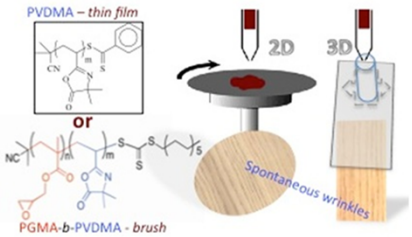
Significance

Here for the first time, we report a fast, facile method of developing wrinkled patterns where the directionality of the wrinkles can be easily tailored by changing the mode of deposition of the polymer films and could easily be adapted for 3D surfaces and other nonplanar, complex geometries for nanopatterning applications.

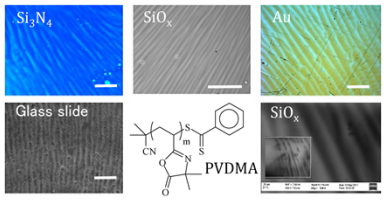
Research Details

- The wrinkling patterns presented in this work are directly created by casting poly(2-vinyl-4,4-dimethylazlactone) containing polymers onto a variety of substrates.
- The topographical orientation of these periodic wrinkles depends on the mode of deposition of the polymer solution onto the substrate.
- Development of wrinkling patterns in 3D structures and wrinkling-assisted controlled nanopatterning of Au nanoparticles at structured interfaces are demonstrated.

M. Ramanathan, B.S. Lokitz, J.M. Messman, C.M. Stafford, S.M. Kilbey
J. Mater. Chem. C, **1**, 2097 (2013).



Scheme summarizing the method by which wrinkles are spontaneously produced in 2D and 3D geometries.



Optical micrographs of wrinkling patterns that are formed by spin casting a 1 wt% solution of PVDMA in $CHCl_3$ at a spin sped of 1000 rpm on a variety of substrates. Scale bars are 200 µm.

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Highlight Narrative Text

(~175 words)

The development of wrinkled polymer thin film structures is viewed optimistically for the potential development of next generation high-tech devices such as stretchable electronics, microlens arrays, and smart surfaces. Here for the first time, we report a fast, facile method of developing wrinkled patterns where the wrinkles are formed spontaneously, in one step, simply upon solvent casting an azlactone-based polymer onto a substrate, without the need to apply any external stress to the system. The directionality of these wrinkles can be easily tailored by changing the mode of deposition of the polymer films onto the substrates. This methodology is not only simple, but also versatile and robust and could easily be adapted for 3D surfaces and other nonplanar, complex geometries. The persistence of these wrinkles over large distances is apparent, as we have noticed a uniform, sinusoidal wrinkling pattern across the full length of a 12” wafer. We expect that this simple, straightforward strategy of wrinkle formation in thin films comprised of a reactive polymer offers myriad possibilities for creating spatially and chemically tailored interfaces for modern applications.

Reference:

“Spontaneous wrinkling in azlactone-based functional polymer thin films in 2D and 3D geometries for guided nanopatterning”
Muruganathan Ramanathan,[a] Bradley S. Lokitz,[a] Jamie M. Messman,[a] Christopher M.

Stafford[b] and S. Michael Kilbey II[ac]
[a] Center for Nanophase Materials Sciences (CNMS), ORNL
[b] Materials Science and Engineering Division, National Institute of Standards and Technology
[c] Department of Chemistry, University of Tennessee
J. Mater. Chem. C, **1**, 2097 (2013)

Acknowledgment of Support:
This research was conducted at the Center for Nanophase Materials Sciences, which is sponsored at Oak Ridge National Laboratory by the Scientific User Facilities Division, Office of Basic Energy Sciences, U.S. Department of Energy.