Fabrication and characteristic of wrinkled stiff thin Films on elastomeric substrates by oxygen plasma treatments

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The wrinkle process comprises stretching of a soft elastic polydimethylsiloxane PDMS substrate[1,2] and subsequent oxygen plasma treatment, resulting in a hard SiO_2-like (SiOx-) layer on the surface.[3]

The PDMS system of choice for the presented process is Sylgard 184(DOW corning) which is usually applied in a 10:1 ratio (w/w) of siloxane and curing agent and requires a thermal curing step. These were treated on one side with oxygen plasma for 5, 10, 15 min to create a nanoscale silica skin, thus presenting identical surface chemistry in all experiments. This paper presents a cost-effective and simple method to form wrinkled stiff SiOx thin films on polydimethylsiloxane (PDMS) substrates at room temperature by oxygen plasma on pre-strained PDMS. The orientation of the generated structures was always perpendicular to the pre-stretched direction and the pitch of the structure could be adjusted ranging from 1.1 μm to 3 μm by controlling the strength of the pre-stretched strain and the thickness of the surface metal film. Upon relaxation, highly controlled and regular wrinkling of the silica skin resulted. Bi-layer substrates under uniaxial compression exhibit micron-scale features that can impart mechanical flexibility in functional electronic devices including interconnects, transistors and solar cells.

Systemic studies have been conducted to understand the dependence of the wavy profile on the PDMS pre-strain, UV/O exposure time, and PDMS modulus. The mechanics analysis has been verified to be quantitatively or qualitatively accurate by experimental comparisons. The wrinkled SiOx/PDMS system is stretchable and provides a wavy mold for stretchable electrodes. The constant electrical resistance during mechanical stretching shows the stretchability of this system. In this study, the metal thin film/contoured substrate is stretchable and has been demonstrated as stretchable electrical conductors.

References

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