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S0621

Project Title
Fabrication of Nanoscale PDMS Wrinkles with Controlled Periodicity for Anti-Counterfeit Application

Abstract

Objectives/Goals
In recent years, the wrinkle fabrication of polydimethylsiloxane (PDMS) has attracted scientists' attention as it provides a cost-effective way of producing nanostructures. Those nanoscale wrinkle structures contain more randomized minutiae patterns than fingerprints and are not cloneable even when fabricated under the same conditions, making them an excellent candidate for anti-counterfeit material. An important question is how to control the periodicity of those random irreproducible wrinkles so they can have tunable security levels. The goal of this research is to develop an effective method to fabricate PDMS wrinkles with controlled periodicity for anti-counterfeit application.

Methods/Materials
The PDMS was made with a 10:1 silicone elastomer to silanizing agent ratio and cured at 65°C. We treated all PDMS in a plasma chamber at the same power for the same time duration. The plasma oxidation altered the chemical composition of the surface and induced a thin stiff skin. The strain mismatch between the stiff skin and the substrate produced nanoscale wrinkles. To control the wrinkle periodicity, we stretched the PDMS at different ratios, and at each stretch ratio, we experimented with different substrate thicknesses and observed the wrinkles under an optical microscope. A nanoimprint mold was then fabricated with optical adhesives cured under UV light.

Results
Varying the substrate thickness effectively changed the PDMS wrinkle periodicity, while varying the stretch ratio only slightly affected it. In the theoretical models for wrinkle periodicity, the substrate thickness is simplified to be semi-infinite and excluded from the equation, but the results of our experiment demonstrate that the substrate thickness has a significant effect on the wrinkle periodicity when the substrate thickness is finite.

Conclusions/Discussion
Changing the PDMS substrate thickness is an effective method to control the wrinkle periodicity, and it is a novel approach to tune the security level of this emerging anti-counterfeit material. More studies can be done to further enhance the security strength of the PDMS wrinkle patterns, and for our future research we plan to use gold nanoparticles to add complexity to the patterns.

Summary Statement
We have developed a novel approach to fabricate nanoscale PDMS wrinkles with controlled periodicity for anti-counterfeit application.

Help Received
We used the lab equipment at the University of California Riverside under the supervision of Dr. Yadong Yin and graduate student Zhiwei Li.