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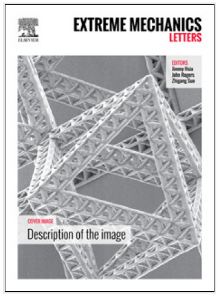

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Zining Yang, Qianli Chen, Ahmed E. Elbanna, Seok Kim

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Transfer Printing Enabled Soft Composite Films for Tunable Surface Topography

Zining Yang[a], Qianli Chen[b], Ahmed E. Elbanna[b], Seok Kim[a]*

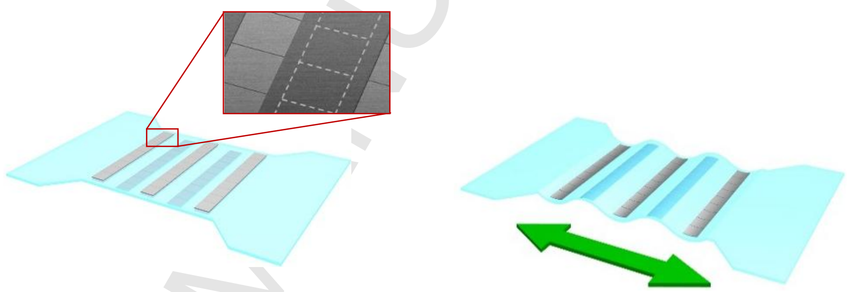
[a]*Department of Mechanical Science and Engineering, University of Illinois at Urbana Champaign, United States*

[b]*Department of Civil and Environmental Engineering, University of Illinois at Urbana Champaign, United States*

HIGHLIGHTS

- Soft composite films are fabricated by transfer printing silicon ribbons onto elastomeric films in a spatially organized manner.
- Tension-induced corrugation on the soft composite film is experimentally observed.
- Corrugation amplitude in response to applied stretch is characterized.
- Mechanism of corrugation formation on the composite film is elucidated by transformation rule.
- Effect of design parameters on corrugation is experimentally and numerically investigated.

GRAPHICAL ABSTRACT



Stretch-free State   Stretched State

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ABSTRACT

Transfer printing, an emerging manufacturing technique for heterogeneous material integration, is combined with the unique mechanics of soft composite films to realize a responsive surface for tunable topography in this work. Soft composite films are fabricated by transfer printing thin silicon ribbons on elastomeric films in a staggered manner. The corrugation formation in soft composite films requires a well-organized spatial distribution of the silicon ribbons which is enabled by transfer printing processes developed here. The corrugation development in response to applied stretching is characterized by optical metrology and the results fit with the numerical model to a good extent. The experimental results reveal that the maximum corrugation amplitude of the film can go beyond 25% of the total film thickness. Furthermore, the effect of geometrical and material parameters on corrugation formation is investigated experimentally and numerically. The results shown here suggest an alternative way to induce tunable surface topography.

1. Introduction

Surface corrugation is commonly manifested in daily life such as in water waves, cloud formations, sand dunes, wrinkles on human skin as well as in corrugated cardboard and metal roof panels. Inspired by such examples, developing engineered soft materials to achieve tunable surface topography, especially wavy geometry, have led to a wide range of applications such as responsive surface with tunable dry adhesion and wettability [1-3], novel electronic devices [4,5], diffraction gratings [6], microlenses [7] and tunable metamaterials [8]. For most of these applications, the soft materials are manufactured into the form of thin films and the corrugation patterns can

* *Corresponding author.* Tel.: +1-217-265-5656 ; fax: +1-217-244-9956.
E-mail address: skm@illinois.edu

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