

3-D Nanomolding

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The ability to produce three dimensional (3D) micro and nanostructures at low cost and with high throughput is very desirable for applications such as biomimetic surfaces, microfluidic devices and photonic crystals.¹ An example of 3D structures that draw significant interest is biomimetic superhydrophobic structures in which nanopillars protruding from sidewalls of microstructures. Polymer molding is emerging as a powerful tool for high throughput micro and nanofabrication.² However, the use of conventional micro and nanomolding techniques is limited to patterning polymer substrates which are flat or slightly curved with large radii of curvature.³ This is attributed mainly to the use of a hard mold and application of unidirectional force during molding and demolding.

In this presentation we show a two-step molding technique, named as 3D nanomolding, which allows for patterning nanostructures on arbitrarily non-planar substrates, even with vertical sidewalls of microstructures. In the first molding step a thin PDMS intermediate stamp is produced by spin-coating on a nanopatterned substrate, which is followed by the second molding step using another PDMS stamp with microstructures. Hierarchical micro and nanostructures to mimic superhydrophobic structures in an elephant ear leaf surface have been demonstrated (Figure 1), indicating that 3D nanomolding is a useful tool to produce biomimetic 3D structures and thus modify surface wetting property. The 3D nanomolded structures can be further used as a master mold for 3D stamp fabrication for mass production of the 3D structures using conventional micro and nanomolding (Figure 2).

¹ J. H. Jang et al., *Adv. Funct. Mater.*, 17 (2007) 3027.

² S. Y. Chou, P. R. Krauss, and P. J. Renstrom, *Science*, 272 (1996) 85.

³ W. M. Choi and O. O. Park, *Nanotechnology*, 15 (2004) 1767.

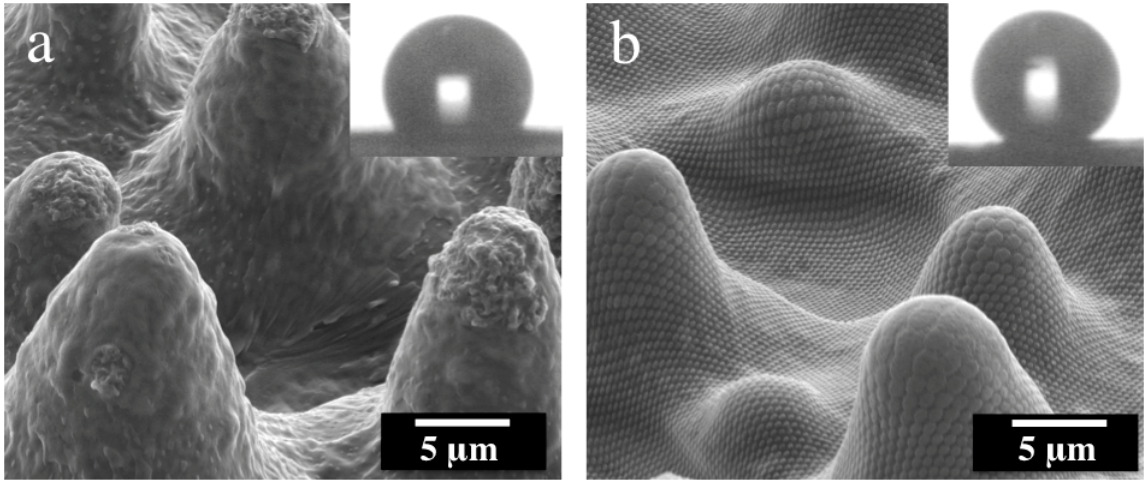


Figure 1: Scanning electron micrographs of PMMA substrate when PDMS replica of lotus leaf surface was used for 3D nanomolding on flat PMMA surface and PMMA which was pre-patterned with nanodots. The inserts show the water droplet on the surface of samples after they are coated by silane.

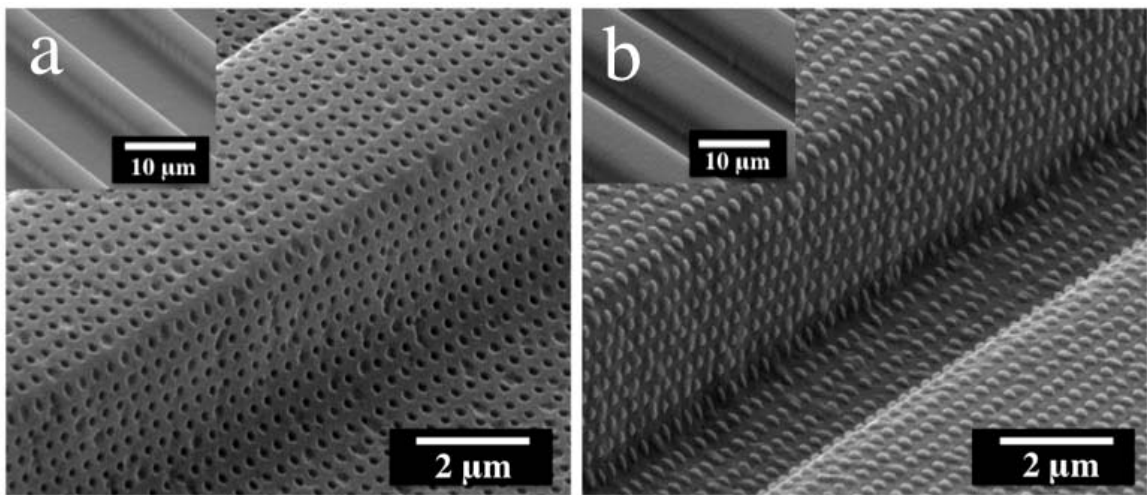


Figure 2: Scanning electron micrographs of (a) 3D hard-soft PDMS stamp after 10 times imprinting. (b) the associated 3D structures fabricated in PMMA. Schematic of the fabrication of 3D structures using 3D stamp is illustrated below scanning electron micrographs.