Biomimetic micromolding: Micro- and Nano-structuring of Polydimethylsiloxane (PDMS) using Bio- and Nature Inspired Templates

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Polydimethylsiloxane (PDMS) is an elastomeric material of interest for biological, biomedical, micro-analytical, and other applications. There is interest in the micro- and nano-patterning or texturing of PDMS for applications such as tissue engineering. There have been several methods developed to pattern PDMS in micro- and nano-scale dimensions, including electron beam lithography[1], focused ion beam writing[2], selective deposition of metal through a stencil mask and its subsequent removal[3], among others. There is a need for simple, inexpensive methods to pattern PDMS. We report on the structuring of PDMS using natural templates with micro- and nano-texture. These natural surfaces include modified eggshells, various agricultural products, among others. This is the first such work employing a diverse range of natural surfaces as templates for patterning PDMS. Our inexpensive method employs a novel molding process that overcomes difficulties often encountered while molding uncured PDMS on nanoscale templates[4], primarily in the filling of nanoscale features with the polymer. In addition to the simple and inexpensive fabrication method, the use of natural templates can potentially allow for the replication of conditions found on the original template. This can potentially result in new bio-applications.

The fabrication method involves preparing the template, and casting uncured PDMS on the template (Figure 1). In the case of eggshell templates, chicken eggshells are cleaned by boiling in water, followed by controlled etching in hydrochloric acid for 5 min. The eggshells are then rinsed in deionized water and dried in nitrogen. PDMS pre-polymer is cast on the treated eggshell in a new molding process designed to drastically improve filling of PDMS in small dimension features in the template. The resulting cured PDMS layer is demolded to yield micro- and nano-scale texture on its molded surface (Figure 1). The process also allows for control of feature depth.

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[1] J. Bowen, D. Cheneler, A.P.G. Robinson, Microelectron. Eng. 97, 34 (2012).
[2] B. Liu, J. Fu, J. Micromech. Microeng. 25, 065006 (2015).
[3] N. Patrito, C. McCaque, P.R. Norton, N.O. Petersen, Langmuir 23, 715 (2007).
[4] C. Con, B. Cui, Nanoscale Res. Lett. 8, 394 (2013).

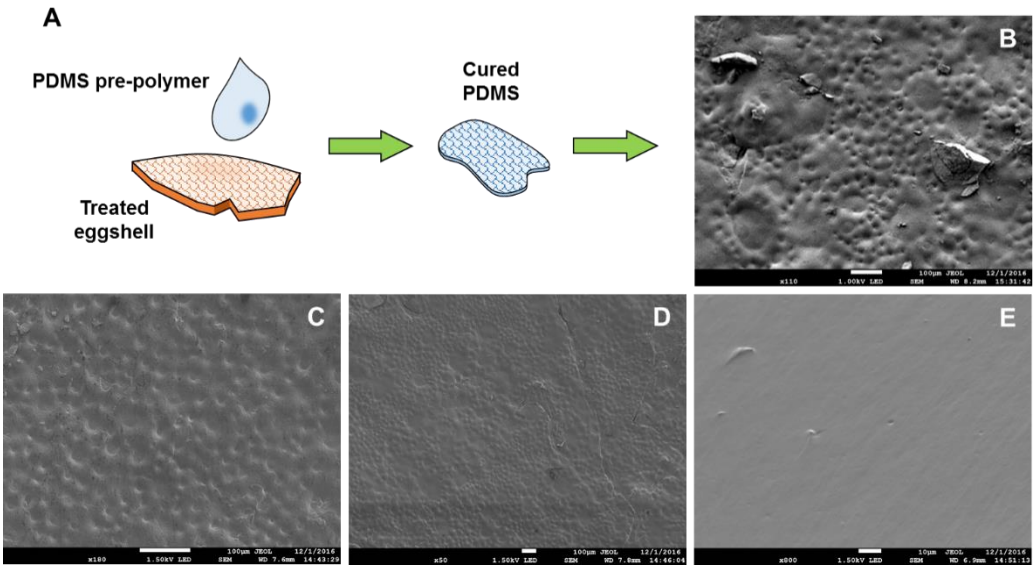

Figure 1: (A) Schematic diagram of fabrication of the nanostructured PDMS by a new molding process; (B) - (D) SEM images of the PDMS textured on chicken eggshells (scale bar is 100 μm); (E) SEM image of plain, non-textured PDMS (scale bar is 10 μm).