Deformation of elastomeric pyramid pen arrays in cantilever-free scanning probe lithography

Shuangping Liu
Monica Olvera de la Cruz
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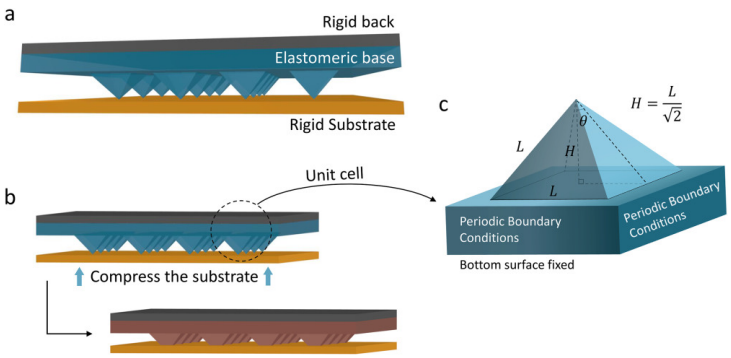
To better understand the mechanical behavior of the elastomeric pyramid pen array during the lithographic printing process, we numerically investigate the compression of an elastomeric pyramid array in a nonadhesive and frictionless contact with a rigid substrate. Simple scaling laws of the width of the contact surface with respect to the compression displacement and force are found and compared with previous models and experiments. By changing the interpyramid distance or the thickness of the base of the pyramid array, increasing deviations from the established scaling laws are observed and explained. Furthermore, we demonstrate that the unique morphology of a compressed pyramid primarily determines the unusual shape of the features fabricated by a specific cantilever-free SPL technique.



Schematics of our model for an elastomeric pyramid array. (a) Schematic structure of the pyramid pen array adopted in cantilever-free SPL. (b) Illustration of the loading procedure in our simulations: a rigid substrate is compressed against an elastomeric pyramid array. (c) Schematic geometry of a single pyramid contained in a unit cell with periodic boundary conditions.

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