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3D Morphing of Azopolymer-based Microstructures: In Between Top-Down and Bottom-Up Approach

Surfaces endowed with three-dimensional (3D) microstructures have captured the interest of the scientific community because of the possibility to introduce intriguing properties that are not present in their planar counterparts. They are extensively used in various fields such as photonics, surface wettability, bio-interfaces, and energy harvesting and storage [1]. Generally, there are two types of techniques for 3D microfabrication: the top-down and the bottom-up approach. On one hand, the top-down approach, such as the conventional photolithography and the imprinting lithography, is well-known for its fast and large-scale production. However, these methods require post processing steps, and often result in 3D structures with limited complexity. On the other hand, while the bottom-up approaches such as direct laser writing and 3D printing bring complexity and accuracy to the 3D structures, they suffer from the slow speed, high-cost procedure, and sophisticated tools. Recently, the direct and reversible light-induced mass-transport in azomaterials has been explored as a very powerful alternative. To create unique and complex 3D microstructures using azopolymers, an initial 3D microstructure is usually fabricated and subsequently exposed to light in order to shape it into various 3D architectures. The photo-driven deformation of azopolymer-based microstructures exhibits a distinctive mechanism in which the initial structure morphs without requiring removal of any material, as in the top-down approach, or addition of any new material, as in the bottom-up approach. Here, we use the light-induced mass transport in azopolymer to create complex and anisotropic textures [3]. By exploiting the polarization-driven transport of the material, a 2D square array of micropillars was reshaped into a grating-like structure with a programmable amplitude, height, and orientation controlling the polarization direction and exposure dose. In addition, the approach can be generalized by using the different light penetration depth in azopolymer volume at different light wavelengths [4]. By exposing the azo microvolumes with light of different wavelengths, we fabricated different 3D microstructures from the same original with tunable structure-dependent properties, such as wettability, with a single exposure with a low-intensity light and simple set-up.

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