Fabrication of 3D Periodic Nanostructures by Using Reusable Colloidal Phase Masks

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Three-dimensional (3D) nanostructures could advance optical and mechanical properties of nanostructures because of their regular porosity and unusual geometrical features. However, conventional fabrication methods for fabricating 3D nanostructures have some limitations. For example, holographic lithography needs complex optical set-up and it has limitation on simple tuning of geometrical features. Also, phase shift lithography using transparent nano-grating has difficulty in the preparation of phase mask which could be fabricated by using e-beam lithography for the elaborate geometry of nano-grating. Here, we demonstrate a facile and cost-effective method for the fabrication of periodic 3D nanostructures by using colloidal particles as phase shift elements. The colloidal monolayer embedded PDMS phase mask was used to produce regular light diffraction pattern on the photo-curable polymer. The geometrical parameters of 3D nanostructures could be easily controlled by adjusting the size of colloidal particles and laser-exposure time. Furthermore, we investigated a potential for the use of the colloidal phase mask as tunable phase mask for fabricating two types of 2D gold nanostructures.