Reusable Soft Polymer for Rapid and Large-scale Nano-Patterning

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In recent years, periodic nanostructure arrays have been extensively explored for widespread applications in areas such as photonics, plasmonics, photovoltaics, and biological/chemical sensors. Generally, these nanostructures are fabricated via conventional lithographic techniques including deep-ultraviolet (UV), electron-beam, and focused ion-beam lithography; however, these techniques always encounter problems of either low patterning speed, small patterning area, or high equipment cost. Substitutional and additive approaches consisting of nanoimprinting, laser interference, and epitaxy, etc., have also been actively investigated, but they are still far from mature to be handled as standard methods.

In this presentation, we introduce, demonstrate and discuss a facile but reliable photolithographic technique, which allows the rapid fabrication of highly ordered nanostructure arrays by employing soft transparent polymer films as optical masks for the area-selective exposure of a photoresist upon flood UV illumination. The soft polymer film either contains a monolayer of self-assembled (SAM) colloidal spheres inside at the near surface or has one side replicated from a SAM colloidal layer, in which the confined colloidal spheres or the surface textures can serves as lenses for light focusing [1,2]. The geometrical feature of the patterns, including the size, pitch, and even the shape, can be finely tuned by adjusting the mask design, exposure time and the thickness of the photoresist layer. Instead of a single usage, the polymer mask can be used numerous times without noticeable distortions in the achieved patterns. The obtained patterns could be used as deposition or etching mask, allowing easy pattern transfer for various applications.

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References

1. Fang M., Lin H., Cheung H.Y., Xiu F., Shen L., Yip S.P., Pun E.Y.B., Wong C.Y., Ho J.C.* "Polymer-Confined Colloidal Monolayer: A Reusable Soft Photomask for Rapid Wafer-Scale Nanopatterning", ACS Applied Materials & Interfaces, 6, 20837-20841, 2014.
2. Fang M., Lin H., Cheung H.Y., Yip S.P., Xiu F., Wong C.Y., Ho J.C.* "Optical Nanoscale Patterning through Surface-Textured Polymer Films", Advanced Optical Materials, 2, 855-860, 2014. [Frontispiece Cover Article].