Hybrid Metasurface Fabrication using Two-photon Lithography

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Metasurfaces represent quasi-periodic nano/micro-structures that modulate the transmittance, reflectance, and polarization of incident light. The continuous miniaturization of such devices and the expansion of their functionality suggests that metasurfaces can provide alternatives to bulky optical components and can be easily integrated with small-sized devices. Structure-based color filters, metalenses, and polarizers represent examples of metasurfaces that have been widely investigated in the last decade[1,2].

Hybrid metasurfaces represent a design at the boundary between diffractive optics and metasurfaces that may provide significant advantages for both digital and hyperspectral imaging in the visible to NIR spectrum. Hybrid metasurfaces employ variable height (3D) phase plates, pillars, and holes that provide additional degrees of freedom beyond purely planar designs.[3-5]

In this work, we employed two-photon lithography (TPL), typically used to print 3D structures, for hybrid metasurface fabrication. This process eliminates the problems of multi-step fabrication and alignment associated with building 3D structures using traditional lithography. A thorough study of the TPL process was implemented to obtain the 3D printing parameters necessary to fabricate hybrid metasurfaces that simultaneously focus and filter light. For example, we show that careful control of laser power is critical to tuning the transmission wavelength of these focusing filters as shown in Figure 1. We will also discuss a novel focusing-filter that provides multiple overlapping focal spots for imaging applications as shown in Figure 2.

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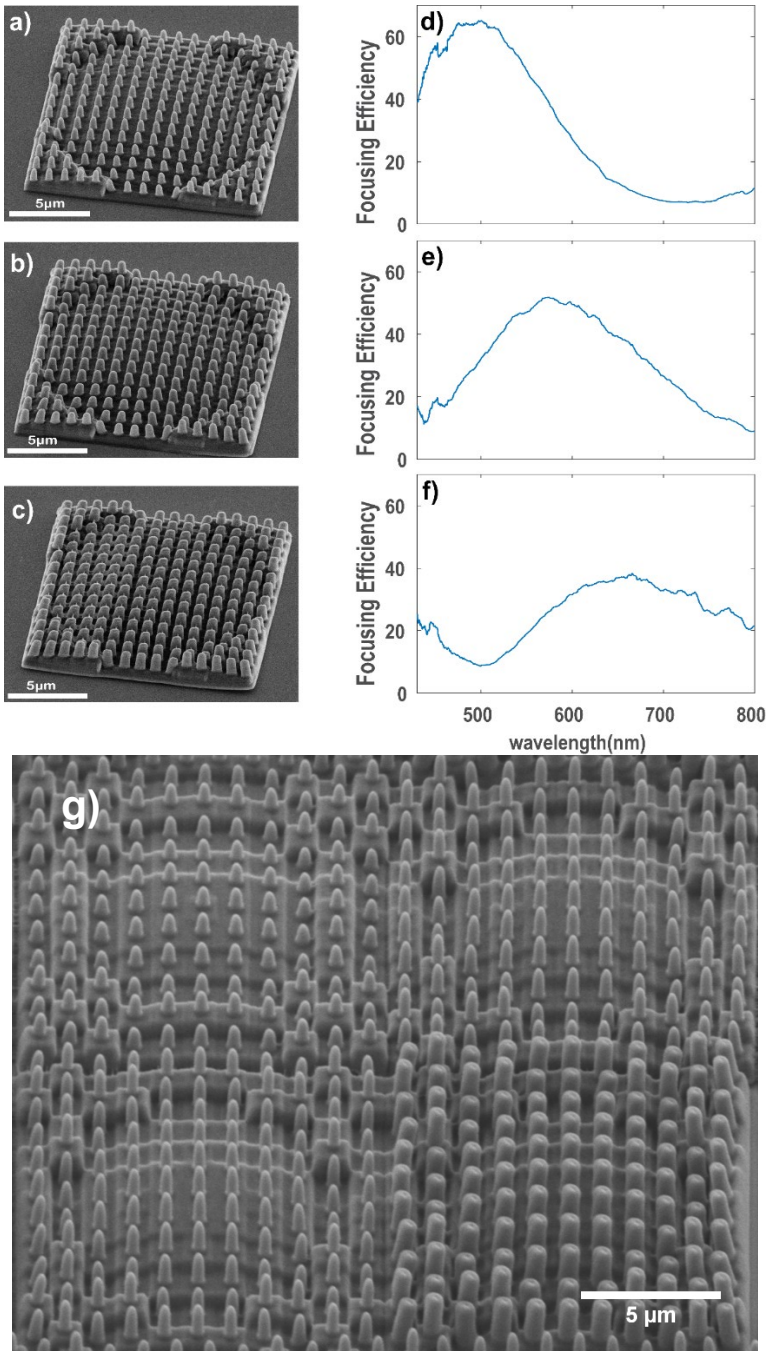

Figure 1: (a-c) show the fabricated hybrid metasurface filters at different exposure laser power for the pillars structures; the used power is (10, 15, and 17.5 mW, respectively). The periodicity of grating pillars is 1.1µm. (d-f) show the focusing efficiency of the fabricated filters; it can be seen how the filter function changes with the laser power. (g) shows a set of focusing filters that produce multiple, overlapping focal spots for imaging applications.