

# Fabricating Nanolens Arrays by nanoimprint lithography

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In recent years, microlens arrays have been fabricated on diamond substrates by using thermal reflow and dry etching techniques [1] and the consequence 3D spherical nanolens can be generated by nanohole arrays photolithography [2]. But it is still a realistic problem to obtain nanolens with high efficiency and inexpensive approach. This paper presents an easy and cost-efficient method to fabricate the nanolens arrays by nanoimprint lithography (NIL). By varying the width of nanohole mold, the various configurations of isolated or connected nanolens arrays can be fabricated.

Fig. 1 shows a schematic illustration of the fabrication process for nanolens pattern. First, the 20mg/ml Poly(3-hexylthiophene-2,5-diyl) (P3Ht) in 1,2-dichlorobenzene was spin-coated on silicon wafer, the thickness is around 90nm. The 300nm depth with 300nm diameter nanohole mold was used to get the polymer cylinder under 150°C with a pressure of 100N/cm<sup>2</sup>. After removing the residual layer by dry etch, the polymer pillars were heated up to its melting point (230°C). During thermal reflow treatment, the pillars turned to be fluid state and formed spherical segments due to surface tension. Finally the silicon can be etched by RIE process. The key of this process is to control the etch rate of the polymer and the single crystal silicon.

[1] Geng, C., Fan, Y. M., Shi, S. S., Yan, Q. F., Wang, L., Xu, S., . . . Bi, W. G. '3D nanohole arrays generated by spherical-lens photolithography'. *Materials Letters*, 209, 178-181. 2017

[2] Zhu, T. F., Fu, J., & Lin, F. 'Fabrication of diamond microlens arrays for monolithic imaging homogenizer' *Diamond And Related Materials*, 80, 54-58. 2017

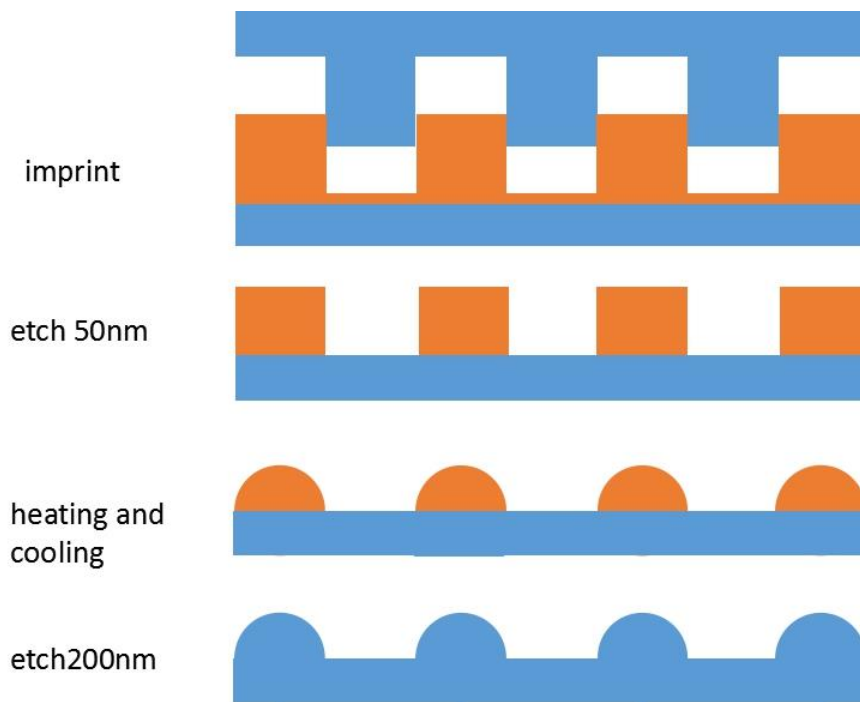


Figure 1: The schematic of fabricating nano-lens arrays.

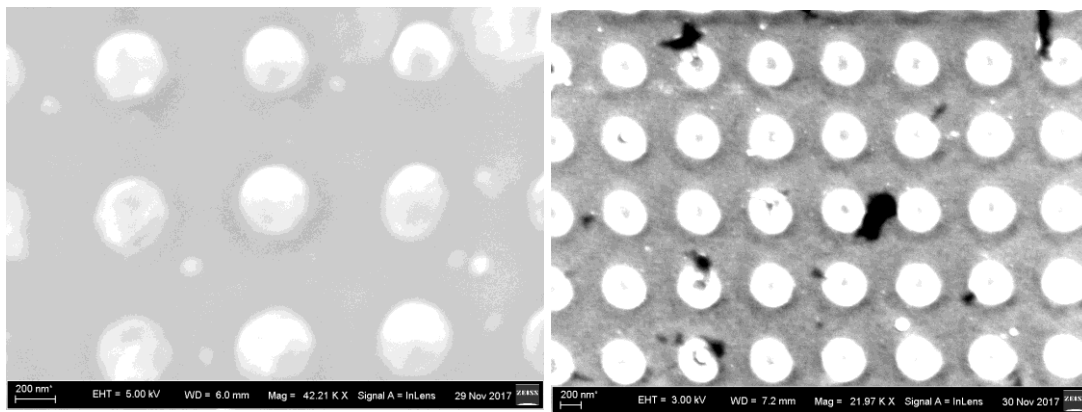


Figure 2(a): The polymer nano-lens after the thermal reflow treatment and; (b) the silicon nano-lens after the dry etching.