# Lift-Off Free Fabrication of Nano-Apertures Using Templated Dewetting

Y.M. Wang, M. Asbahi, D. Zhu
*Institute of Materials Research and Engineering, Singapore 117602, Singapore*
*wangym@imre.a-star.edu.sg*

J.K.W. Yang
*Institute of Materials Research and Engineering, Singapore 117602, Singapore*
*Singapore University of Technology & Design, Singapore 138682, Singapore*

Here, we present an approach that utilizes metal dewetting from lithographically defined nanostructures to fabricate highly ordered ~15 nm diameter nano-apertures in metal films. We first use hydrogen silsesquioxane (HSQ), a high contrast negative tone resist, to pattern 10 nanometer-scale pillars on a silicon or glass substrate. After gold deposition, we thermally anneal our sample to induce dewetting from the HSQ pillars. As a result, we obtain arrays of nanoscale apertures with high yield. Conventional methods that involve metal lift-off often require good metal adhesion. However, metals such as gold and silver adhere poorly to common substrates like silicon and silicon dioxide, necessitating the use of a metal adhesion layer (e.g. titanium or chromium). In our method, good metal adhesion is not a pre-requisite. This is an important advantage in the fabrication of plasmonic structures, where metal adhesion layers are known to damp out surface plasmons.[1,2] In addition, the annealing step that is inherent to our method reduces metal grain boundaries that also contribute to plasmon damping.[3,4] To obtain nanoholes, the HSQ pillars can be removed by hydrofluoric acid etching. However, the fact that the template features do not have to be removed in the fabrication process presents an interesting opportunity for easy interfacing metal nanostructures to templates that consist of active materials. Our method may eventually allow for fabrication of active nanoplasmonic devices with sharp resonances and high sensitivity.

---

[1] T. Habteyes, S. Dhuey, E. Wood, and D. Gargas, ACS Nano 5702 (2012).
[2] T. Siegfried, Y. Ekinci, O. Martin, and H. Sigg, ACS Nano 2751 (2013).
[3] O. Hunderi, Physical Review B **7**, 3419 (1973).
[4] P. Dawson et al. Physical Review B **44**, 6372 (1991).

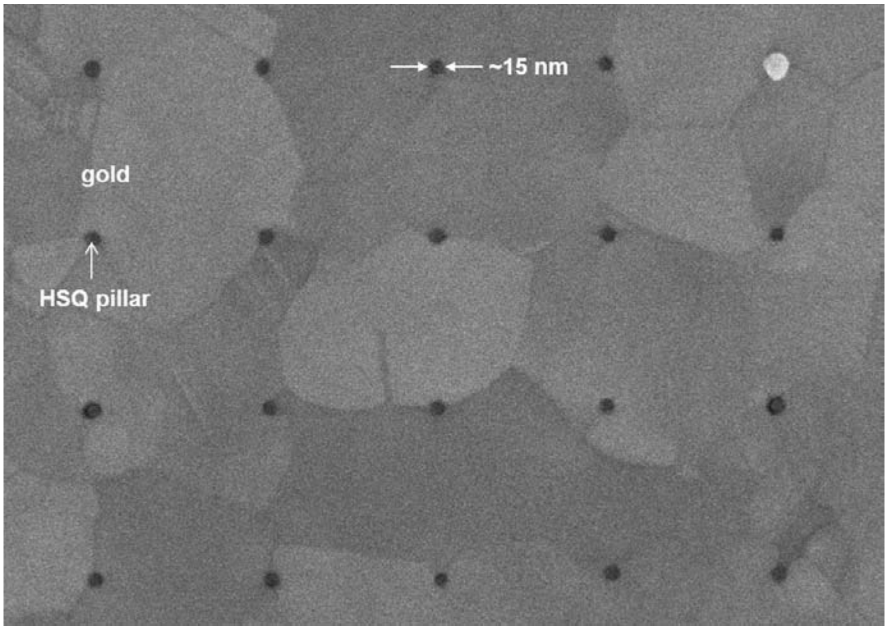


*Figure 1: Nanoapertures in gold film obtained through templated dewetting.* The diameters of the apertures obtained are about 15 nm. The top right hand corner shows an example of a pillar that did not completely dewet. Instances of incomplete dewetting can be minimized through further optimization of the ratio of deposited metal thickness to template height.