# Fabrication challenges towards realization of MEMS-enabled spectrally tunable metasurface filter for long-wavelength infrared

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Conventional spectrometer systems are bulky and require complex stabilization methods, limiting their application and creating high costs. Spectrally tunable MEMS-enabled Fabry-Perot interferometers address these issues [1]. However, this approach extends poorly into longer infrared wavelength ranges (LWIR and beyond) as the cavity gap and mirror layers become unfeasibly thick.

Plasmonic metasurfaces exhibiting extraordinary optical transmission (EOT) [2] are a promising candidate to realize tunable filters over the LWIR band. To achieve a tunable single peak within 8-12 µm wavelength range the target design consists of a suspended perforated gold membrane with a vertically tunable thin silicon structure above it, as depicted in Fig.1.

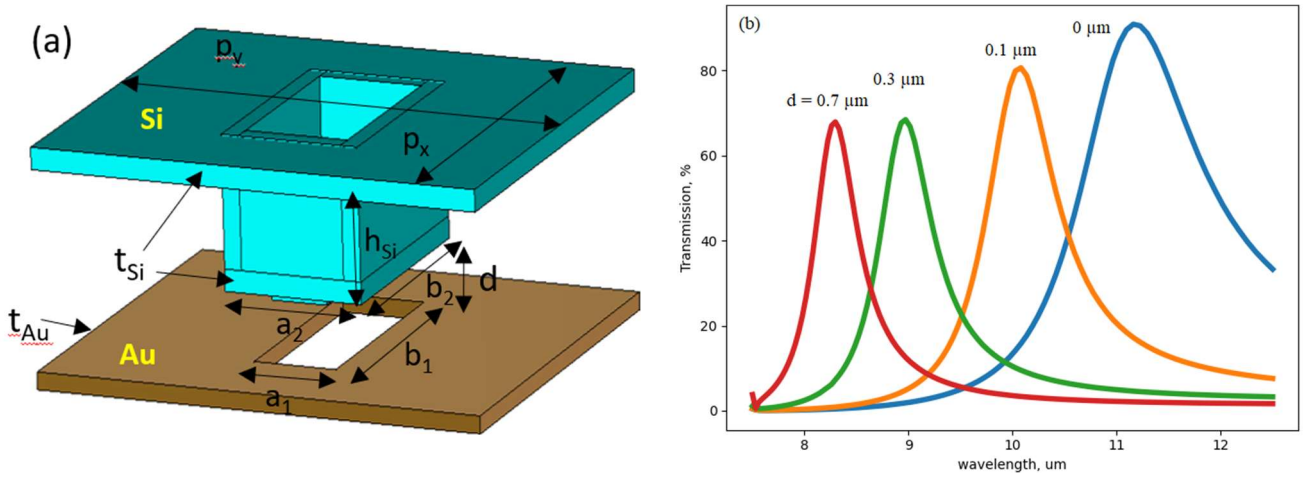


Figure 1. (a) Schematics of the unit cell of the proposed metasurface wavelength filtering device and (b) expected LWIR optical transmission spectra for a device where $a_1$=1.2 µm, $b_1$=3 µm, $a_2$=2 µm, $b_2$=3 µm, $t_{Si}$=0.25 µm, $t_{Au}$=0.25 µm, 0<d<0.7 µm, $p_x$=5.5 µm and $p_y$=6.5 µm.

Significant fabrication challenges exist for successful realization of such a device. These include the need to remove the substrate from the optical path without detrimental effects on the static perforated gold layer as well as the vertically tunable MEMS silicon structure. This needs to be achieved over areas as large as few $mm^2$ and issues related to thin film stress built-up are very significant. We discuss those challenges and the need to maintaining parallelism between the two suspended membranes. First fabrication runs indicate adequate device performance to give us confidence to meet these challenges by the time of the conference.

[1] Martyniuk, M., et al., Advanced Functional Materials, 2022, 32, (3), pp. 2103153

[2] T. W. Ebbesen, H., et al., Nature, vol. 391, no. 6668, pp. 667–669 (1998).