Wavelength tunable band-pass IR filters for gas concentration measurements

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This project involves exploring different designs for movable, periodically perforated, sub-wavelength metal gratings in order to build IR band-pass filters with dynamic wavelength tuning. Designs such as translation / tilting of single gratings, and interaction between multiple gratings will be studied. Students may also devise and test their own approaches.

Spectroscopy [1] is a widely used technique for identifying substances based on the spectrum that they emit or absorb. The concentration of the substance may also be back calculated based on the intensity absorbed according to the Beer-Lambert Law [2]. The ability to detect and quantify concentration makes spectroscopy especially useful in gas detection for safety and security purposes. Previous work has shown that a perforated Aluminum grating may be used as an IR band-pass filter, with the wavelength filtered being determined by device geometries [3]. However, the limitation is that a single grating only offers single wavelength operation. Theoretical work based on movable perforated dielectric gratings demonstrated that it may be possible to tune the active wavelength that is filtered [4]. The goal of this project is to realize a similar tunable filter, but using metallic gratings to filter IR wavelengths in the 2-10 um regime. The advantages of this proposed technique include: 1) Low cost; 2) Ubiquitous deployment; 3) Range of gas detection; 4) Integration with lab-on-chip solutions.

References:

[1] http://en.wikipedia.org/wiki/Spectroscopy
[2] http://en.wikipedia.org/wiki/Beer-Lambert_law
[3] D.A Horsley, J. Provine, J.L. Skinner, “Integration of subwavelength metal gratings with MEMS actuators,” Smart Medical and Biomedical Sensor Technology III, Proceedings of the SPIE, Volume 6008, pp. 209-216 (2005).
[4] W. Suh, M.F. Yanik, O. Solgaard, Shanhui Fan “Mechanically switchable photonic crystal structures based on coupled photonic crystal slabs,” Photonic Crystal Materials and Devices II, Proceedings of the SPIE, Volume 5360, pp. 299-306 (2004).