Asymmetric Fabry-Perot cavity based perfect absorber for infrared spectroscopic devices

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Artificial subwavelength structures such as plasmonic perfect absorbers, metallic gratings and photonic crystals have been proposed to tailor the spectral absorption for spectroscopic devices. Though, the subwavelength scalability constraints of these patterned structures require high-precision and multi-stage lithography. Facilitated by rapid progress in thin film deposition techniques, importance of multilayer planar films to achieve near-unity absorption for large-area surfaces have been recently reinvigorated. Among many types of layered structures, asymmetric Fabry-Perot (FP) cavity structures have shown distinct advantage of tunability and high-resolution spectroscopy due to their strict resonant condition of multiple interference. Previously, although much work has been done to investigate asymmetric FP cavity structures, little effort was directed to systematically analyze and optimize the parameters of asymmetric FP cavity with various top reflector configurations and realize practical thermal emitters and detectors.

In this work, we proposed and investigated asymmetric FP cavity based spectrally selective thermal emitters and detectors in two forms: plain Metal-Dielectric-Metal (MDM) and hybrid {Distributed Bragg Reflector}-Dielectric-Metal (DBRDM). The asymmetric FP cavity based perfect absorbers show advantages of lithography-free fabrication, excellent spectral controllability and high-resolution spectra. The Au-Al_2O_3-Au based spectrally selective emitter aimed at the absorption band of CO (~2.3 μm) with the full-width-at-half-maximum (FWHM) of ~110 nm. The 3(SiO_2-Si)- SiO_2-Al based spectral selective pyroelectric detector aimed at the absorption band of CH_4 (~3.3 μm) with very narrow FWHM of ~22 nm.

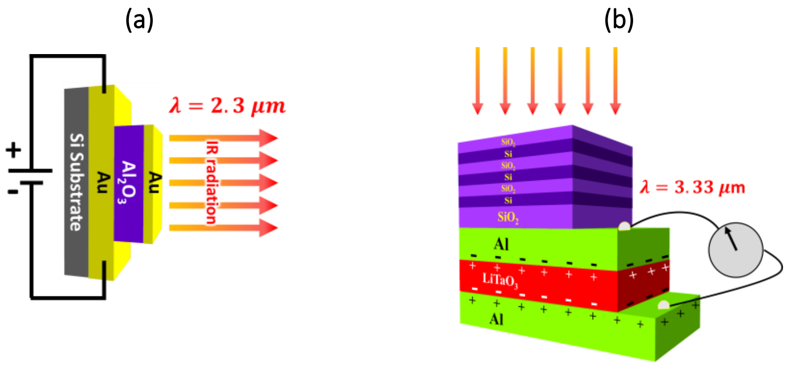

Figure: Schematic structural design of Au-Al_2O_3-Au based spectrally selective emitter **(a)** and 3(SiO_2-Si)-SiO_2-Al based spectral selective pyroelectric detector **(b)**.