Pixelated plasmonic metasurfaces as a platform for sensing applications in mid-IR

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Plasmonic metasurfaces are two-dimensional arrays of metallic nanoantennas (meta-atoms) with subwavelength dimensions and spatially varying phase responses. Plasmonic metasurfaces promise a paradigm shift in optics by replacing traditional bulky optical elements, e.g., beam deflectors, lenses, waveplates, vortex generators, and holograms, with ultrathin, lightweight, and easy-to-integrate two-dimensional optical interfaces. They are easy to fabricate, support field confinement beyond the diffraction limit, and have the potential to respond on the timescale of a few femtoseconds. These properties are unparalleled in traditional optical elements, which makes them a promising candidate for sensing applications, especially in the mid-IR range. However, because of the mismatch between mid-IR wavelengths and dimensions of the molecules, the sensitivity of mid-IR spectroscopy is limited when detecting signals from nanometer-scale samples. This drawback can be addressed by exploiting the strong near-field enhancement of the plasmonic metasurfaces; if the metasurface resonance is spectrally overlapped with the absorption fingerprints of the molecule, the enhanced molecule-resonator coupling can lead to a change in either the frequency or the strength of the resonance, from which the molecular fingerprints can be extracted. This presentation will discuss the fabrication of pixelated plasmonic metasurfaces with reflectance resonances tuned in the range of 1000 cm^{-1} to 1800 cm^{-1} for optical sensing.

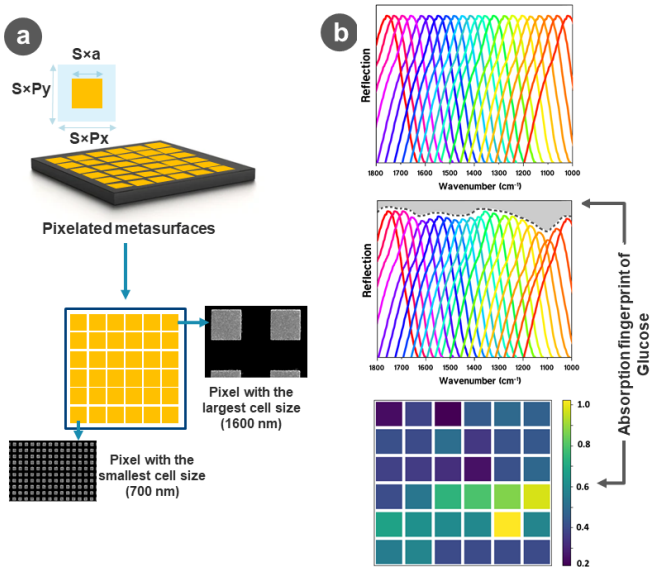

Figure 1. (a) Schematic illustration of the fabricated plasmonic metasurfaces containing 36 pixels with different cell sizes according to the scaling factor (S). (b) Resonance spectra of each pixel before (top row) and after (middle row) the addition of the analyte (Glucose (1 nM) in this case). The bottom row shows the 2D barcode-like map of reflectance difference.