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Tunable multiband metasurfaces by moiré nanosphere lithography

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Supplementary Information

Optical Measurements

The transmission spectra of the moiré metasurfaces were measured with a FTIR microscope (Continuum, Thermo Fisher Scientific Inc.) equipped with a 50 x 50 μm^2 aperture. N_2 was constantly purged into the microscope interior while the measurements were being taken. A nitrogen-cooled mercury cadmium telluride detector was applied to collect the transmitted light through the samples. A plain glass slide was used as a reference when calculating the transmittance. An infrared polarizer (Continuum, Thermo Fisher Scientific Inc.) was placed in the detection path for polarization dependence measurements. The dark-field scattering spectra were measured on a dark-field microscope (Ti-E inverted microscope, Nikon) and a Witec alpha300 S microscope (Witec GmbH, Germany).

Simulation Methods

The optical properties are simulated using FDTD methods with commercially available software package (FDTD Solutions, Lumerical). The moiré metasurfaces are positioned on top of a glass substrate. The optical properties of SiO_2 are adapted from Palik.[1] The optical constants of Au are adapted from Johnson and Christy[2] for wavelengths from 400 nm to 1500 nm, and from Palik[1] for wavelengths from 1500 nm to 5000 nm. The nanostructures used in the simulations are directly imported from the SEM images. The thickness of Au layers is set as 50 nm. Normal incident plane waves are used as light sources. A two-dimensional frequency domain power detector is used to measure the transmission and scattering light from the Au metasurfaces. A point detector is placed at the center of the nanogaps to record the near-field spectra and field enhancement distributions.

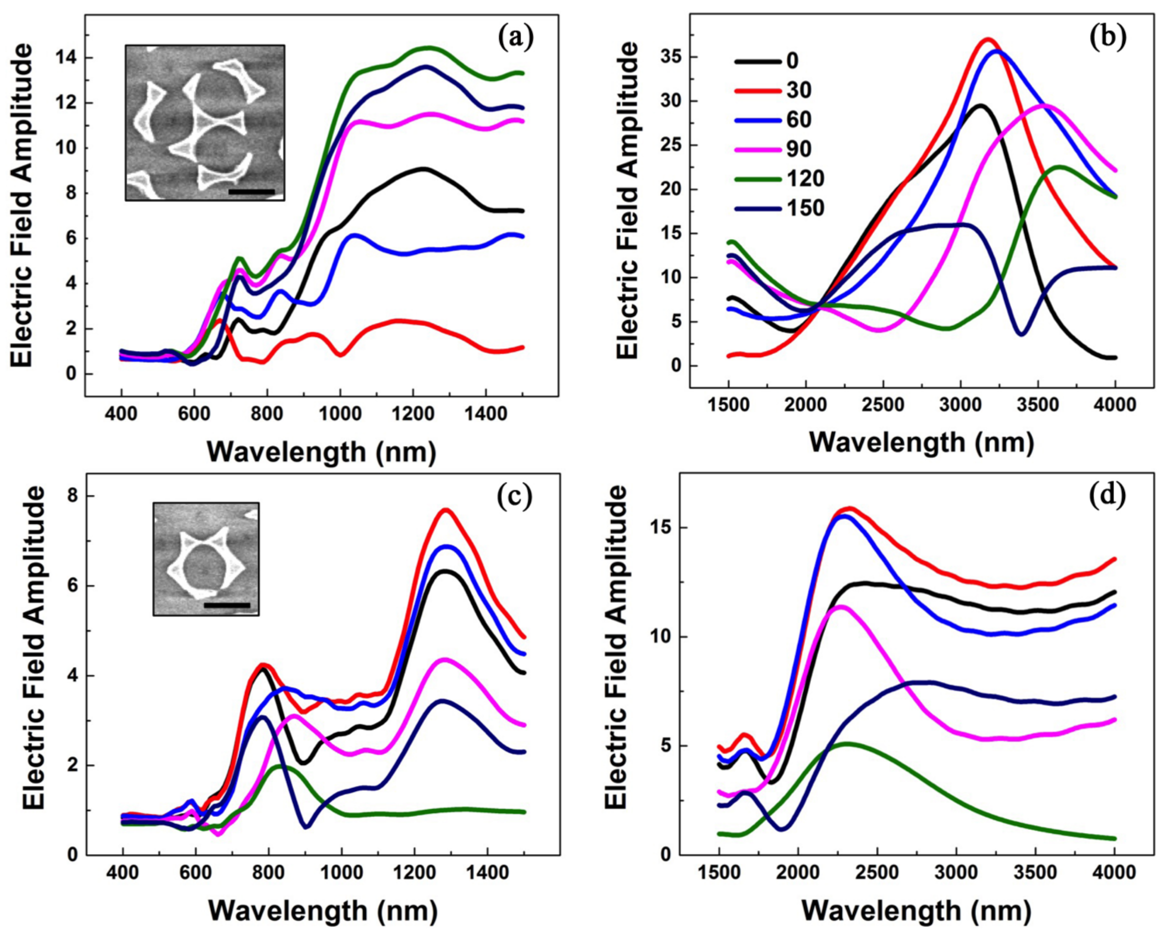

Figure S1. *(a & b) Near-field optical spectra of fan-like nanostructure within the two different wavelength regimes. The spectra were taken from the center of the bottom nanogap in the fan-like nanostructure as shown in the SEM image of the inset of (a). The incident light has variable polarizations from 0° to 150°. The scale bar in the SEM image is 500 nm. (c & d) Near-field optical spectra of the split-ring nanostructure within the two different wavelength regimes. The spectra were taken from the center of the nanogap in the split-ring nanostructure as shown in the SEM image of the inset of (c). The incident light has variable polarizations from 0° to 150°. The scale bar in the SEM image is 500 nm.*

References

1. E. D. Palik, *Handbook of optical constants of solids*, Academic press, 1998.
2. P. B. Johnson and R.-W. Christy, *Phys. Rev. B*, 1972, **6**, 4370.