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Metagratings for wavefront manipulation

Motivations:

Conventional metasurfaces show efficiency limitations for extreme wave transformations, requiring complex fabrication. The innovative **metagrating** concept simplifies fabrication procedure. Operating in the few-diffraction order regime, **metagratings** are capable of efficiently manipulating EM wave for high-performance wavefront transformations.

Methodologies:

- Far field equation (For determining wavefront manipulation)

$$E_m = E^{rt} + E^{sca}(I)$$

E_m: Electric field of the m^{th} diffraction order

E^{rt}: Reflection/transmission field of the excitation

$E^{sca}(I)$: Radiation field of line currents

- Near field equation (For designing surface structure)

$$Z_q I_q = E^{ext} - \sum_{p=1}^{N} Z_{qp} I_p$$

Z_q: Load impedance of the meta-atom

E^{ext}: External field of the excitation

Z_{qp}: Self/ Mutual impedance

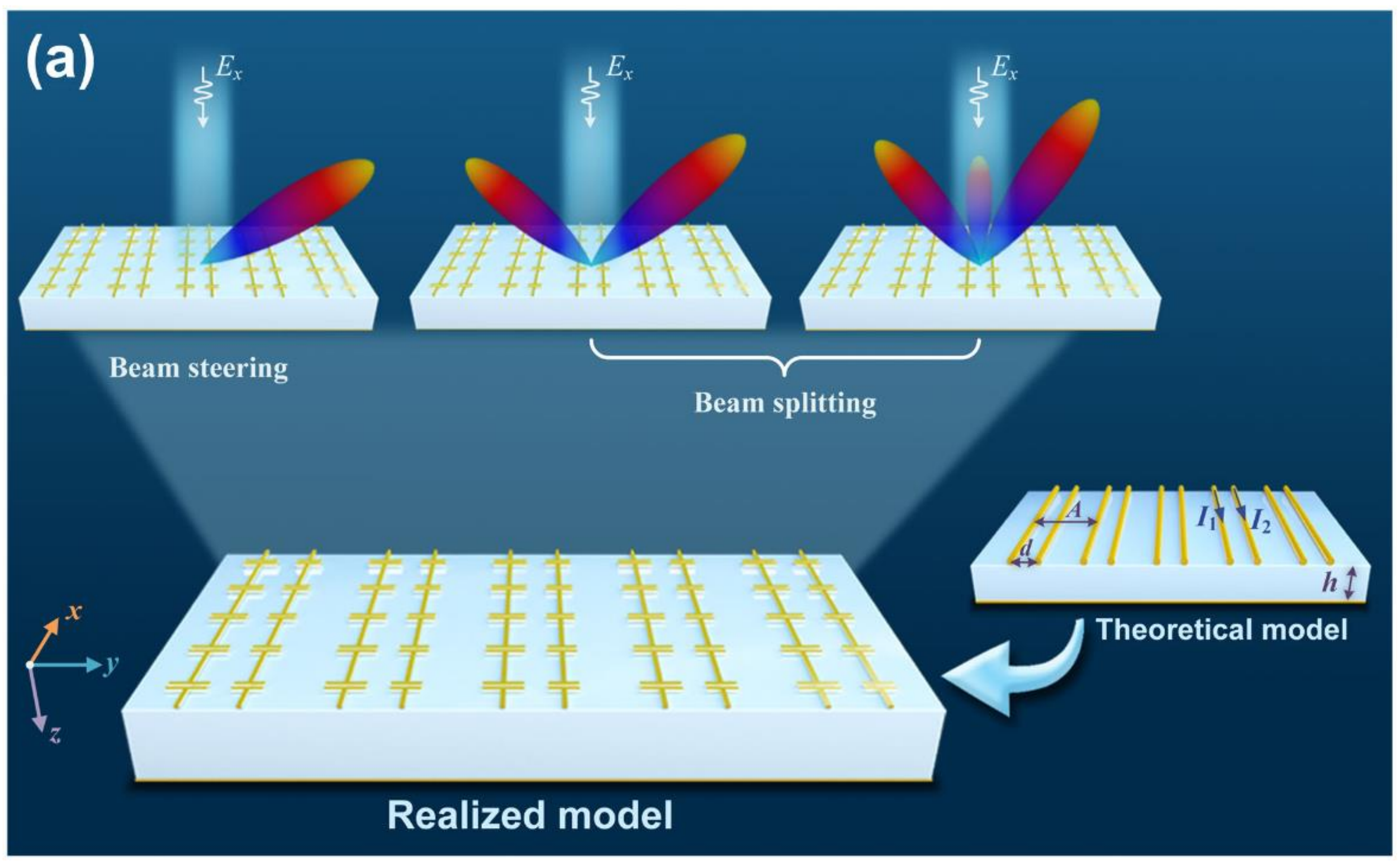
I_q/ I_p: Amplitude of line currents

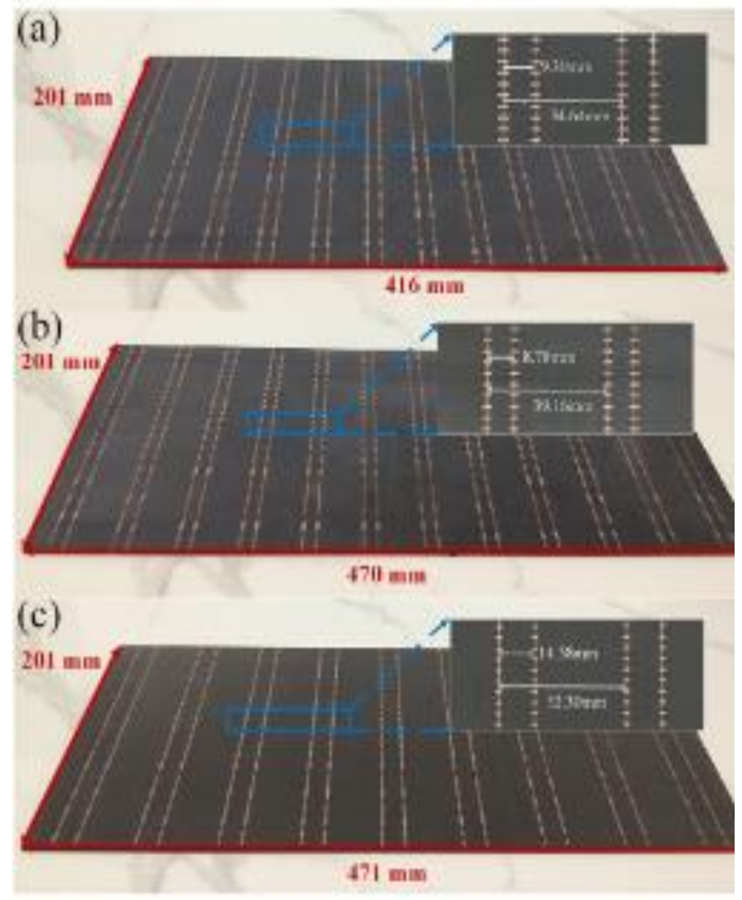
- Analytical design steps

① Solving for the line current I from the far-field equation

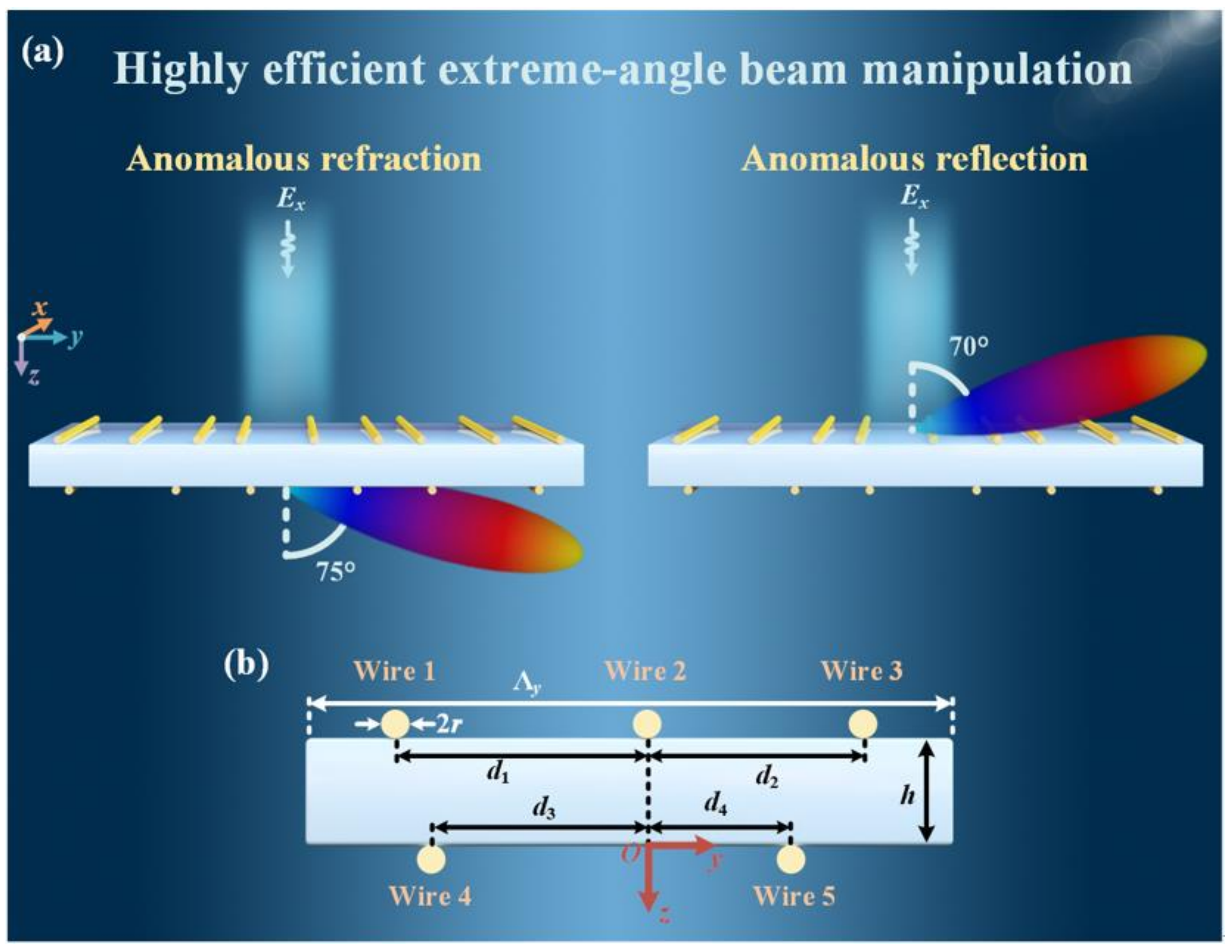
② Substituting the current I into the near-field equation to solve for the load impedance Z_q

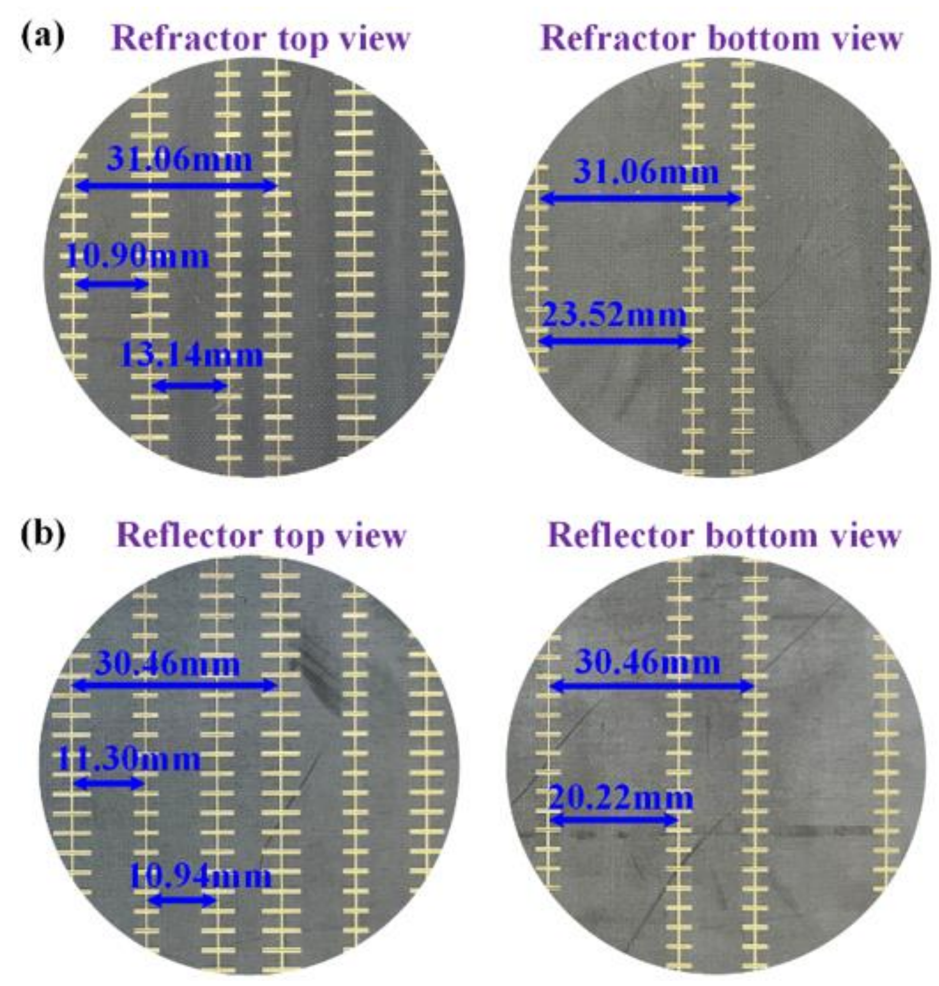
I. Anomalous reflection and beam splitting



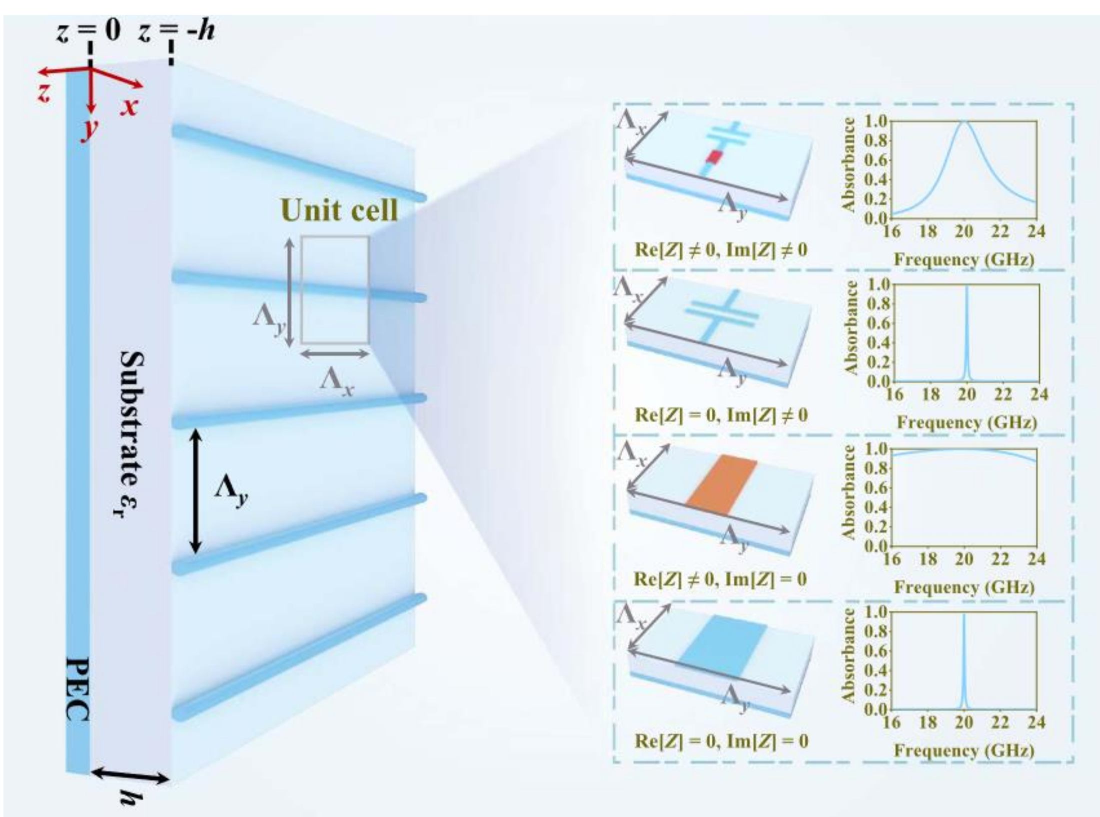


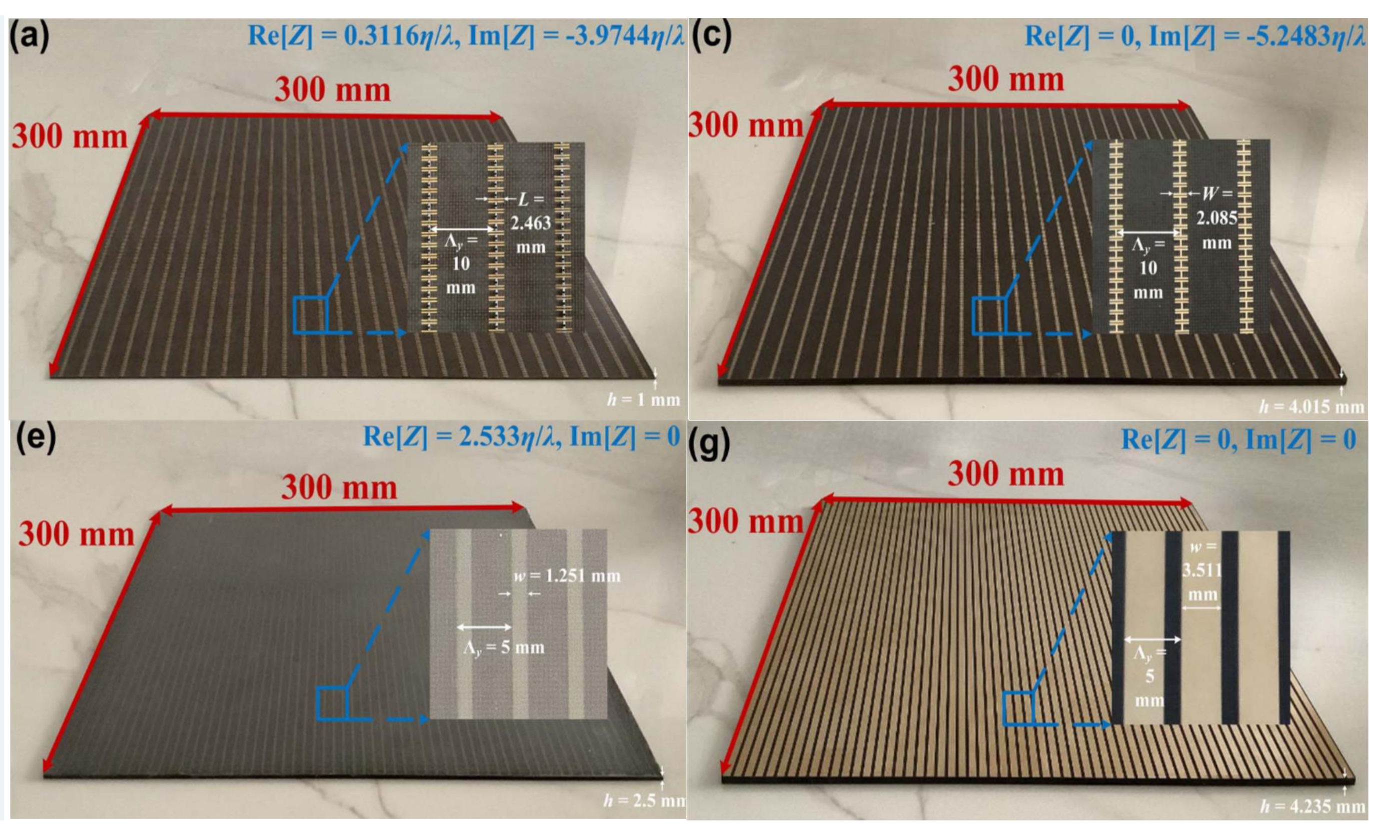
II. Anomalous refraction and reflection

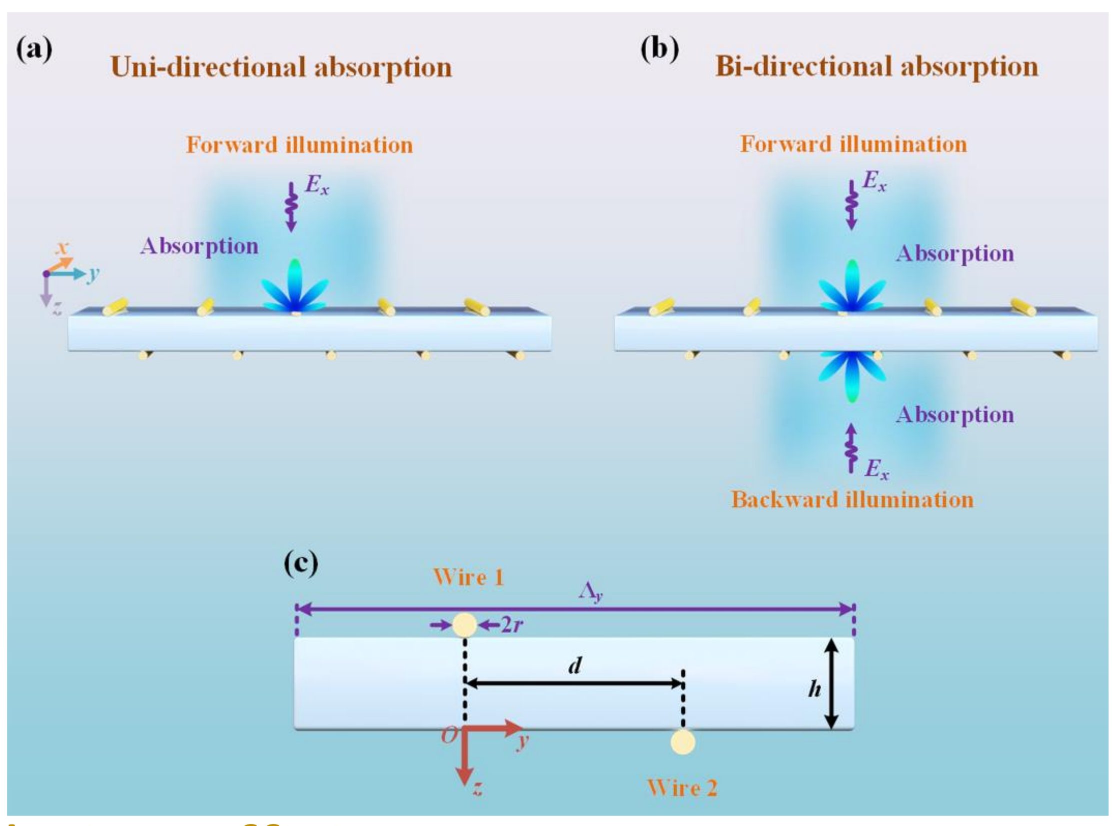


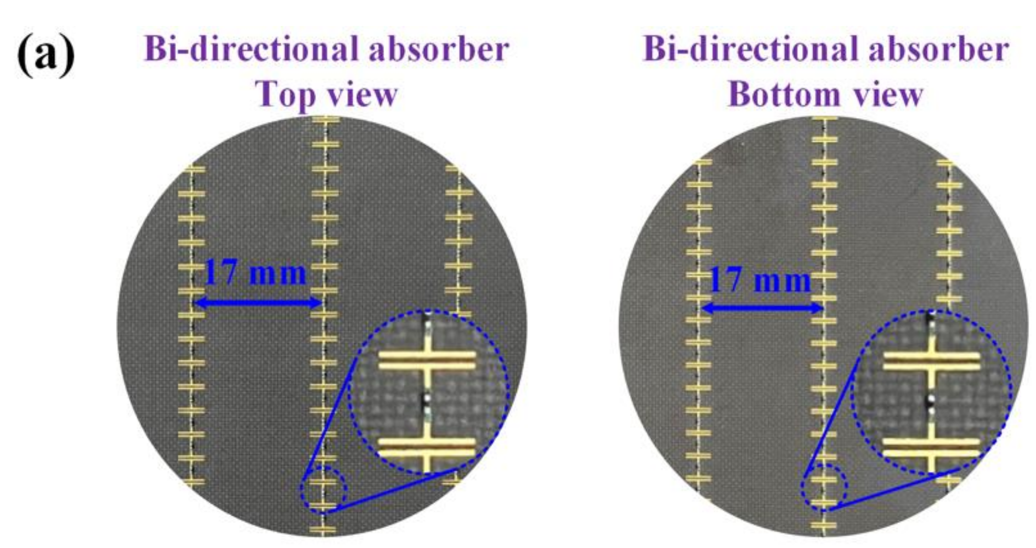


III. Wave absorption









Conclusions:

- Extremely high wavefront manipulation efficiency
- Sparse and simple structures

Perspectives:

Metagratings open the door to potential applications in future wireless communication, radar detection, electromagnetic stealth and so on.

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