Smart devices for terahertz wavefront manipulation

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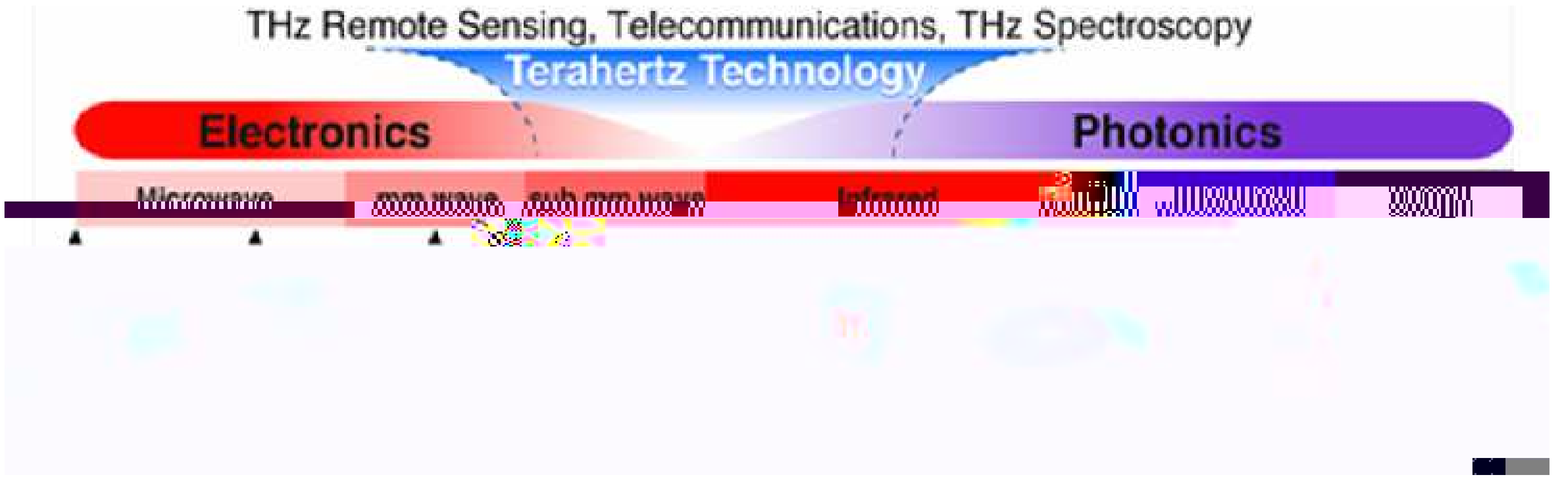
2013.09.14

Outline

- Introduction of THz
- Metasurface based devices for THz wavefront control
- Active control of THz wavefront
  - Optical control of THz wavefront via metasurface
  - Optical control of THz wavefront via optically generated hologram
- Conclusions

Introduction of Terahertz

1 THz~1 ps~300 μm~33 cm^{-1}~4.1 meV



- Terahertz (THz ! THz"!#!$ Hz% sandwiched between the microwave and infrared

Unique nature

- Coherent detecti
- Transparent
- Low photon energ
- Fi !

Identification

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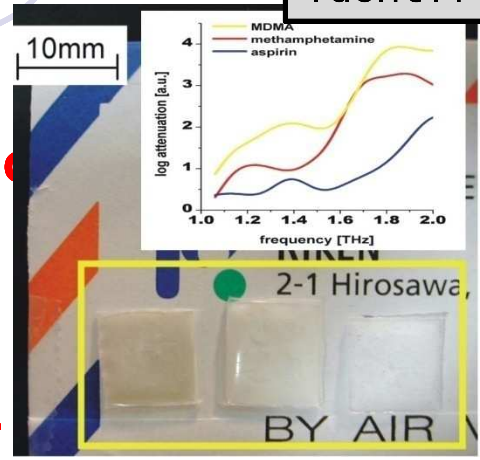
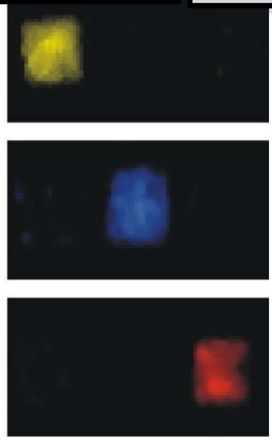
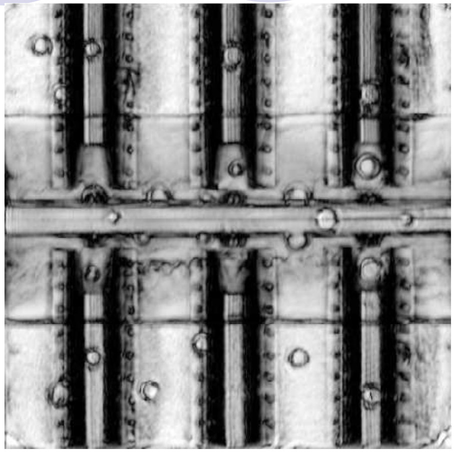
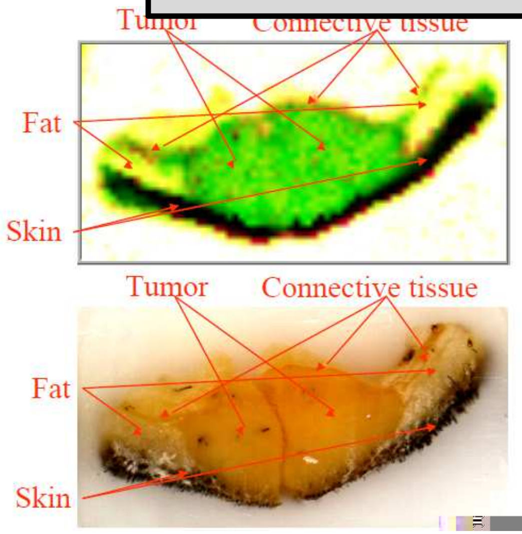






Spot the knife? Millimeter waves, close to terahertz, show their ability to see through clothes and paper.



Applications of Terahertz

Defense:

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Research:

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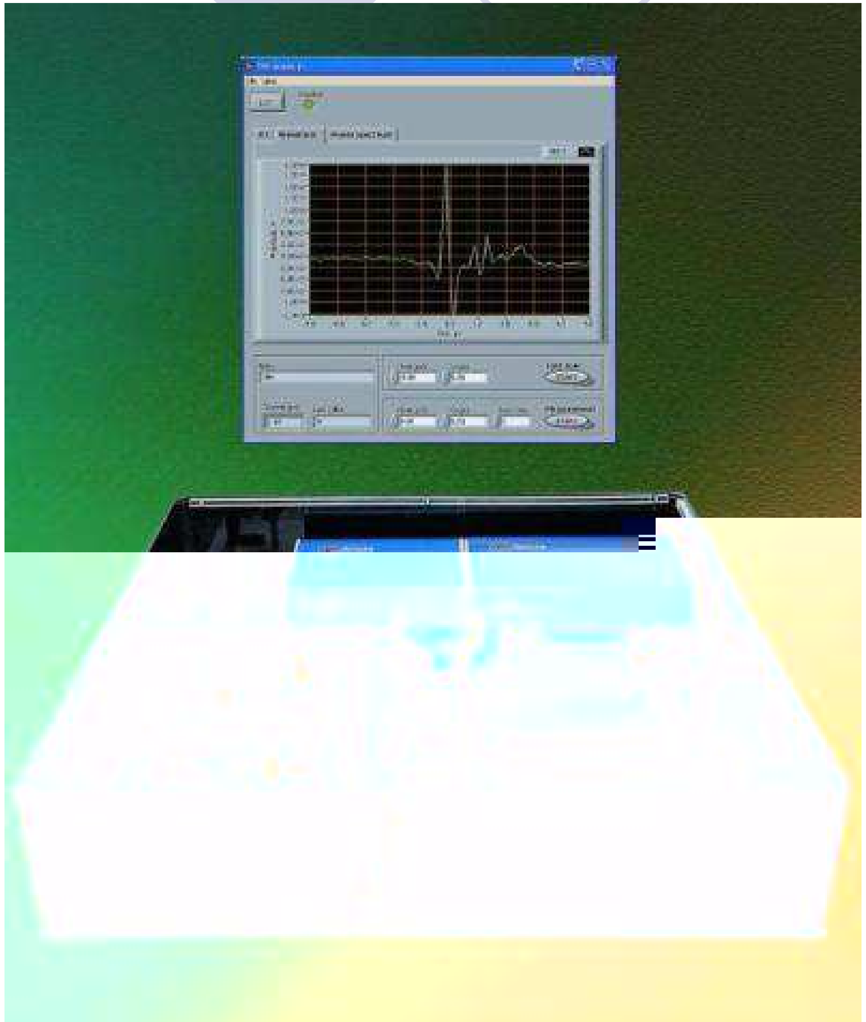
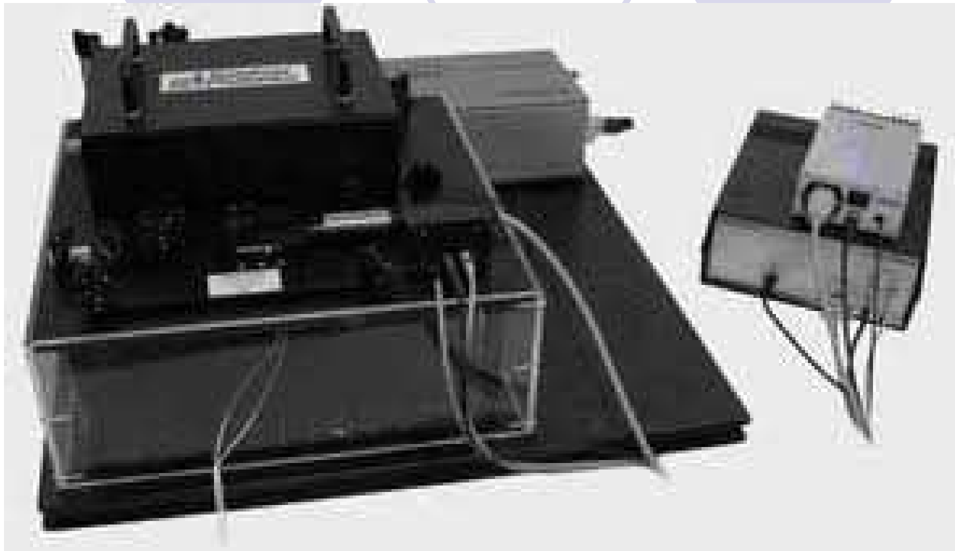
Introduction of Terahertz

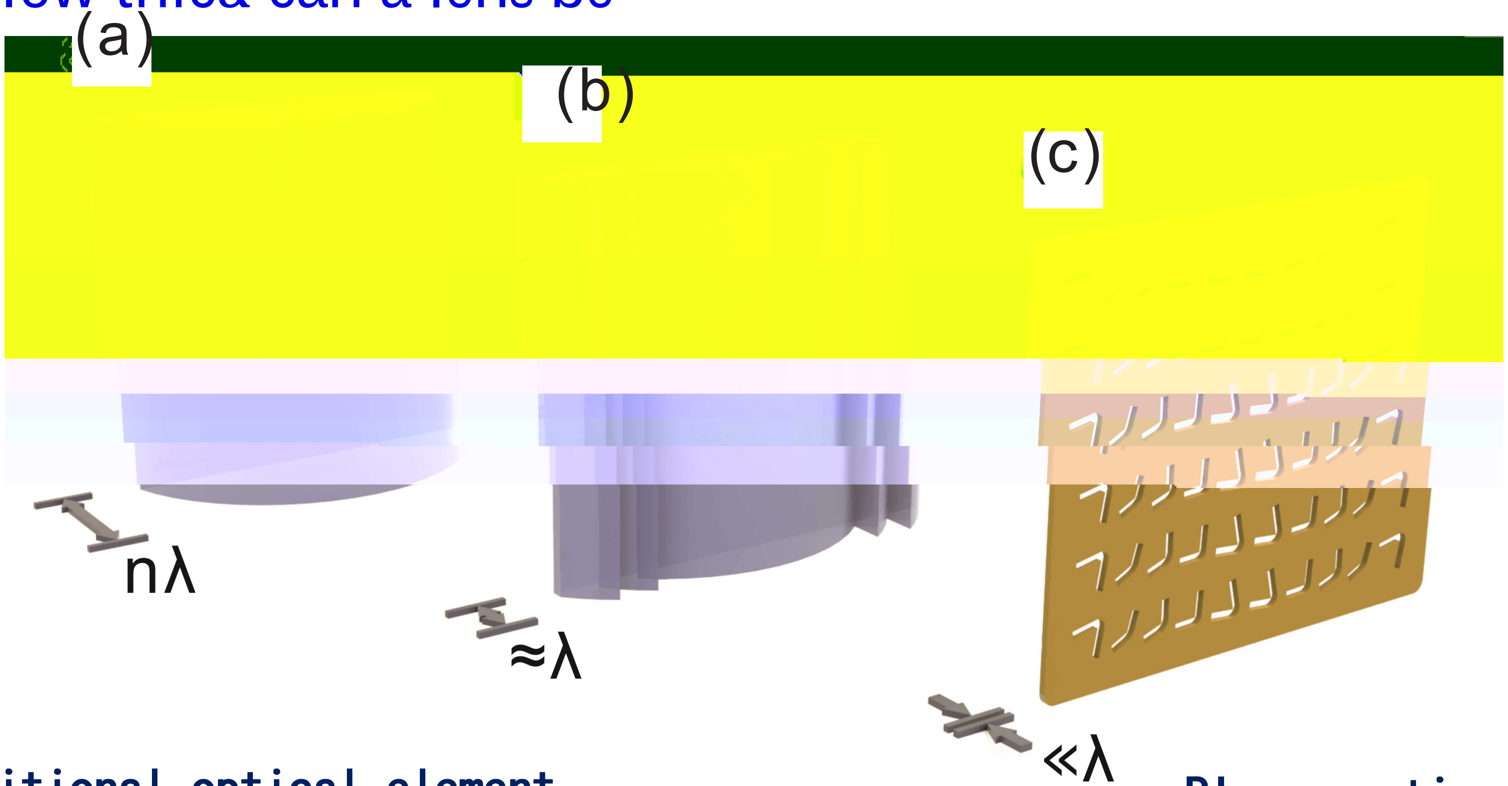




THz system is too huge for real applications.

More flexible method for wavefront control

How thic& can a lens be'

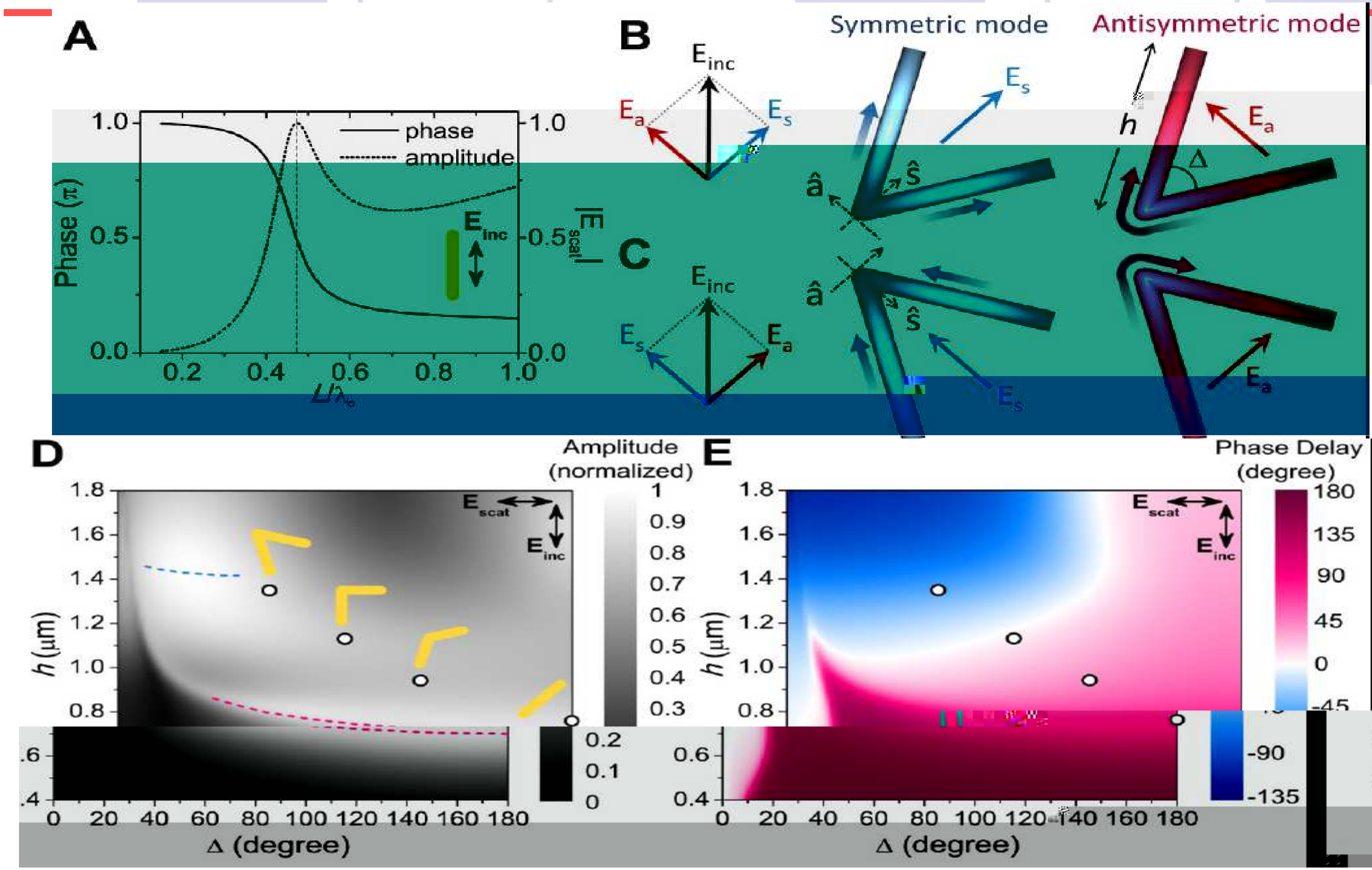


Traditional optical element

Planar optical element

Diffractive optical element

Metasurface based devices



(hase modulation based on antenna resonance

Science ***2011, 334, 333***

Huygens' Principle

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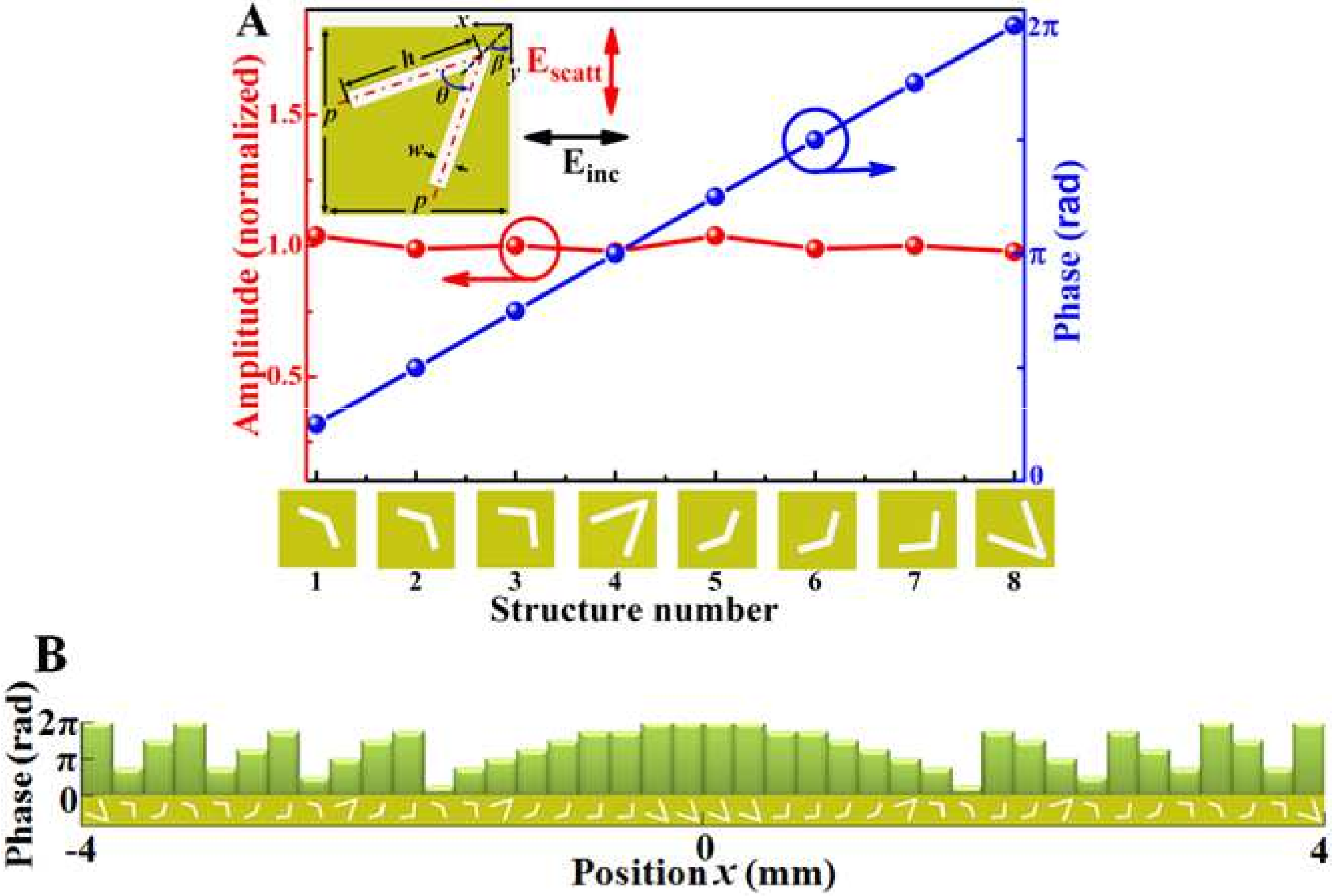
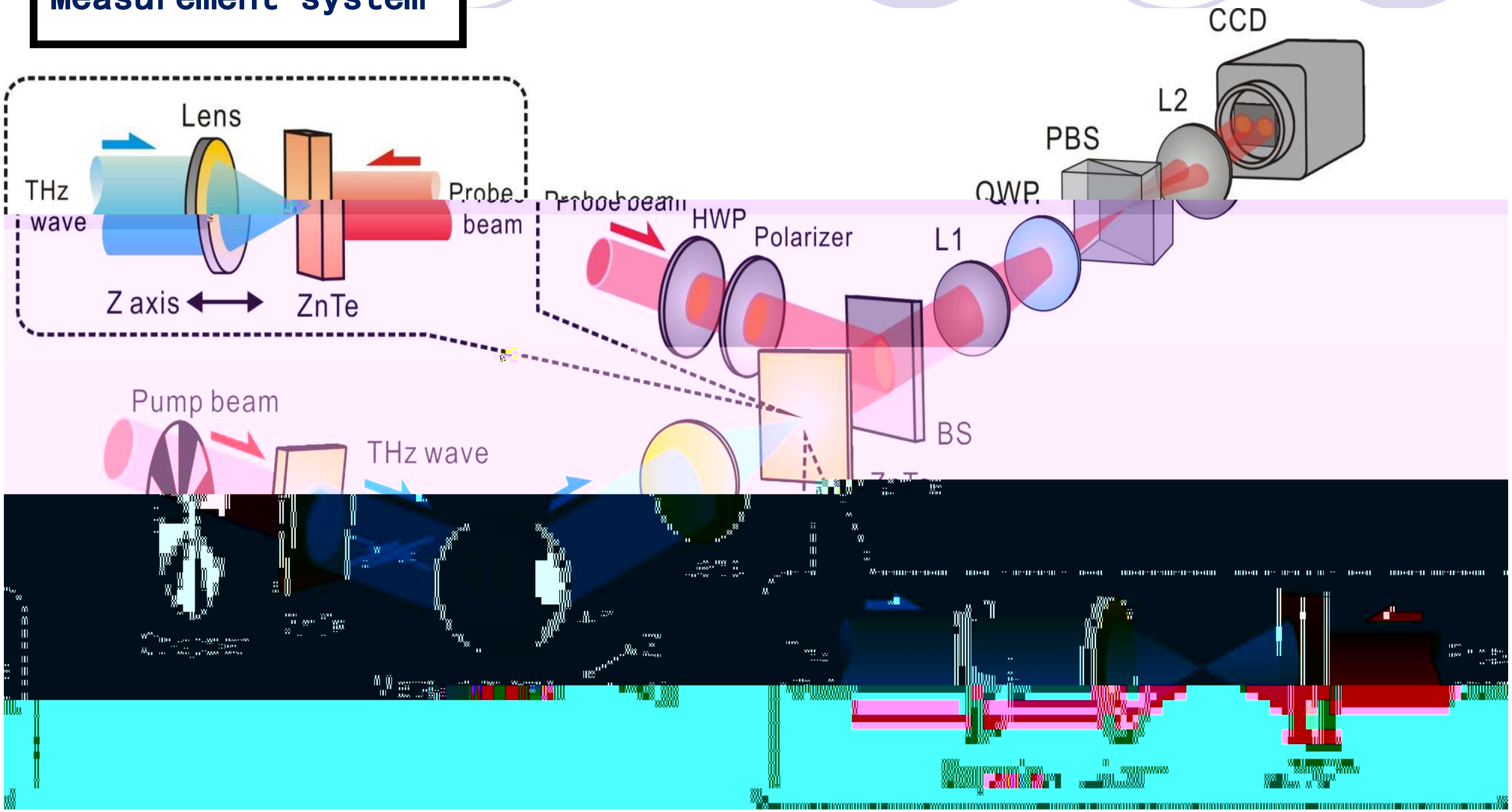
Metasurface based devices

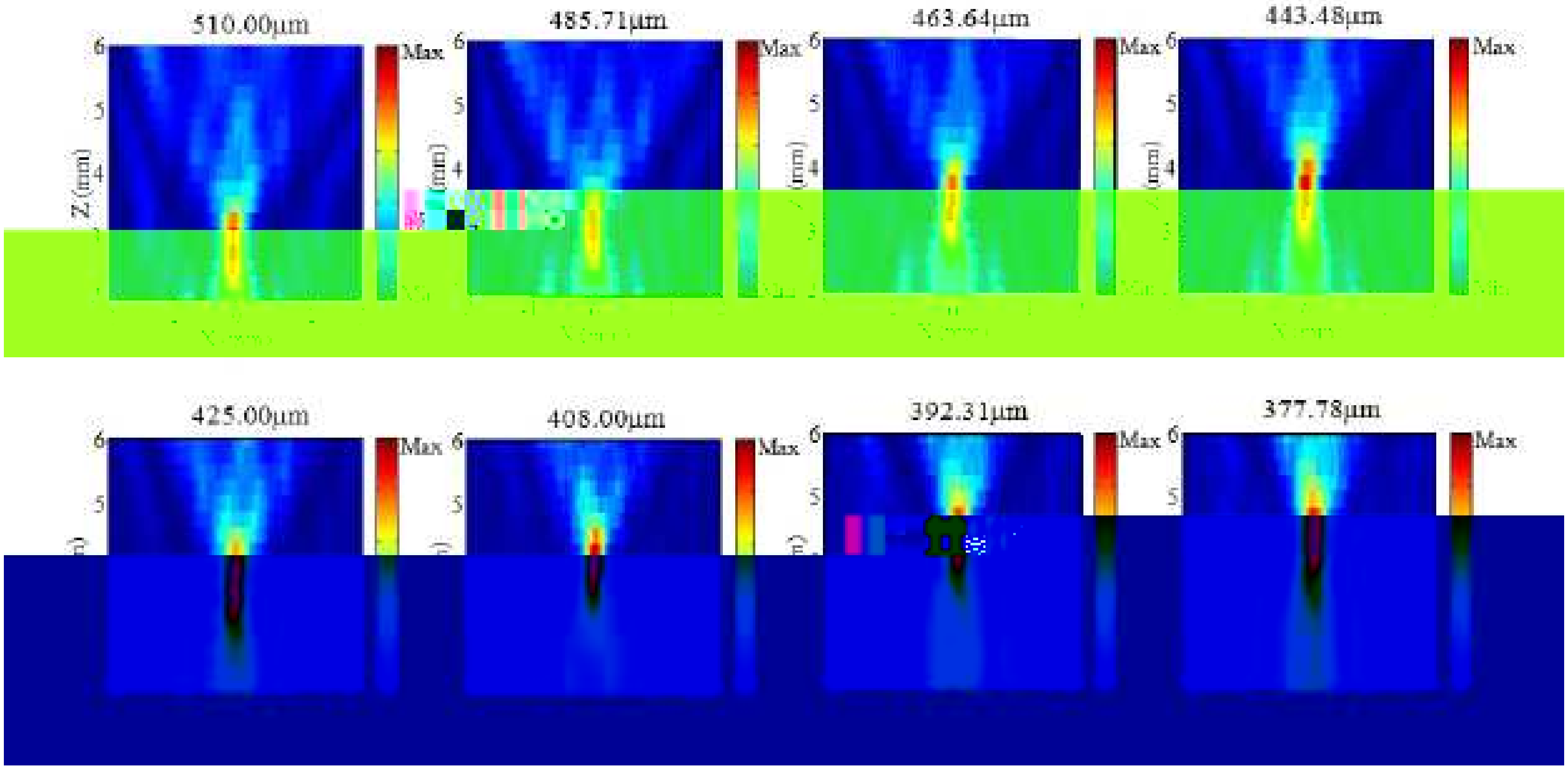


Part of cylindrical lens

Focal length:
4mm@400μm

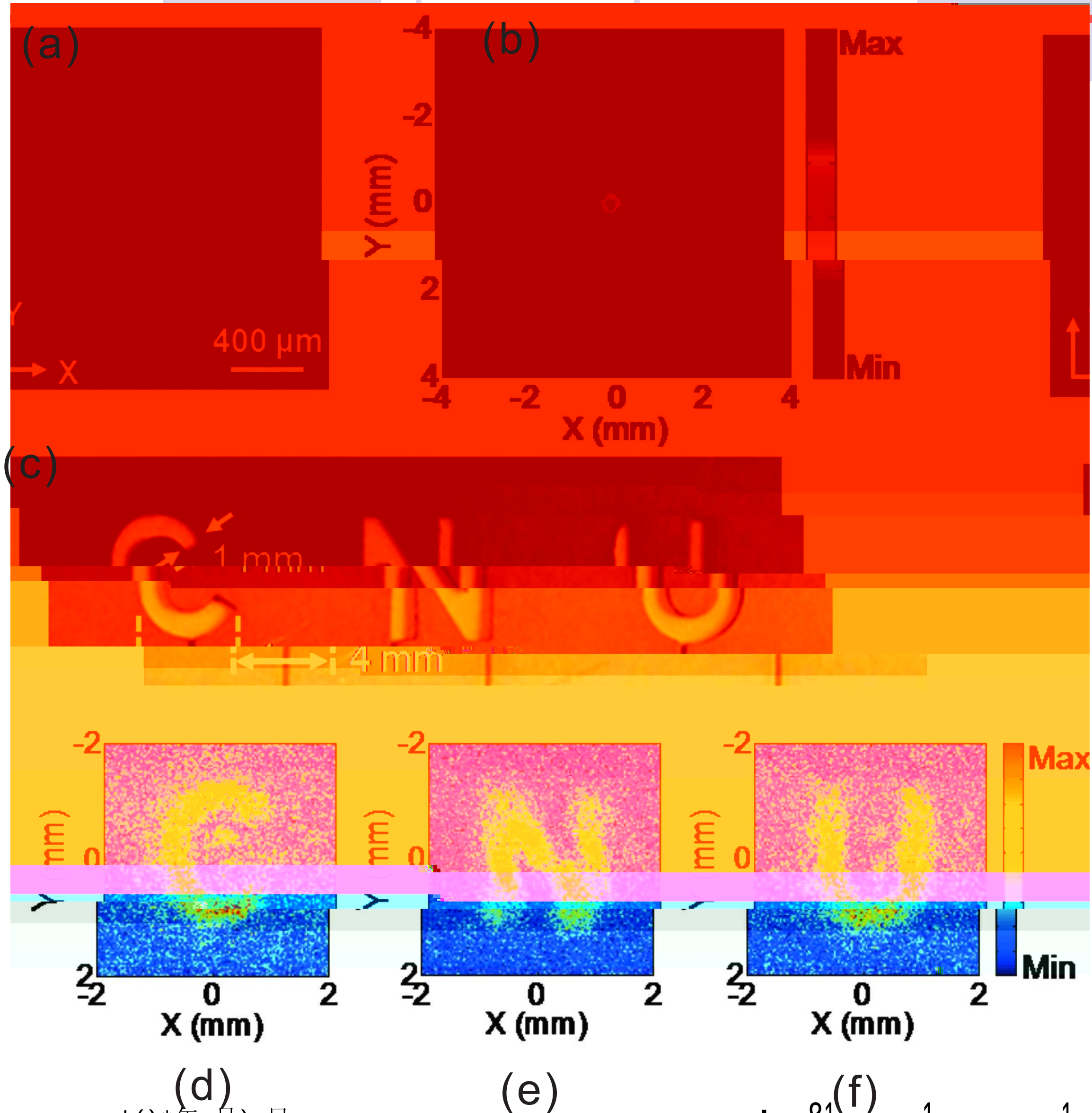
Measurement system





Dispersion of the cylindrical lens

Metasurface based devices



The thic&ness of the lens is only !)*### of the wavelength+

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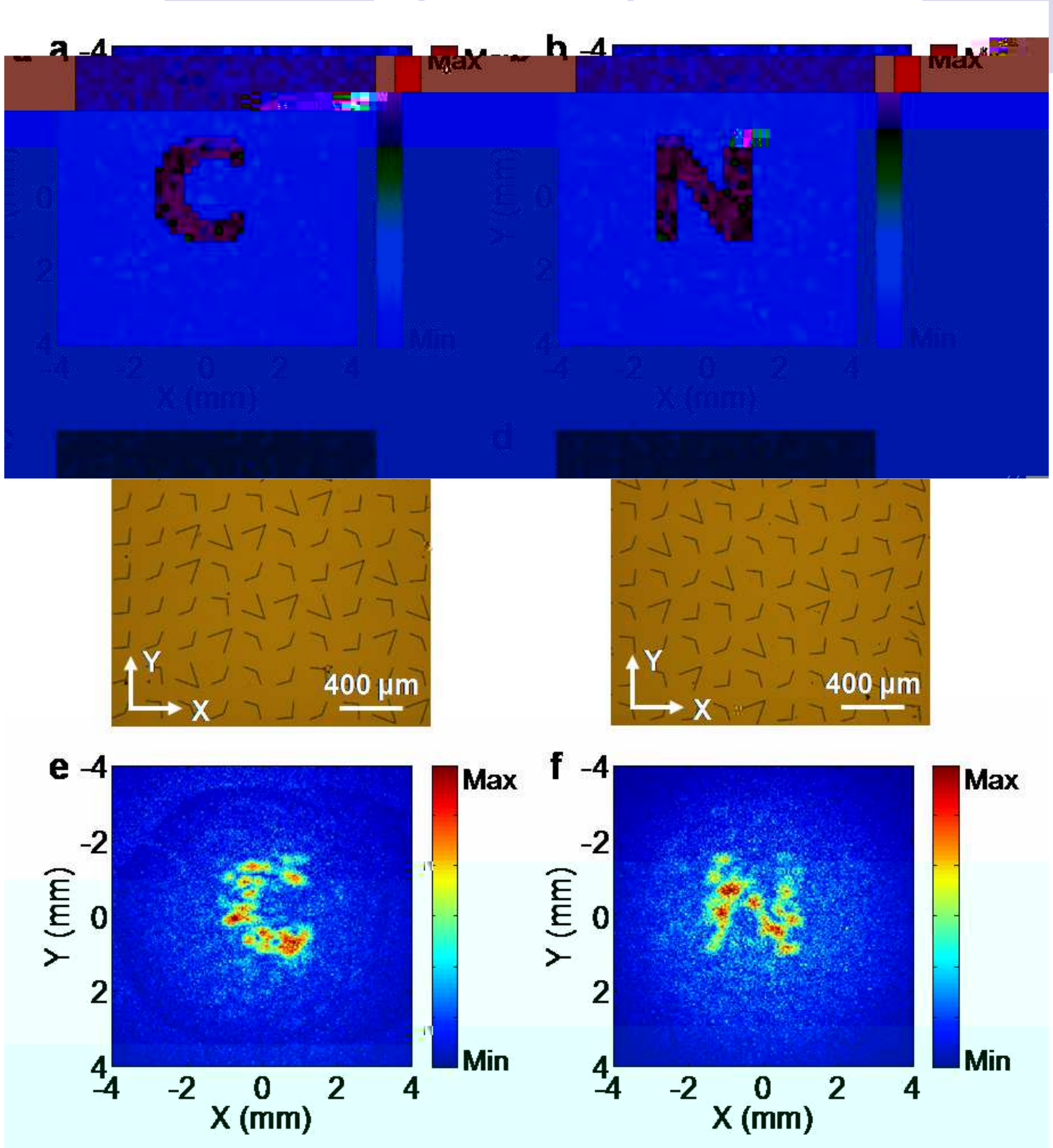
Metasurface based devices



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(a) (b) !

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- 0

1 (c) (d)

0 6 7 6 7

& 1 (e) (f)

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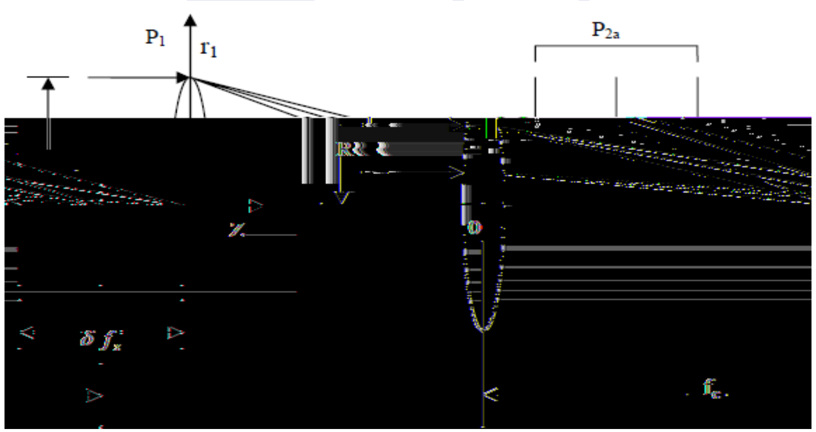
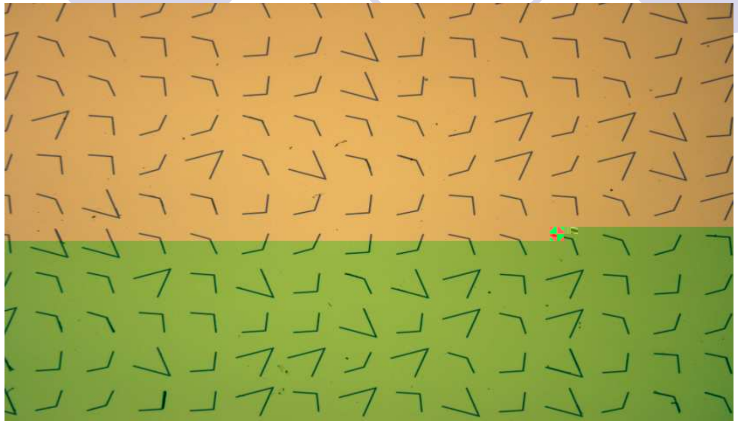
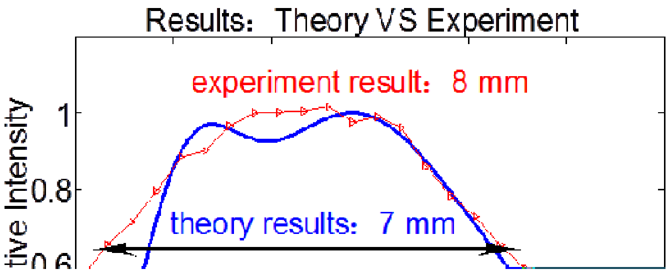
Metasurface based devices







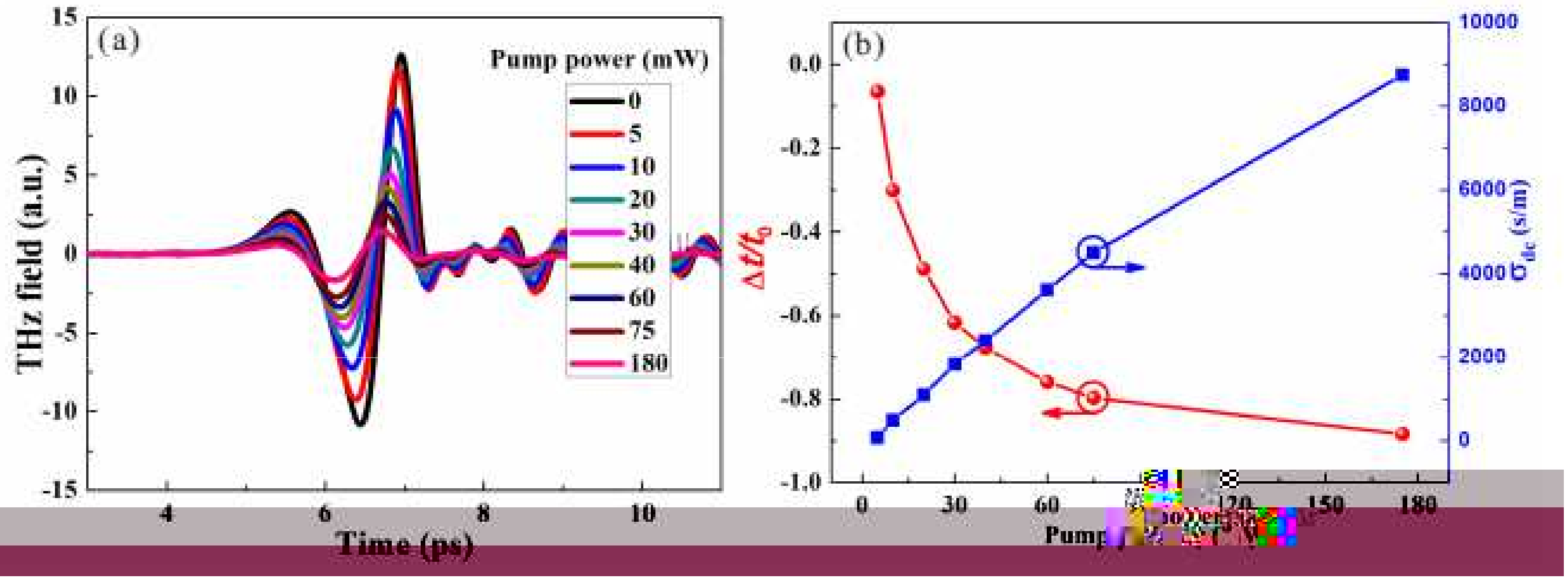
Active control of THz wavefront

7ltrathin planar elements

- thin aberration free **8 8**
- low efficiency function fi**9**ed

Active control of THz wavefront

Active control of THz wavefront



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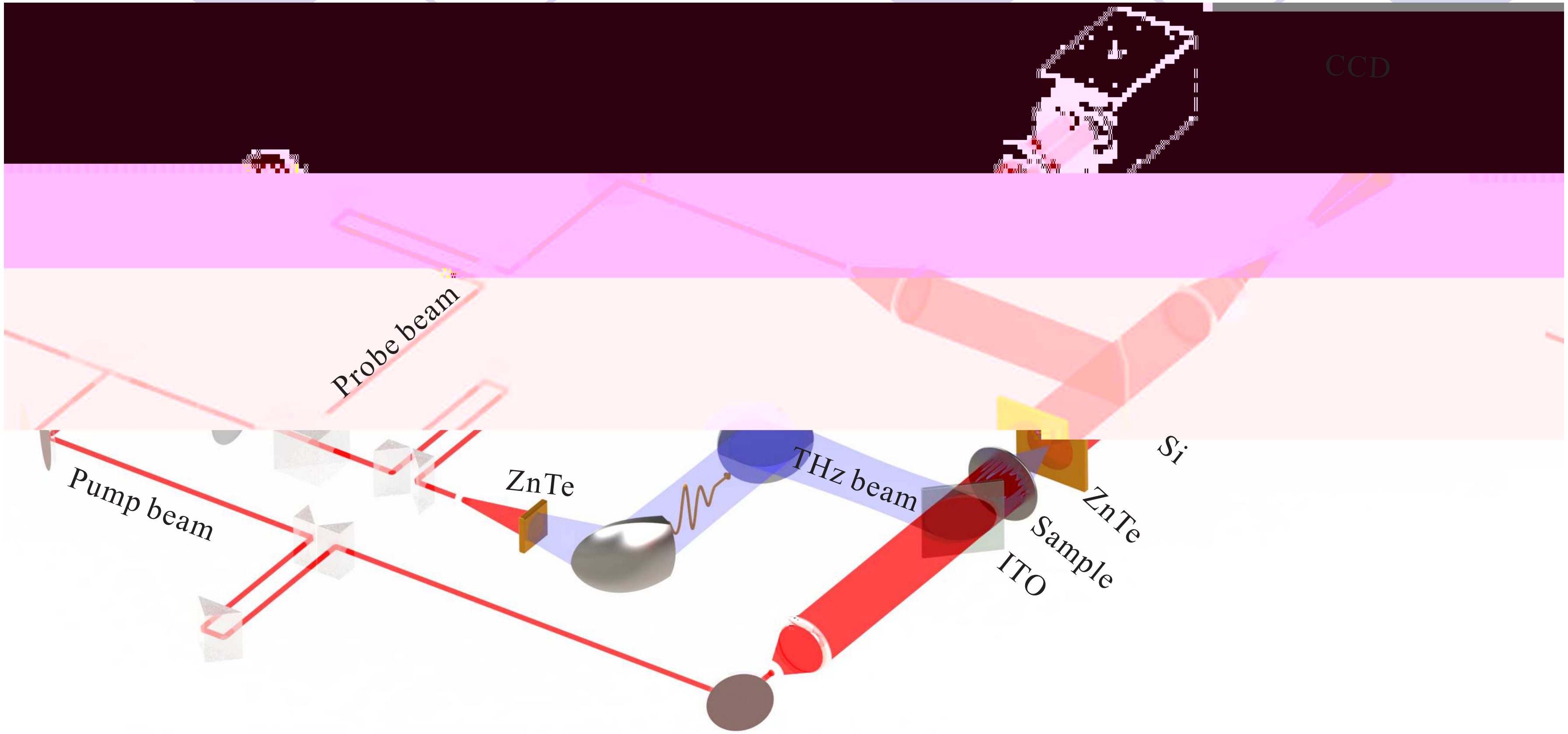
Active control of THz wavefront



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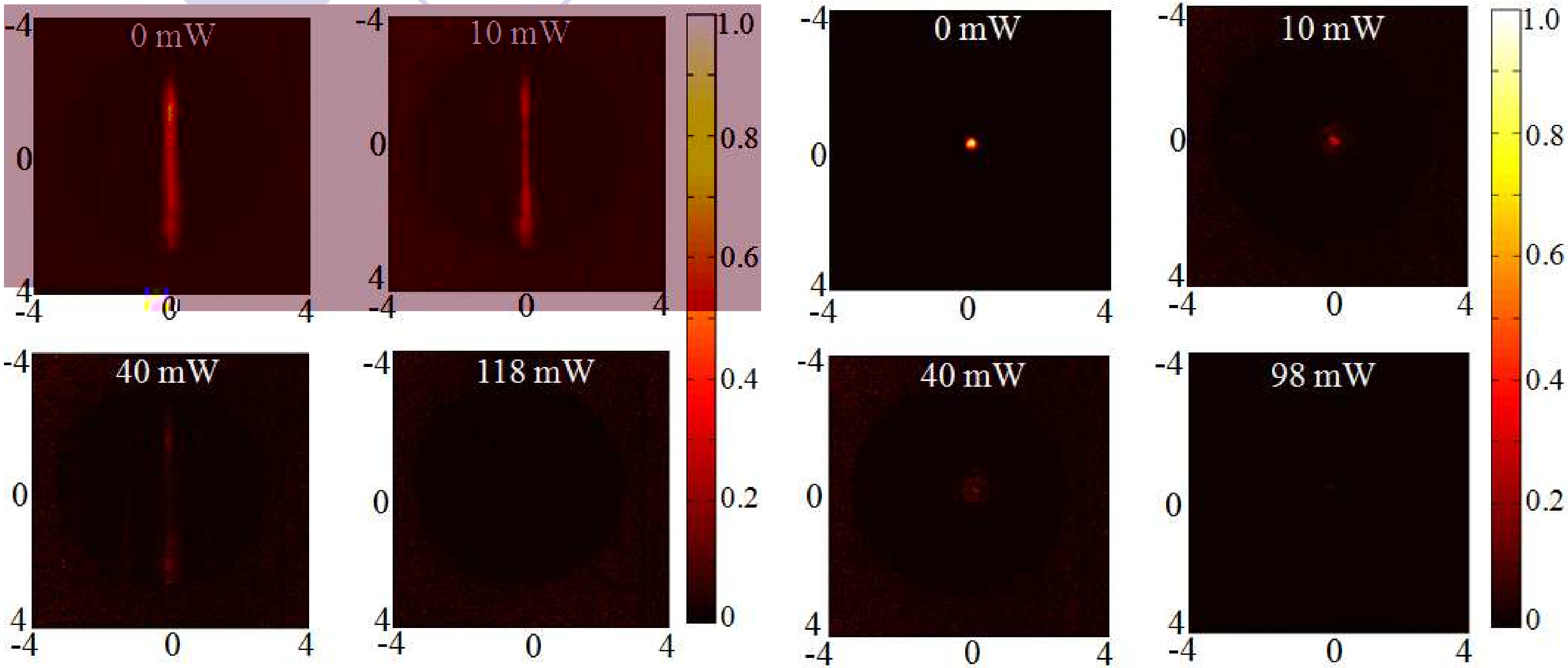
Active control of THz wavefront



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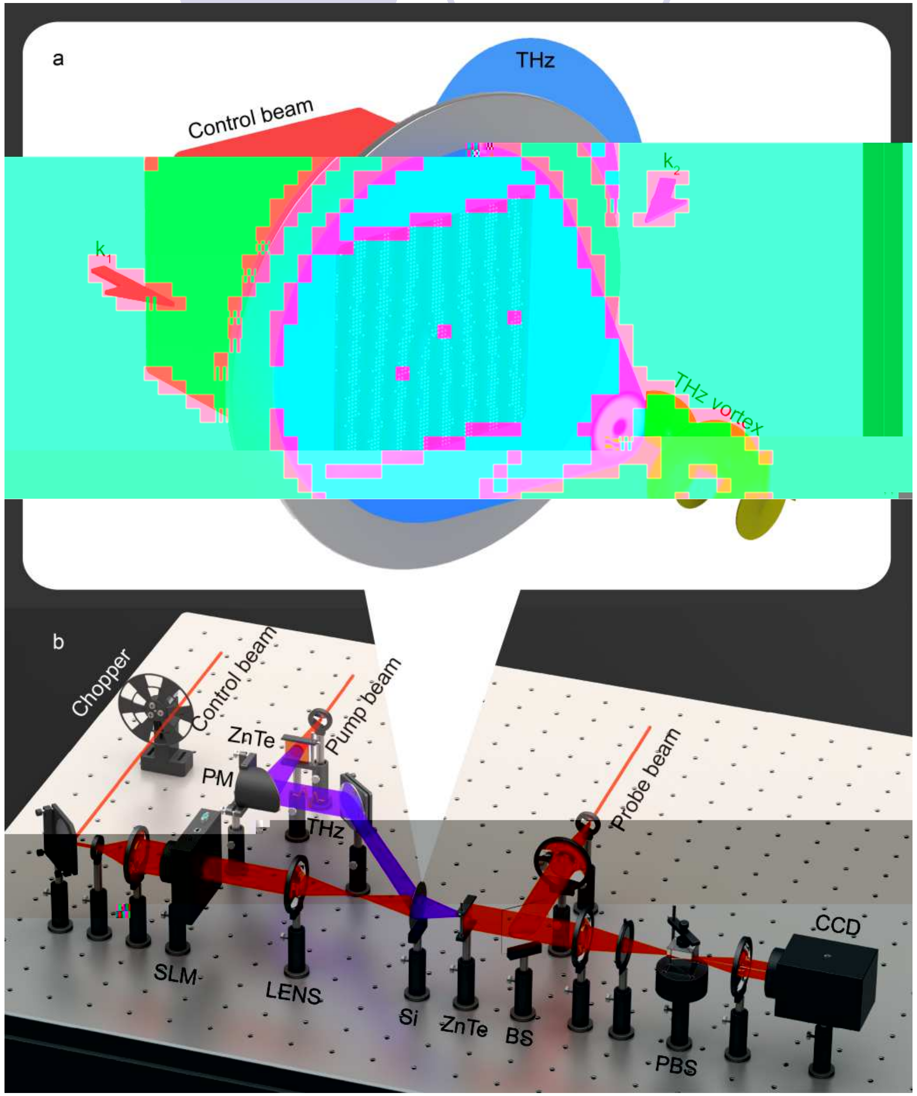
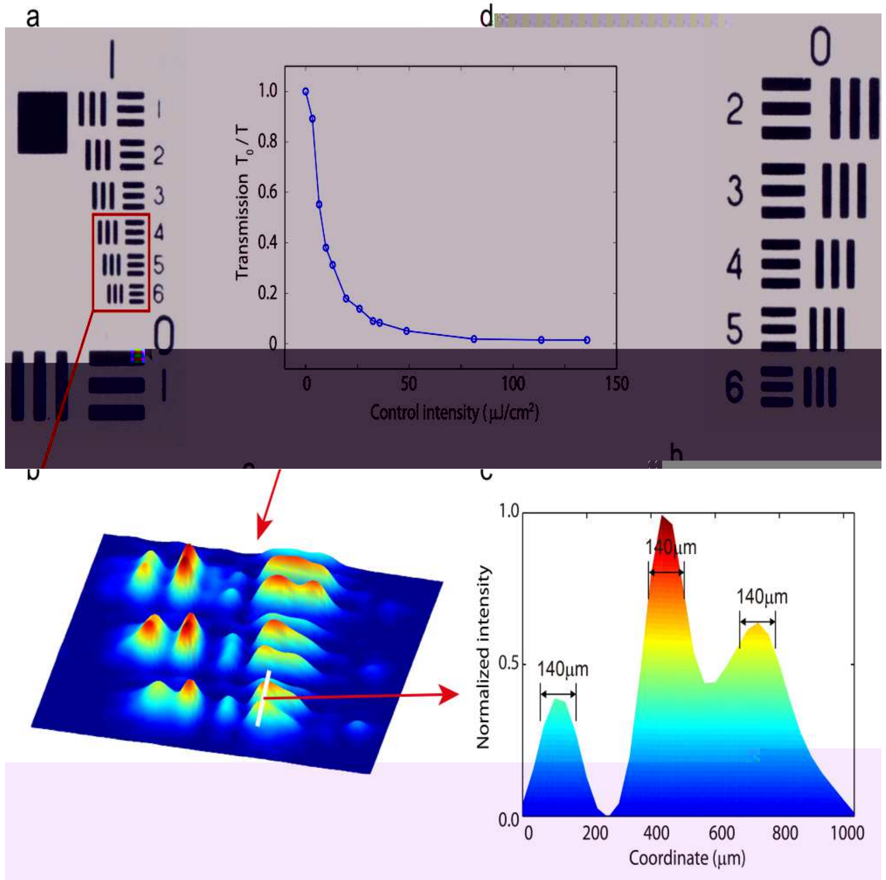
Active control of THz wavefront





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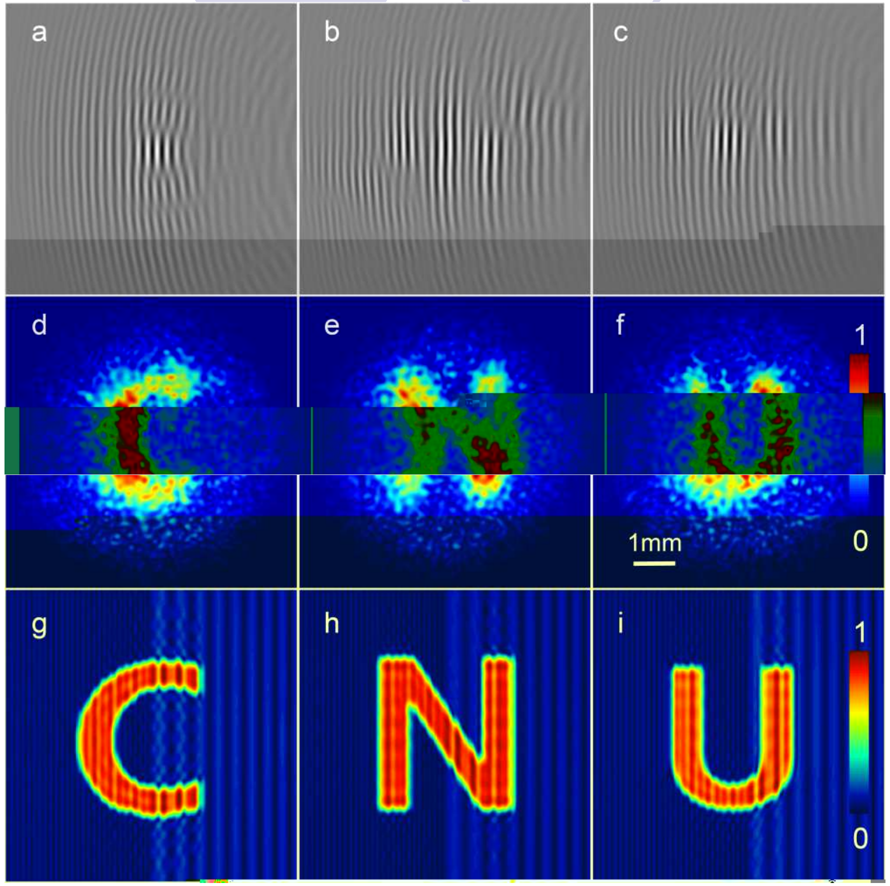
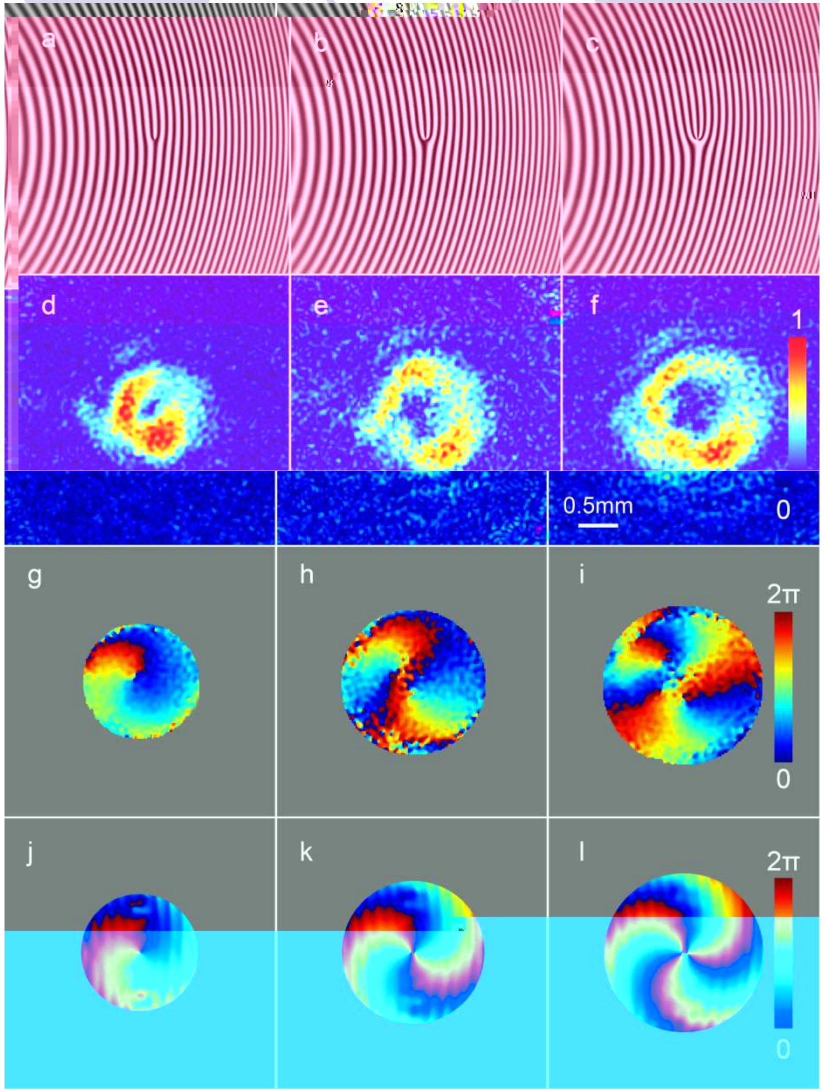
Active control of THz wavefront





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Conclusion:

- 7ltrathin planar elements

  :ens holograms diffractive phase elements 8

- Characterization of ultrathin planar elements

  Intensity phase polarization wavelength 8

- Active control of THz wavefront

Thank you for your attention!

Metasurface based devices


REVIEW

Planar Photonics with Metasurfaces

Alexander V. Kildishev, Alexandra Boltasseva, Vladimir M. Shalaev*

in a metal sheet) can be used for the extra-strong focusing of light (with a focal length as short as 2.5 μm) in the visible wavelength range (*25*). In addition, ultrathin terahertz planar lenses have also been proposed (*26*).

26. D. Hu *et al.*, http://arxiv.org/abs/1206.7011v1 (2012).
27. Y. Zhao, M. A. Belkin, A. Alù, Twisted optical metamaterials for planarized ultrathin broadband circular polarizers. *Nat. Commun.* 3, 870 (2012).