

# Metasurfaces

## Bridging Diffractive and Freeform Optics

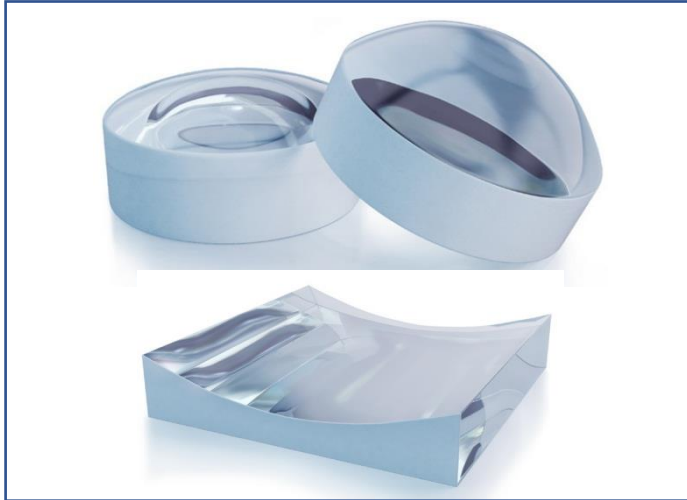


Reza Khorasaninejad, CEO @ LEADOPTIK Inc.



# Why Metasurfaces?

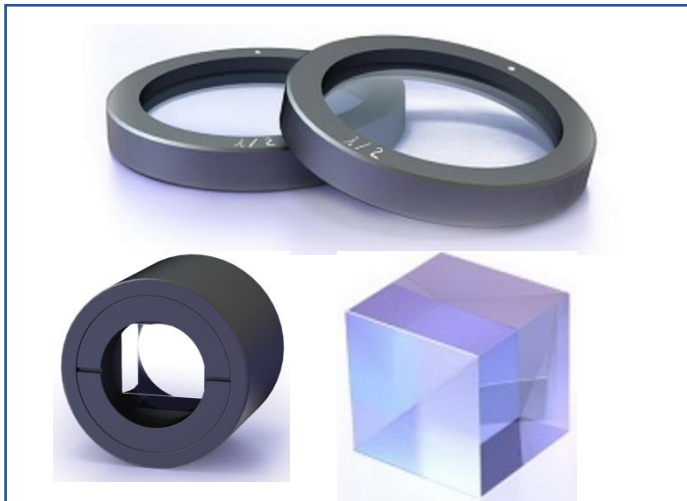
## Refractive Optics



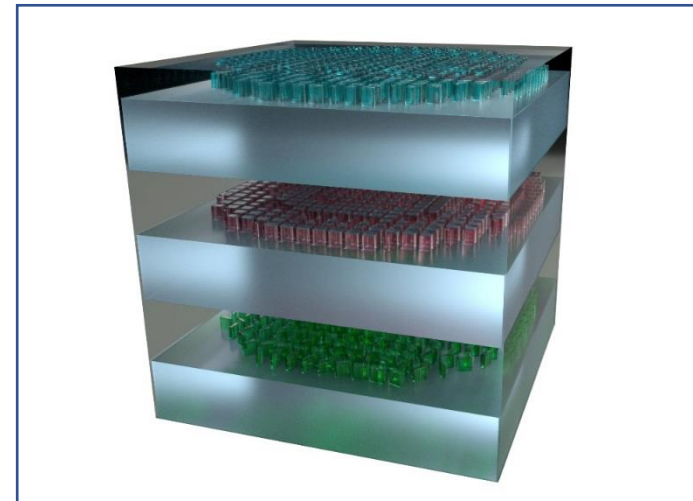
## Gratings and Filters



## Wave-plates and Polarizers

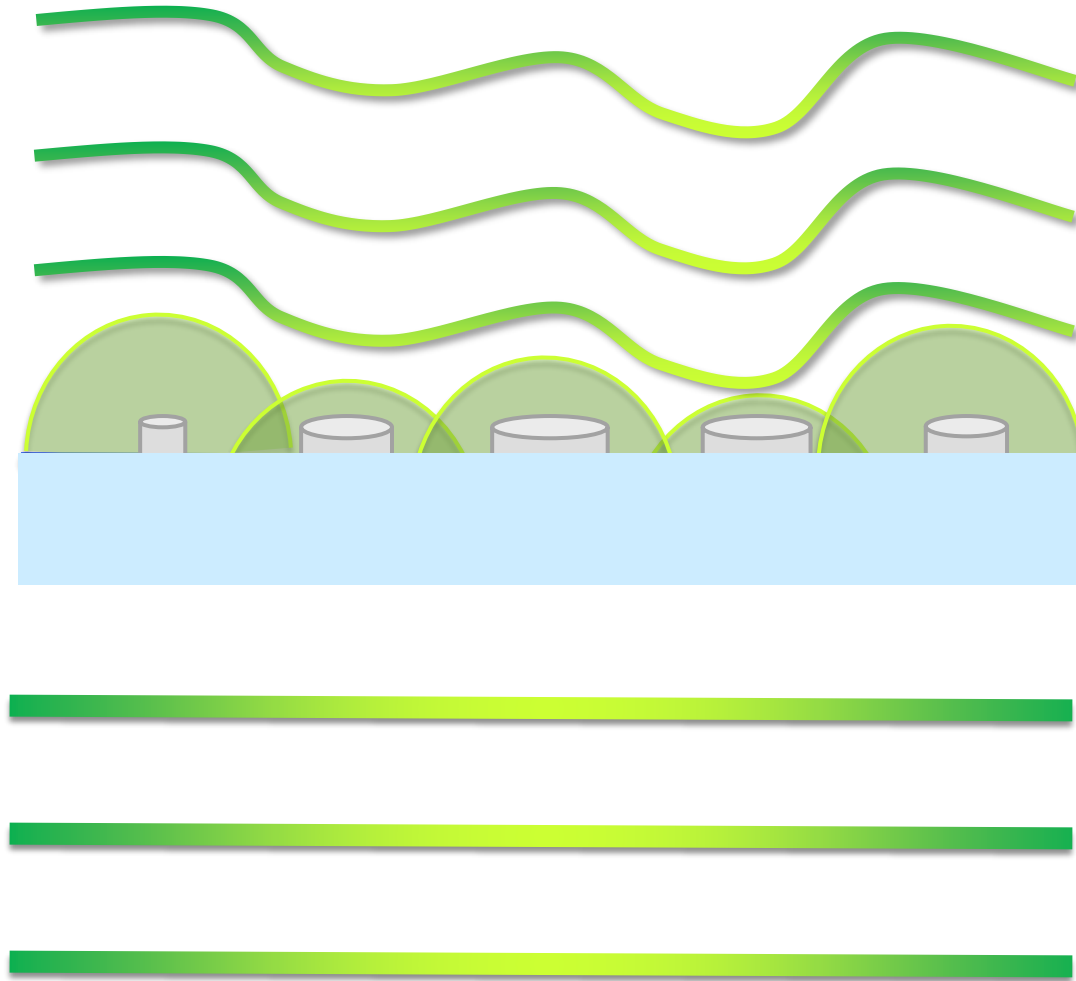


## Vertical Integration



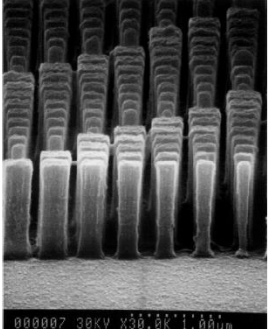


# Simple Yet Powerful Concept

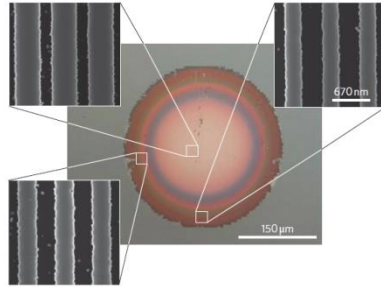




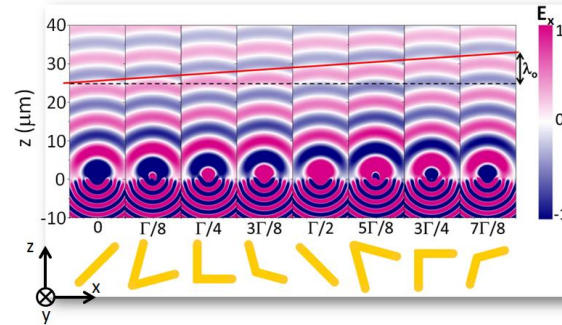
# Choice of Metasurfaces' Building Blocks



Astilean et al., opt. let., (1998)



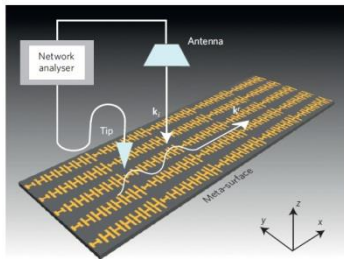
Fattal et al. Nat. Phot. 4, (2010)



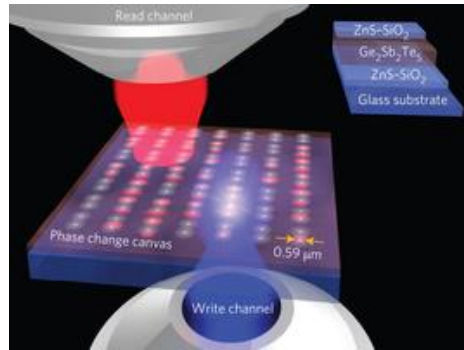
N. Yu, et al., Science 334, 333 (2011)



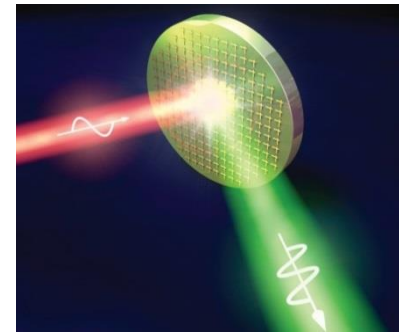
X. Ni, et al., Science, (2012)



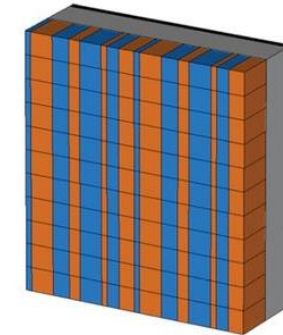
Sun et al. Nat. Mat. 11,(2012)



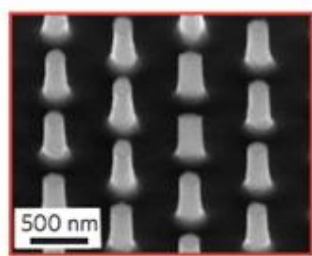
Q. Wang, et al., Nat. Photonics (2016)



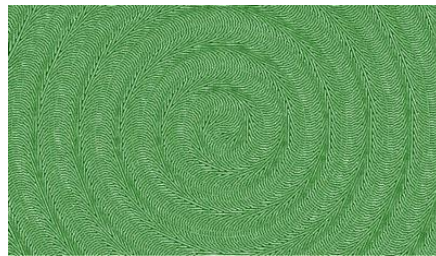
J. Lee, et al., Nature (2014).



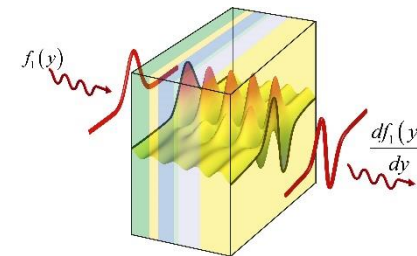
F Monticone, et al. PRL, (2013).



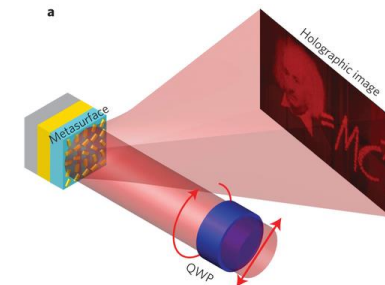
A. Arbabi, et al., Nat. Nano (2015)



D. Lin, et al., Science(2014)

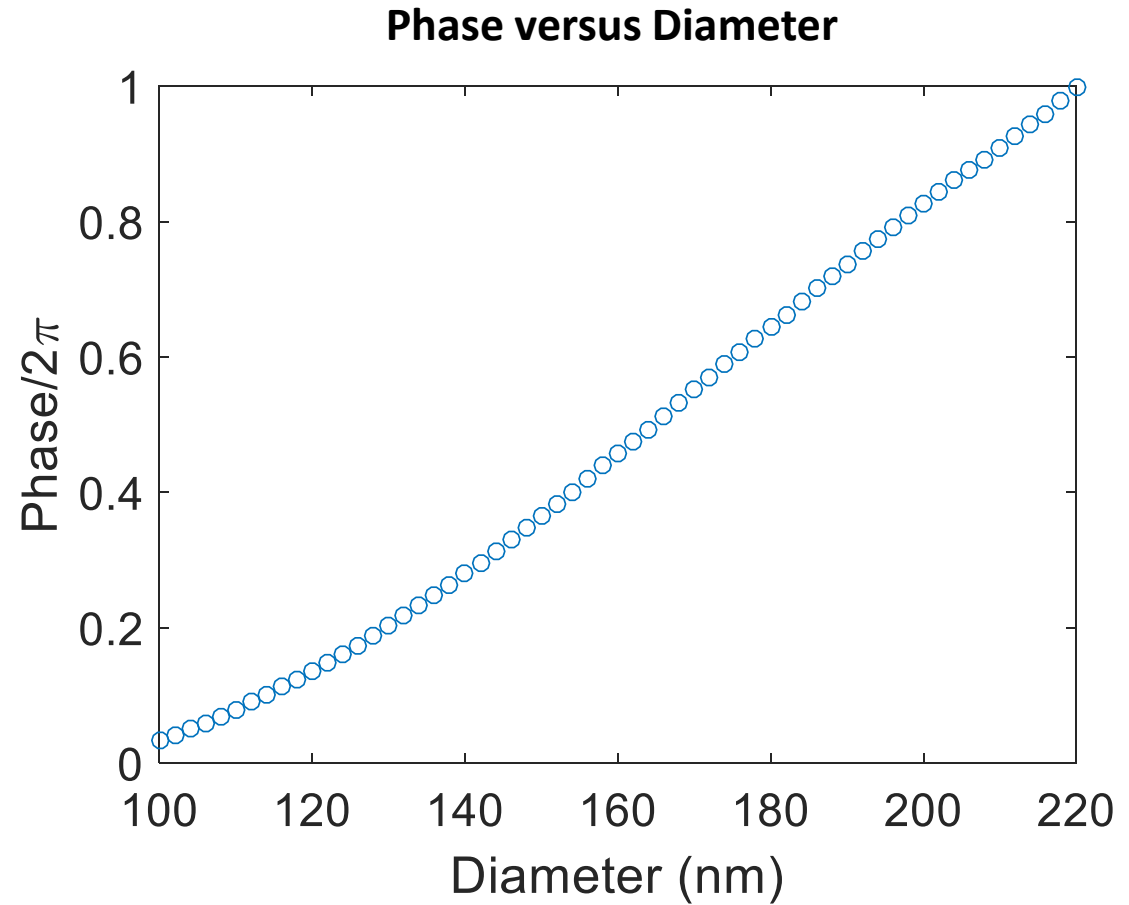
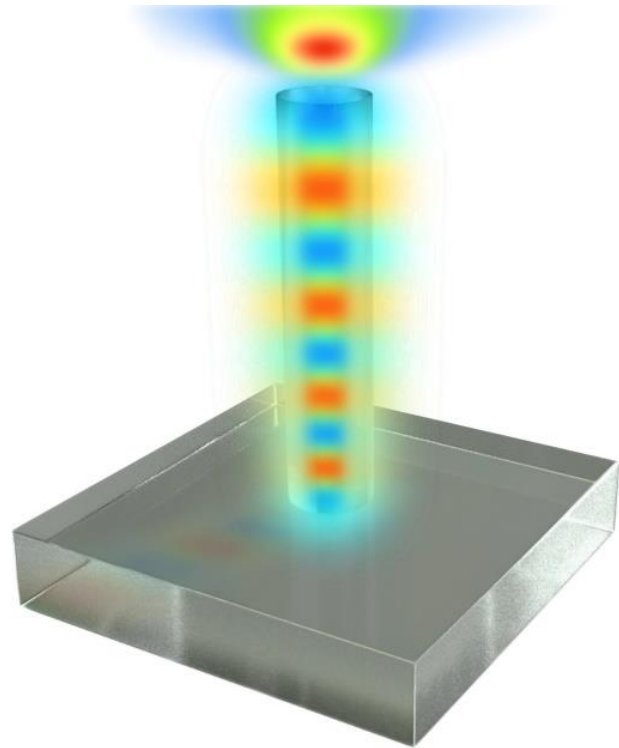


A. Silva, et al., Science (2014)

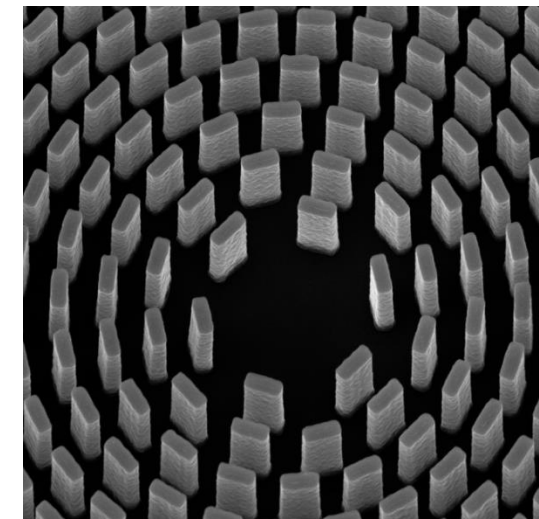
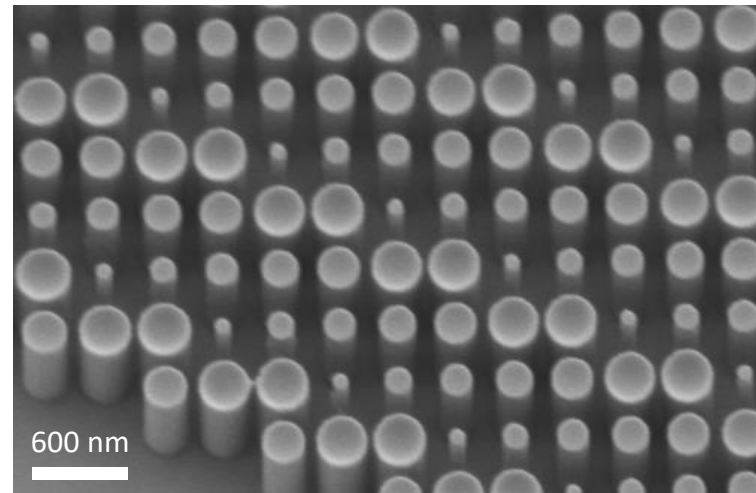
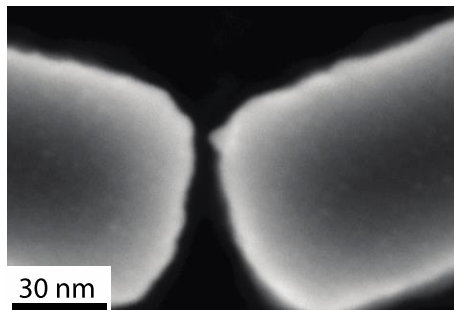
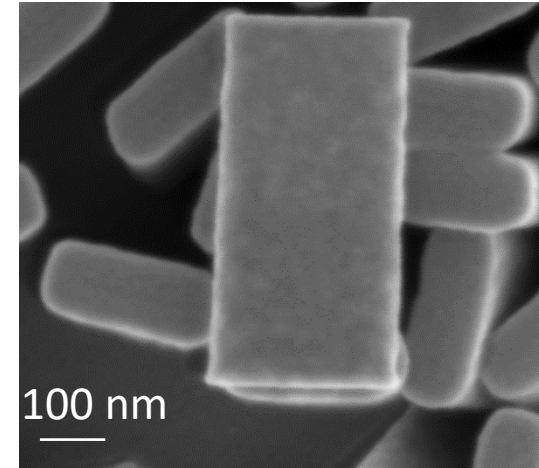
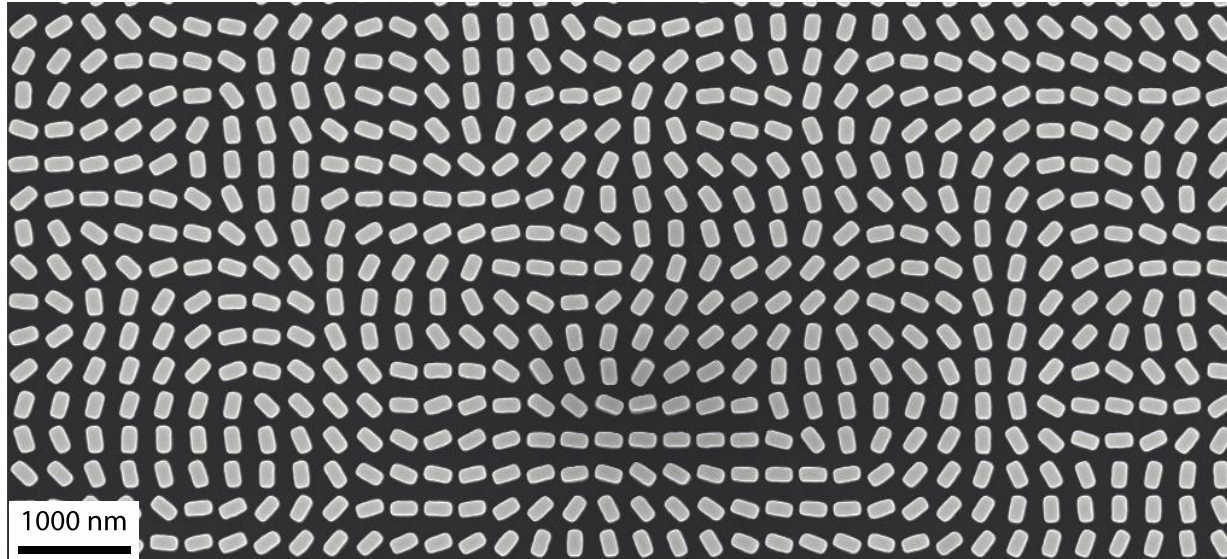


G. Zheng, Nat. Nano., (2013)

# Building Block: Waveguiding Effect

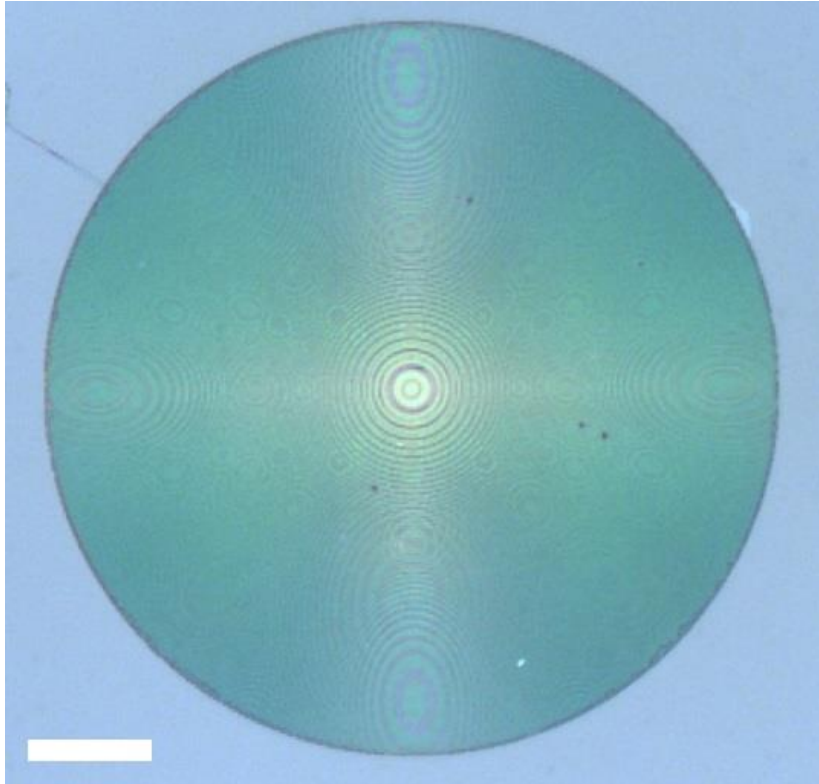


# Some Example of Dielectric Metasurfaces

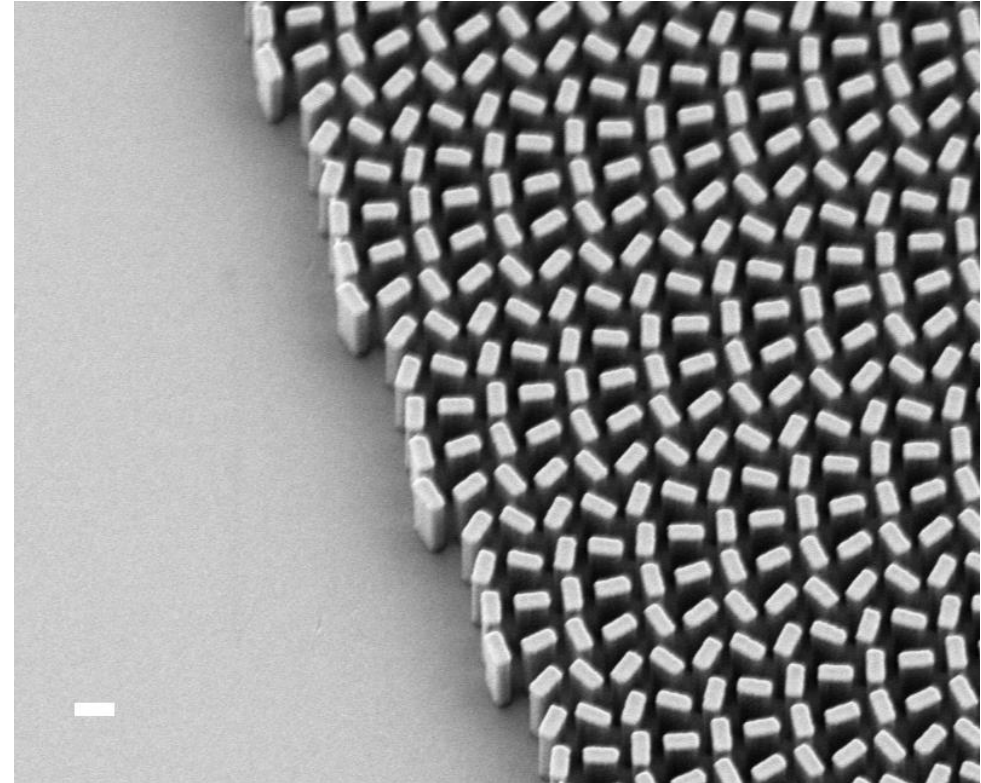




# Flat Lenses for Visible Wavelength



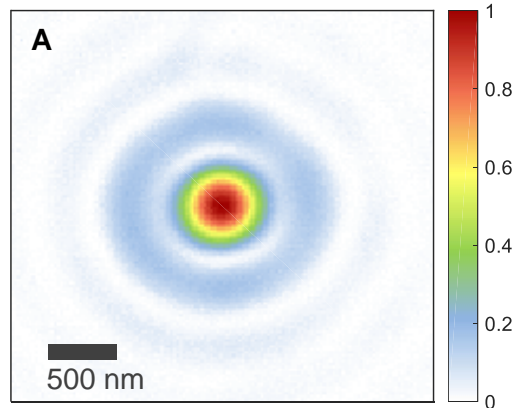
Scale bar: 40  $\mu\text{m}$



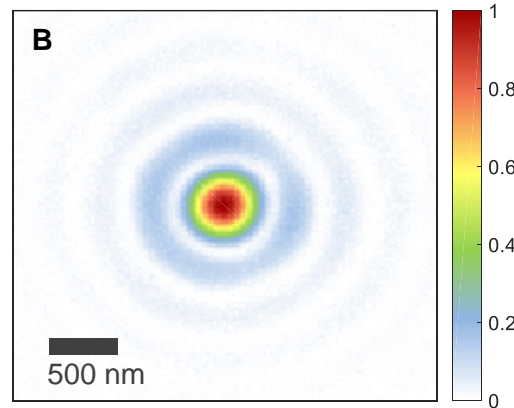
Scale bar: 300 nm

# Focusing Quality

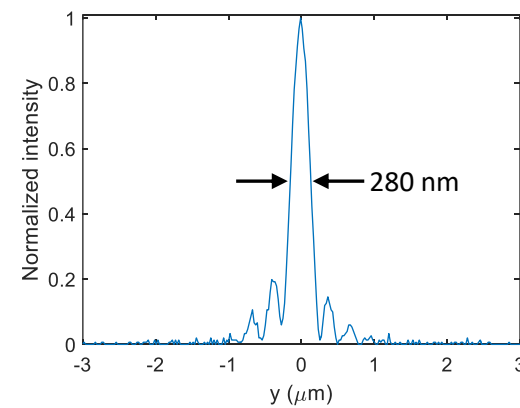
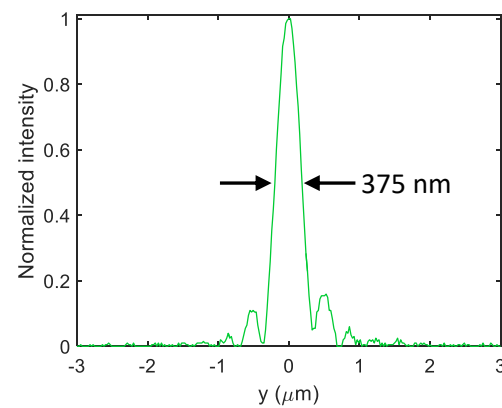
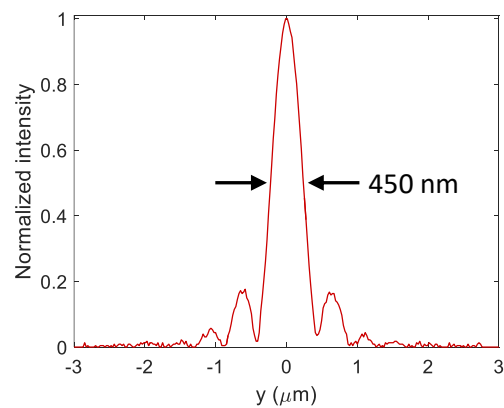
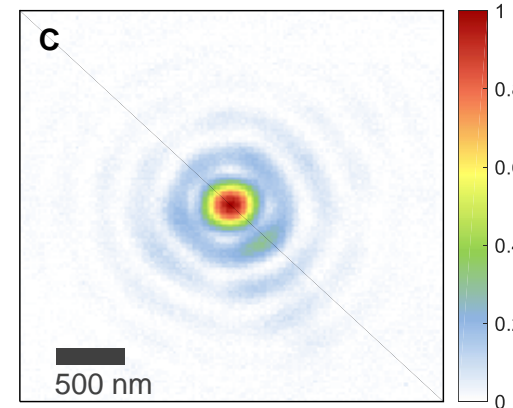
$\lambda=660$  nm  
FWHM=413 nm



$\lambda=532$  nm  
FWHM=333 nm

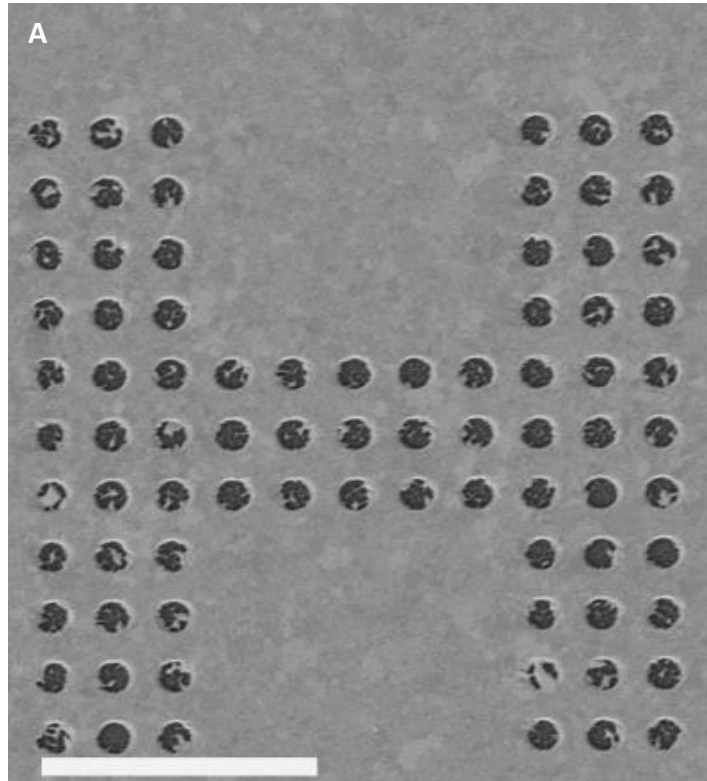


$\lambda=405$  nm  
FWHM=254 nm

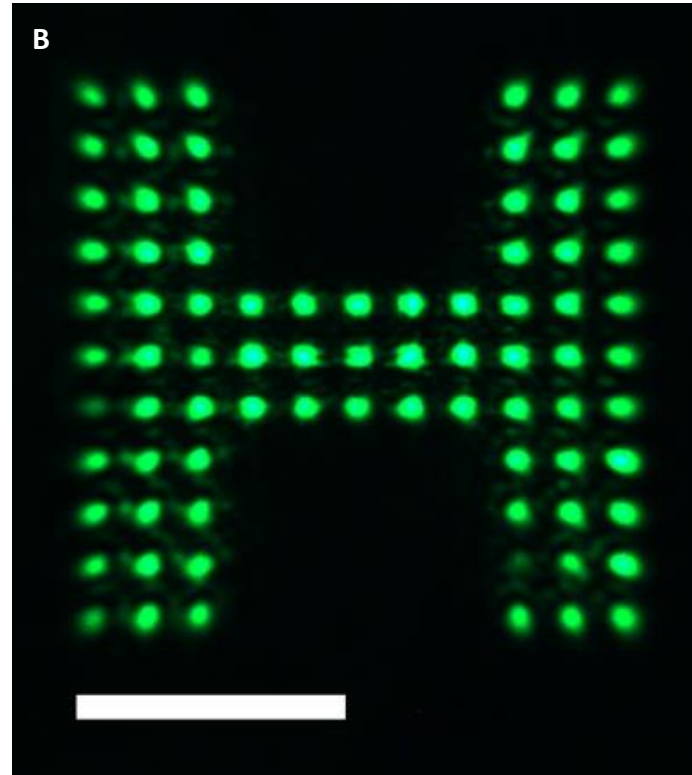




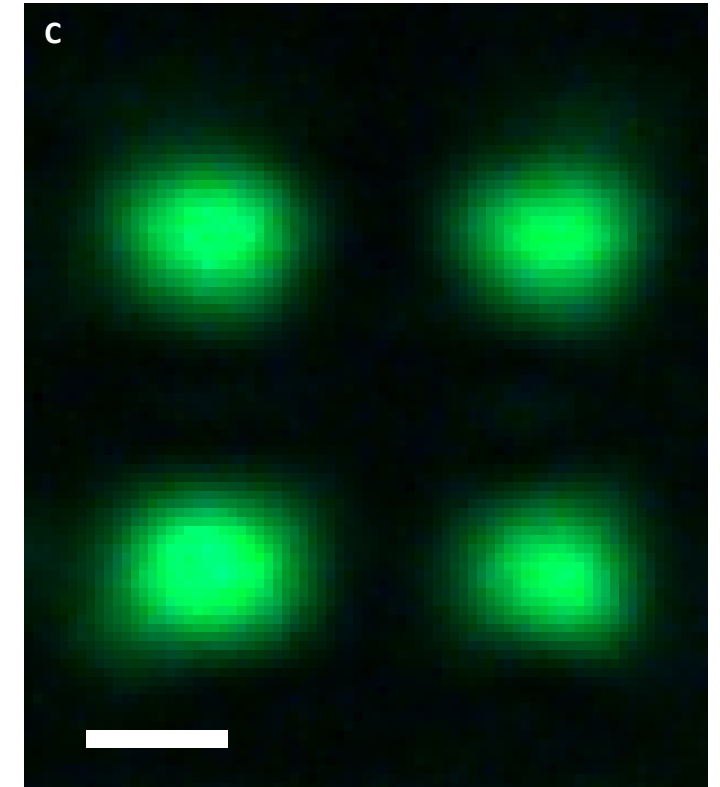
# Imaging Capability



Scale bar: 10  $\mu\text{m}$

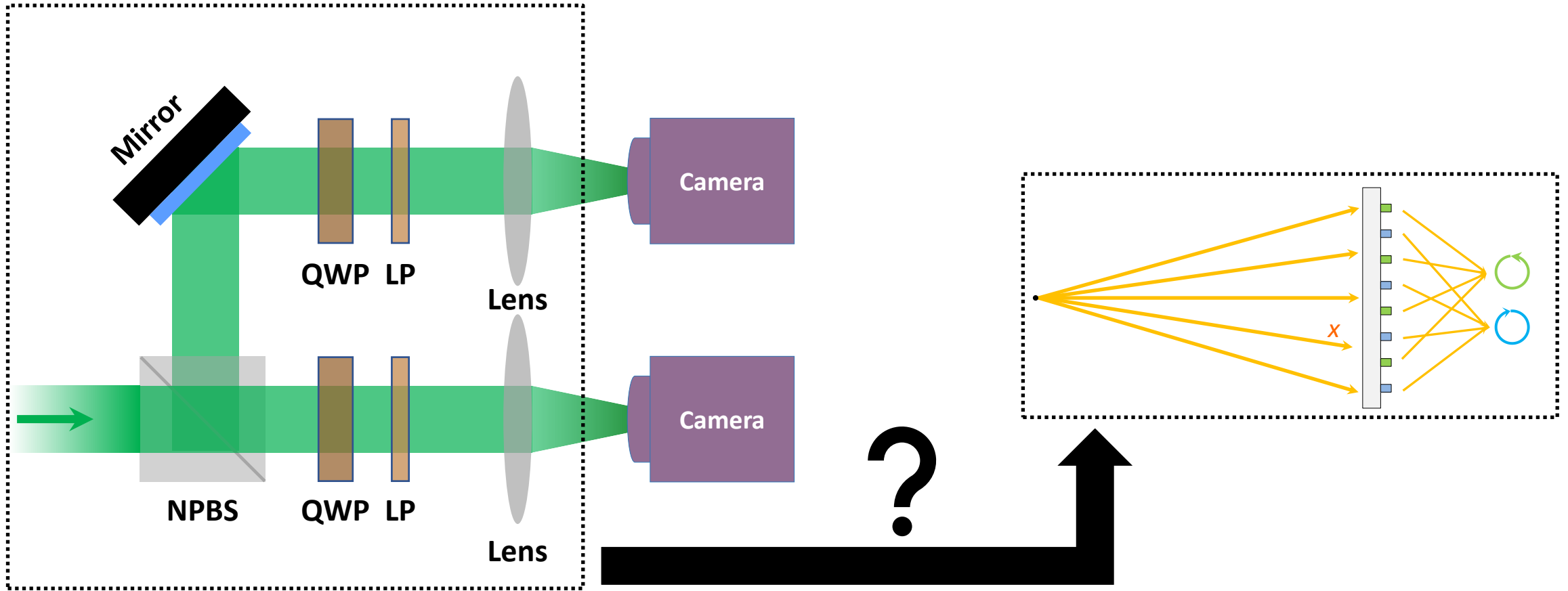


Scale bar: 10  $\mu\text{m}$



Scale bar: 500 nm

# Multifunctionality

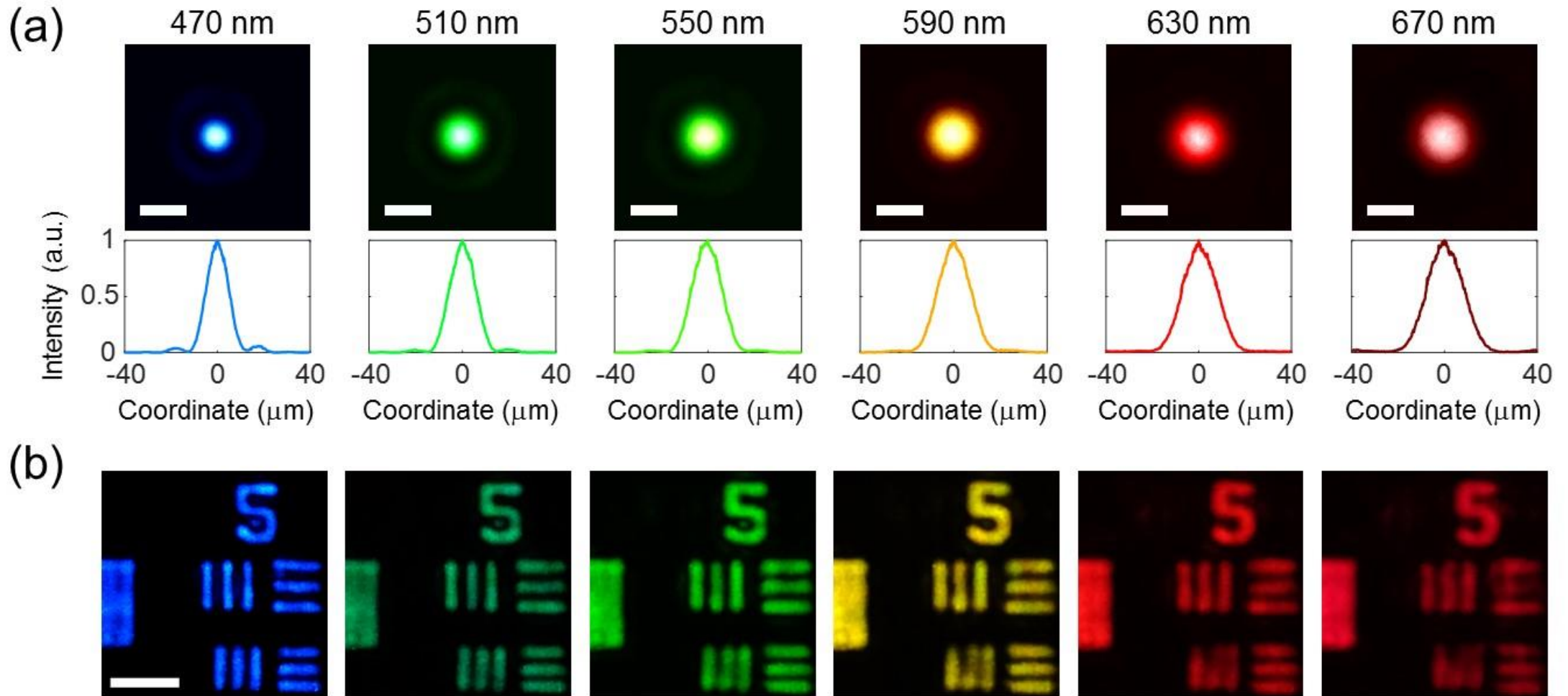




# Polarization Resolved Imaging with a Single Metasurface

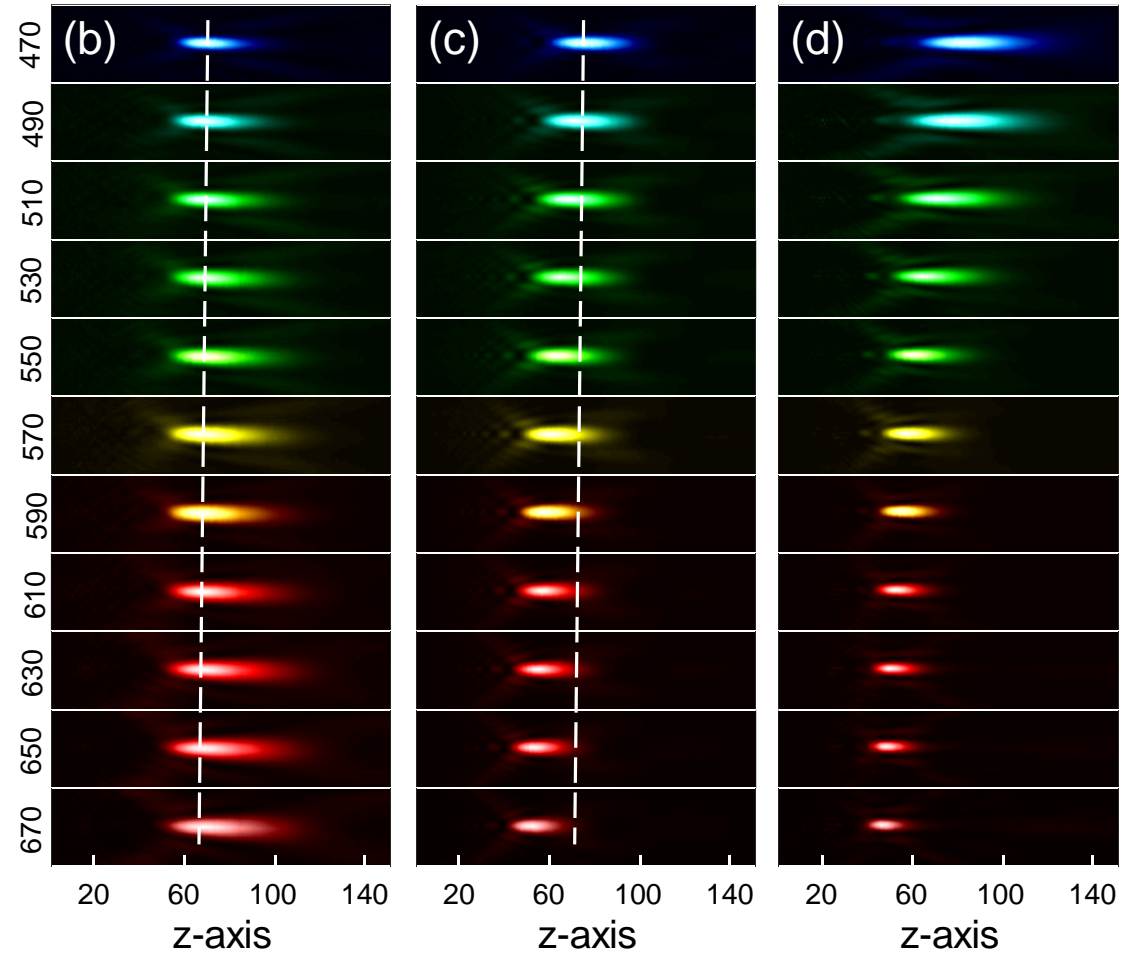
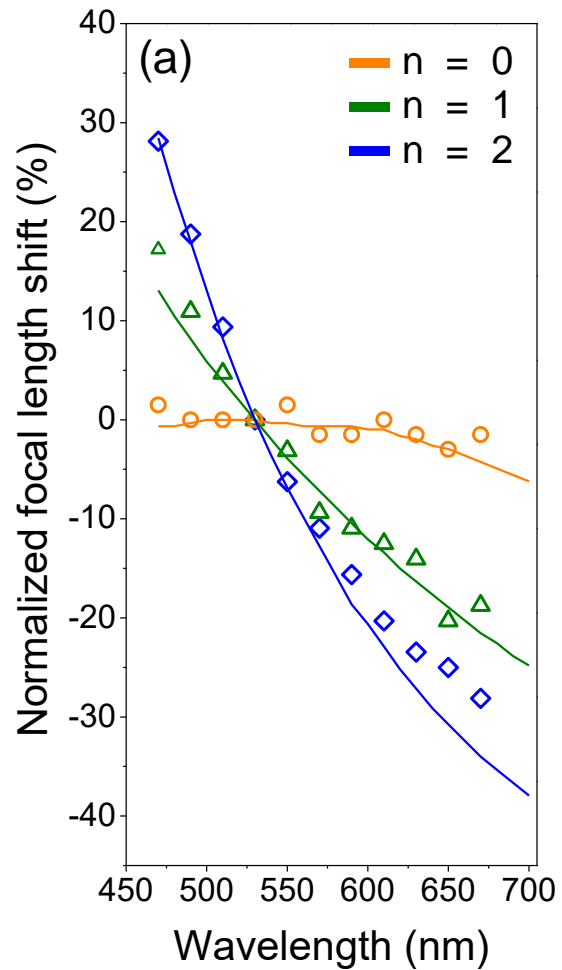


# Achromatic Flat Lens

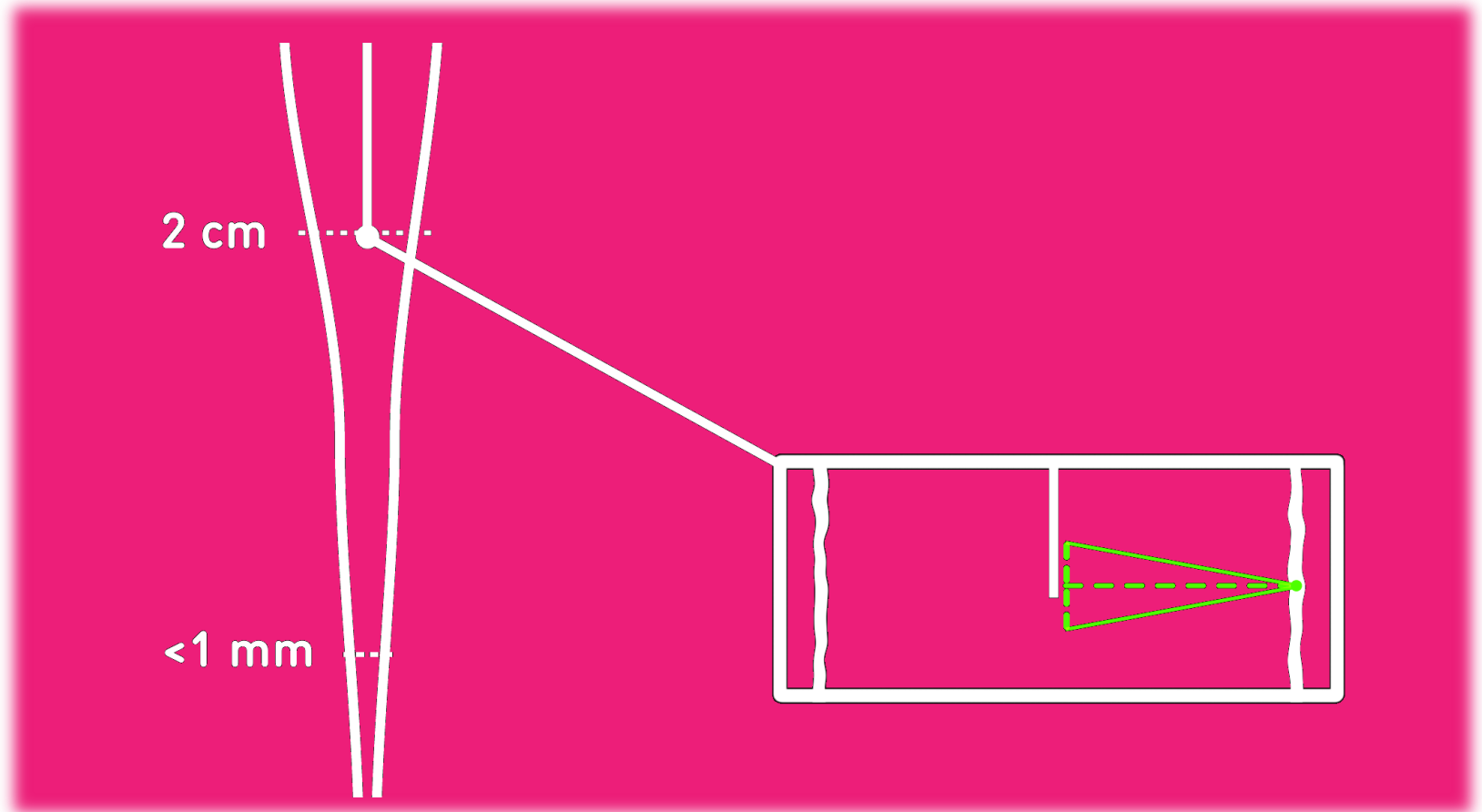
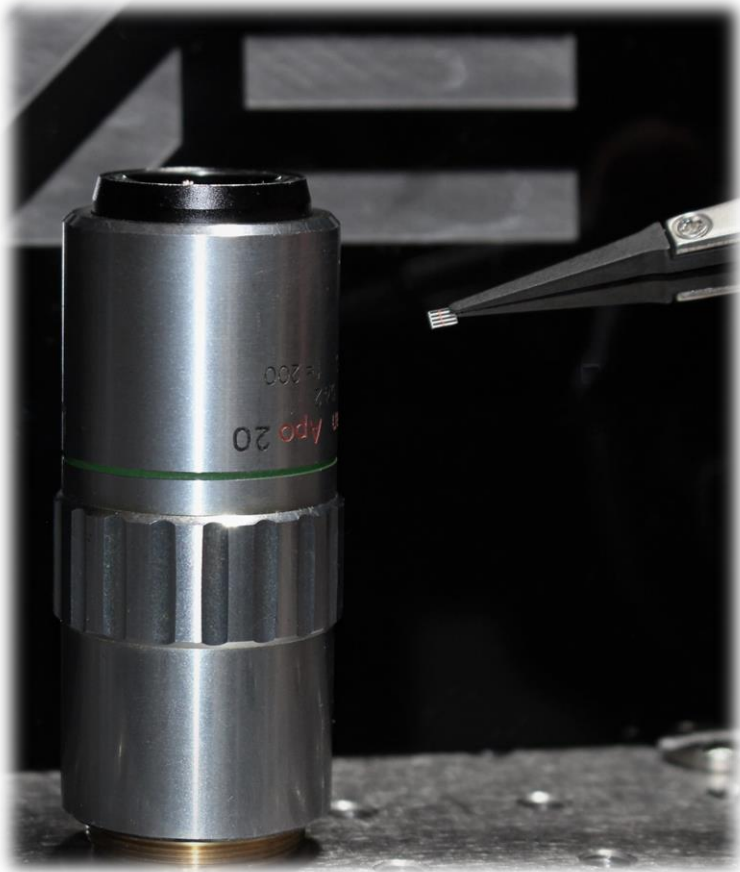




# Dispersion Engineering



# Zooming on Demand at Submillimeter Form Factor



# Acknowledgment



Federico Capasso



Jiang You



Wei Ting Chen



Robert Devlin



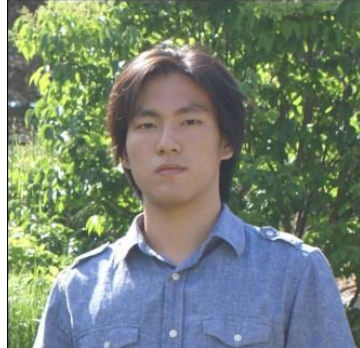
Alexander Zhu



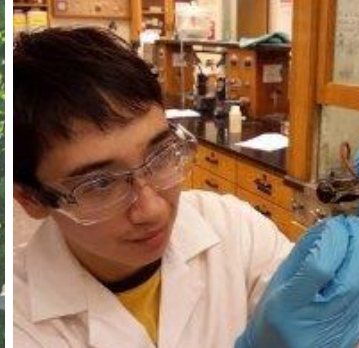
Zhujun Shi



Vyshakh Sanjeev



Jaewon Oh



David Rousso

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