

# Nanophotonics Research

*Imaging Physics Day, Halloween 2022*

Stefan A Maier

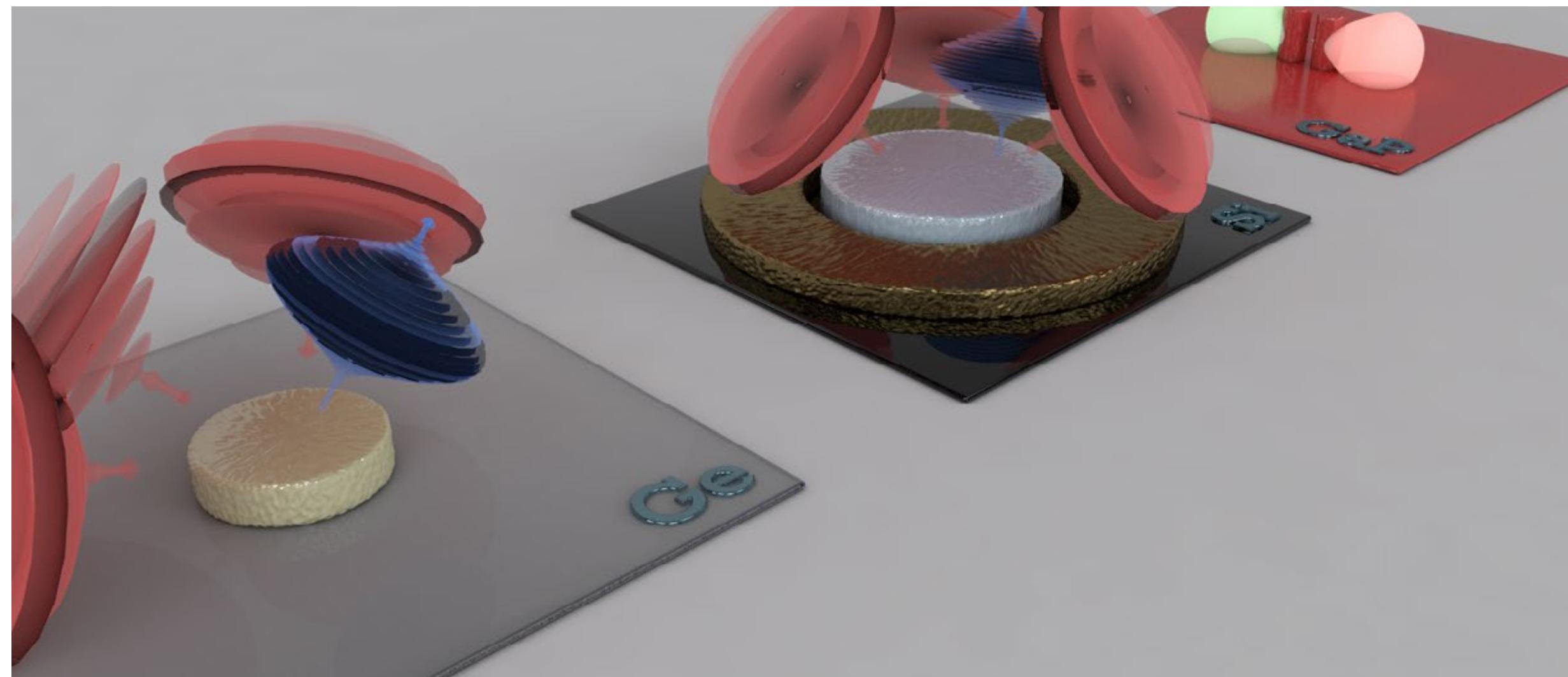
School of Physics and Astronomy, Monash University, Melbourne, Victoria

Lee-Lucas Chair in Experimental Physics, Imperial College London

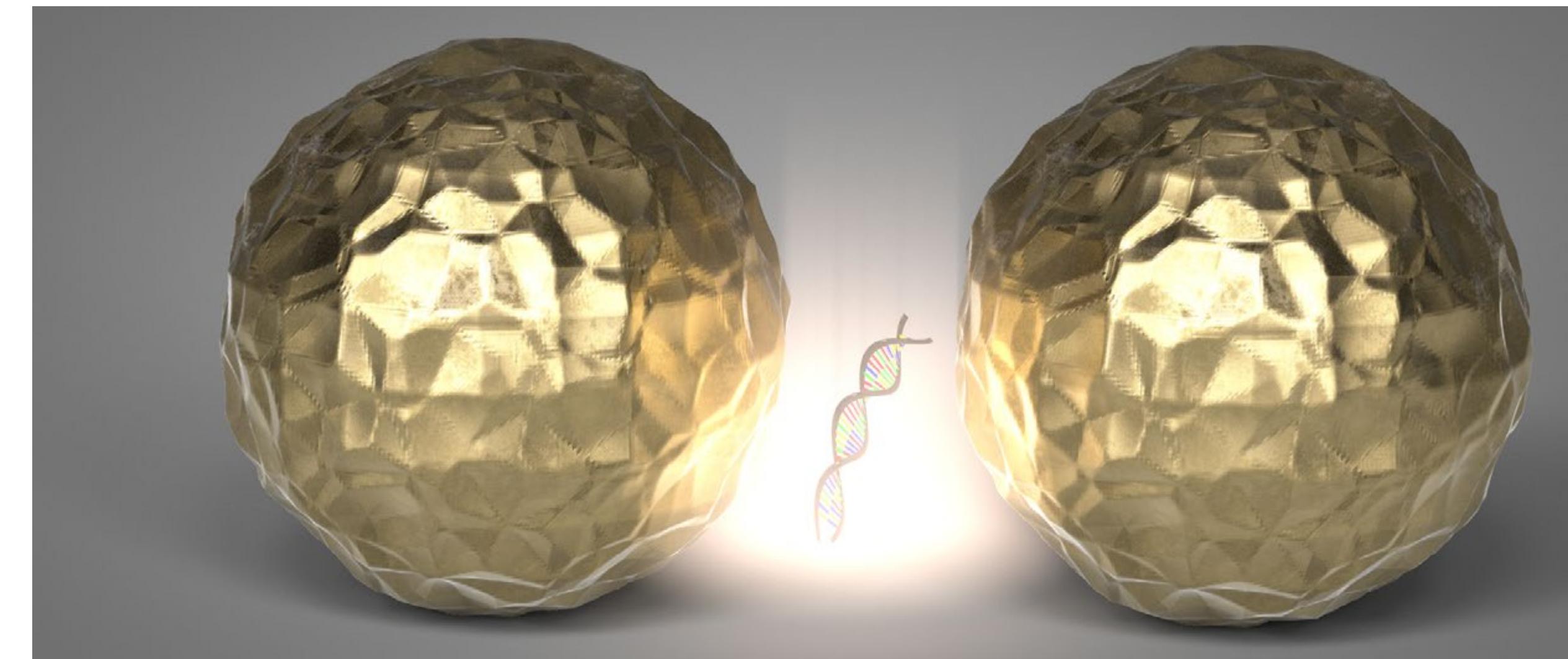
[Stefan.Maier@monash.edu](mailto:Stefan.Maier@monash.edu)

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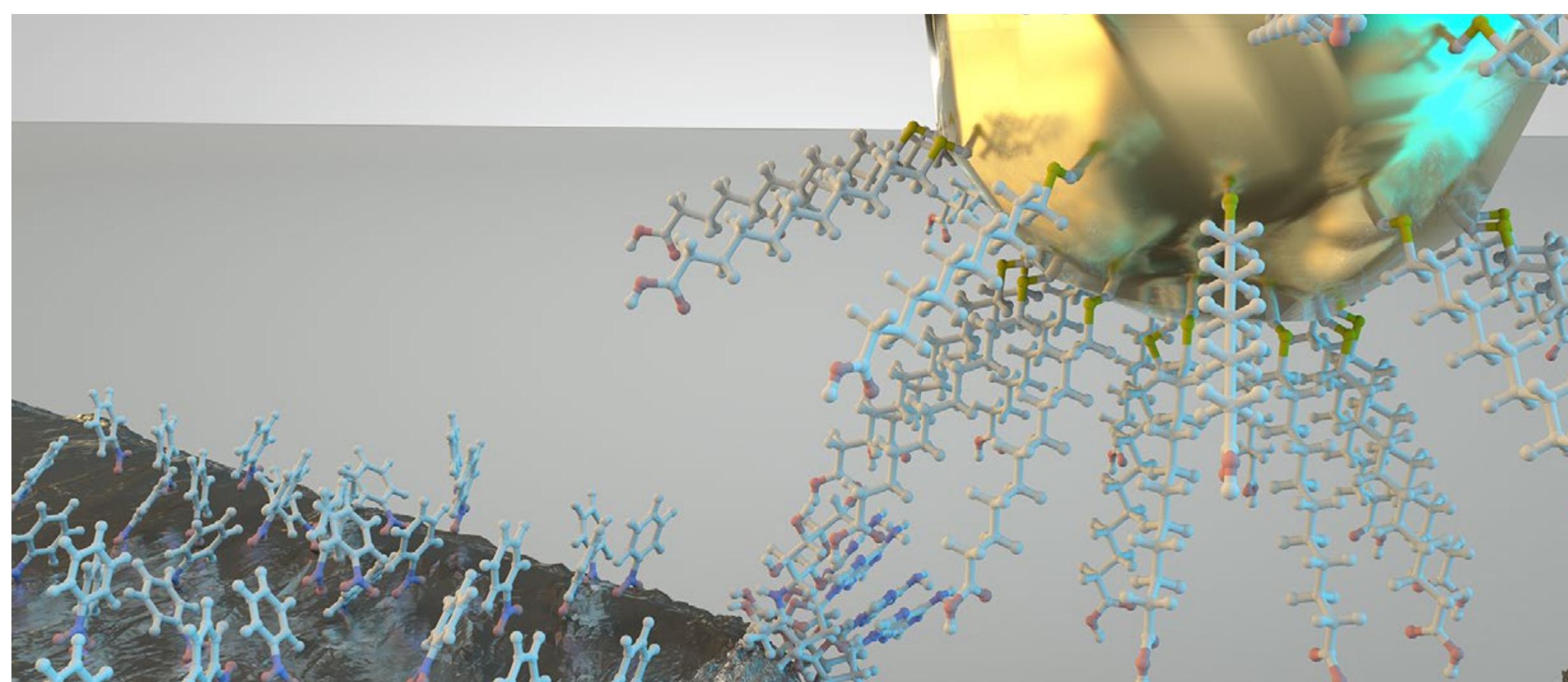
# Nanophotonics for control of light-matter coupling



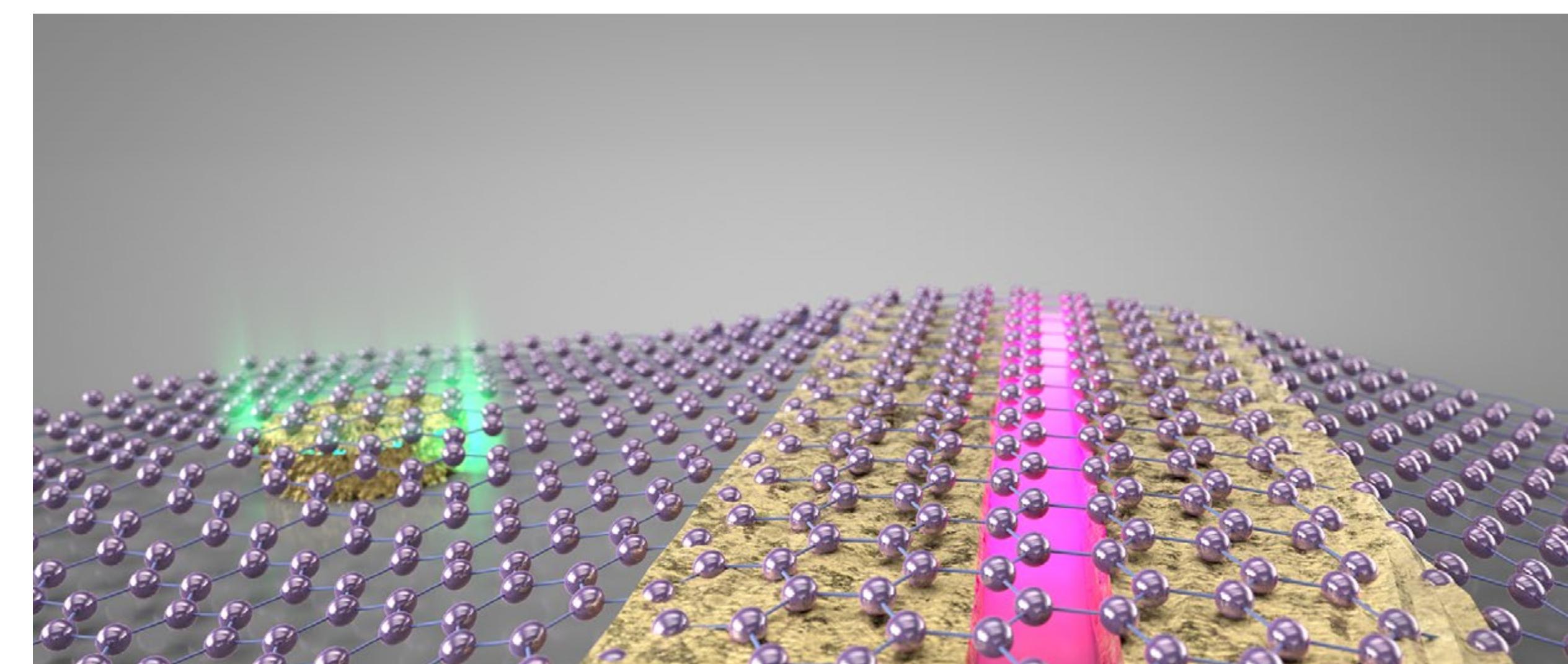
Non-linear interactions and emission control



Surface-enhanced sensing and spectroscopy

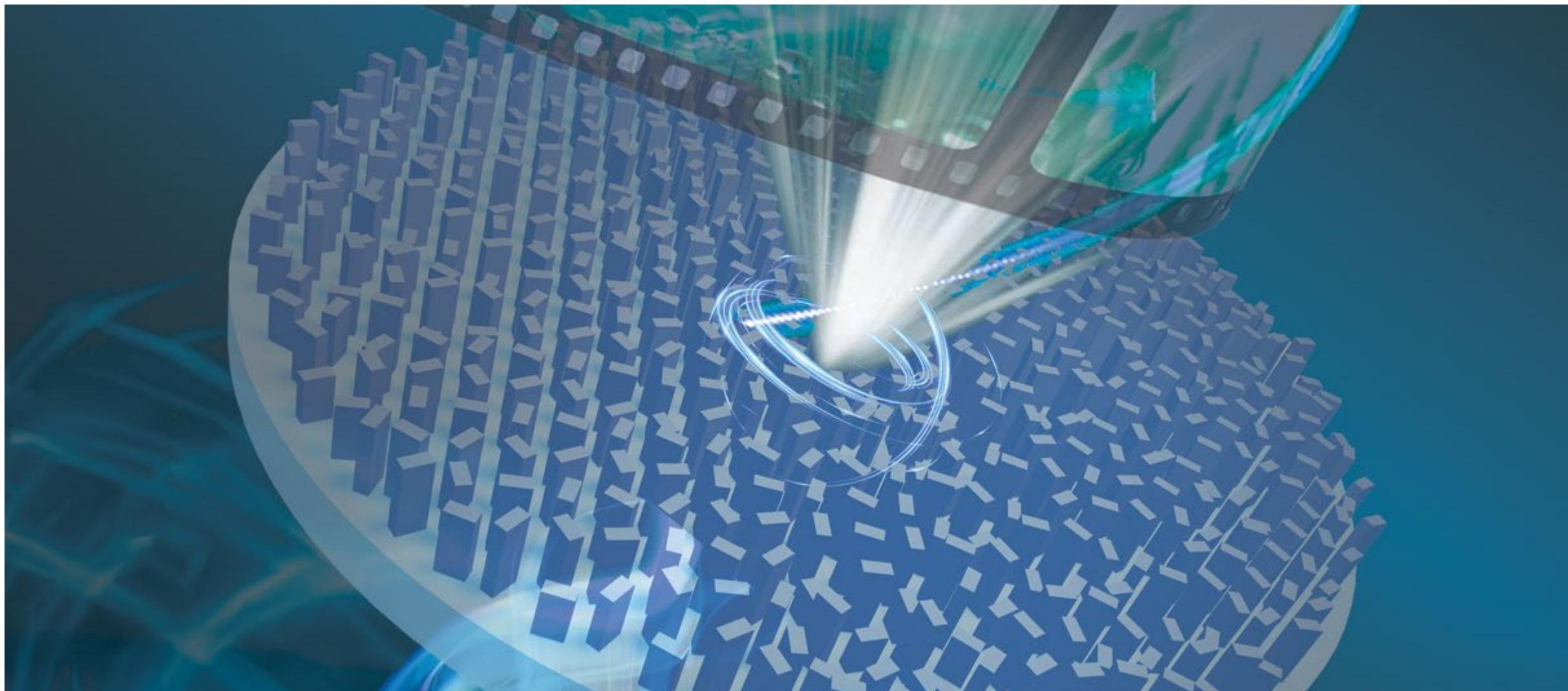


Energy conversion and plasmonic chemistry

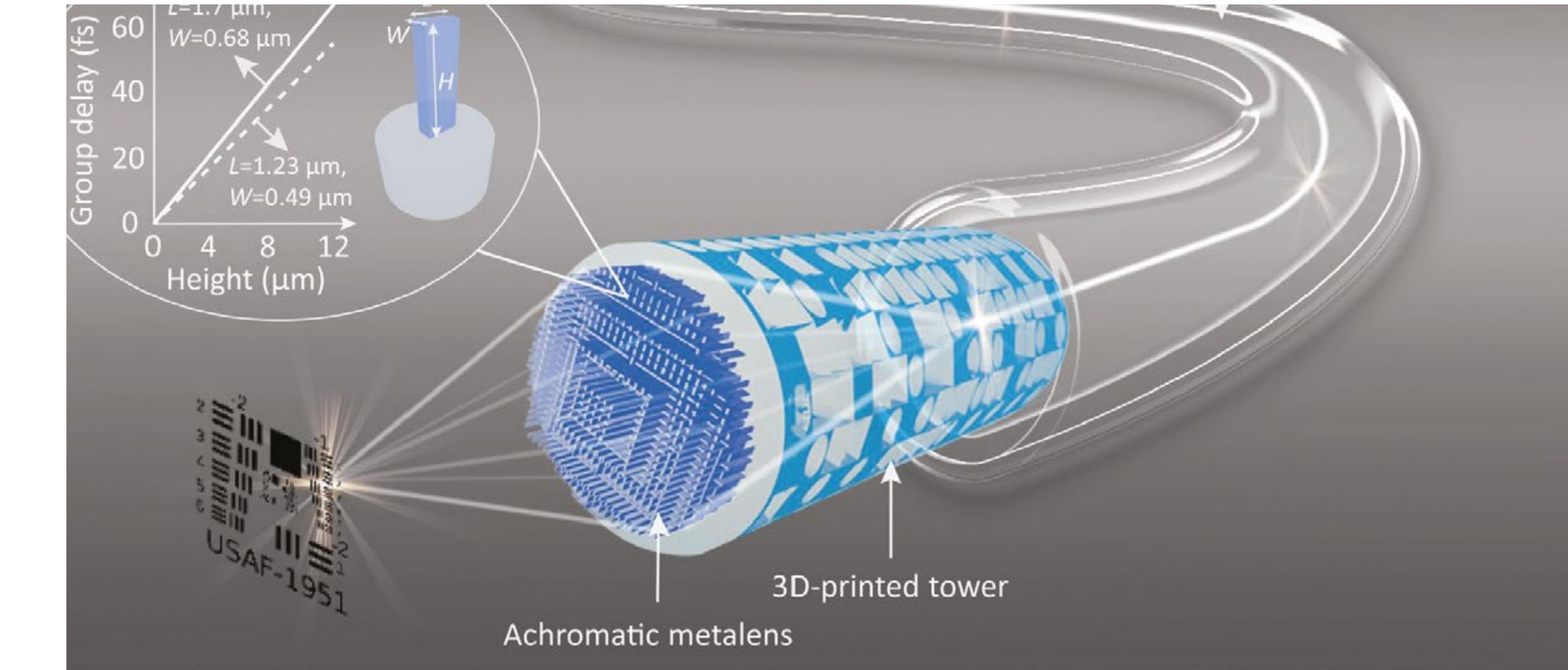


Coupling to low-dimensional materials and devices

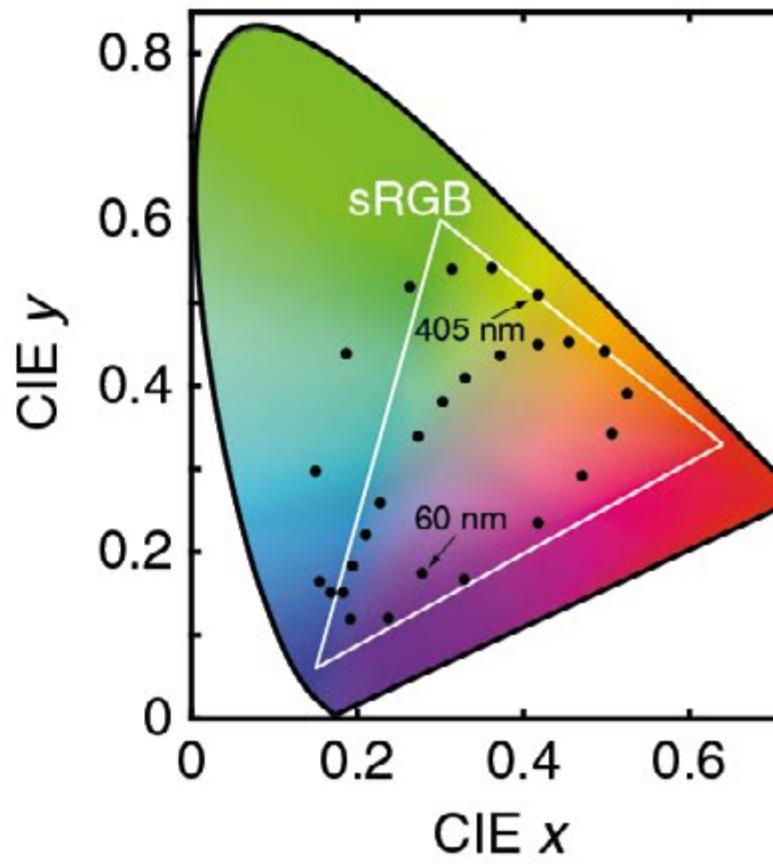
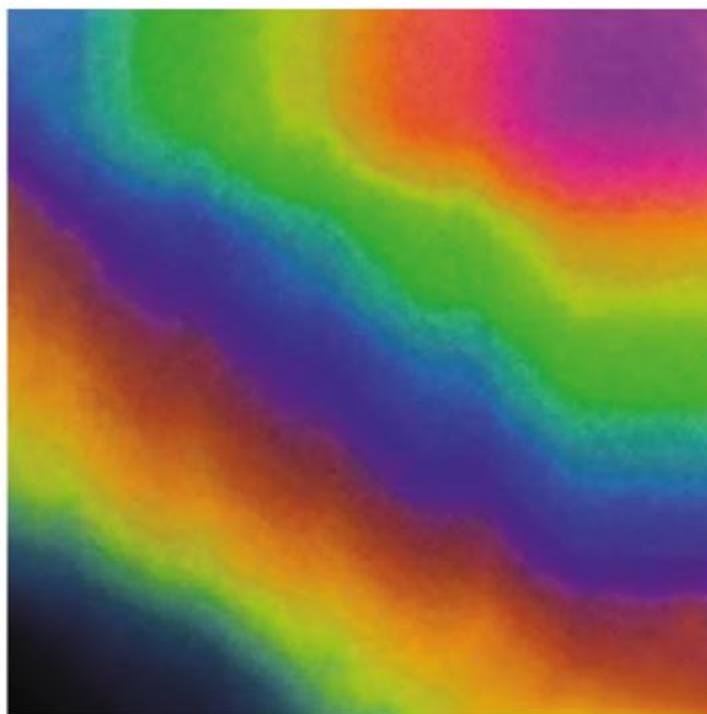
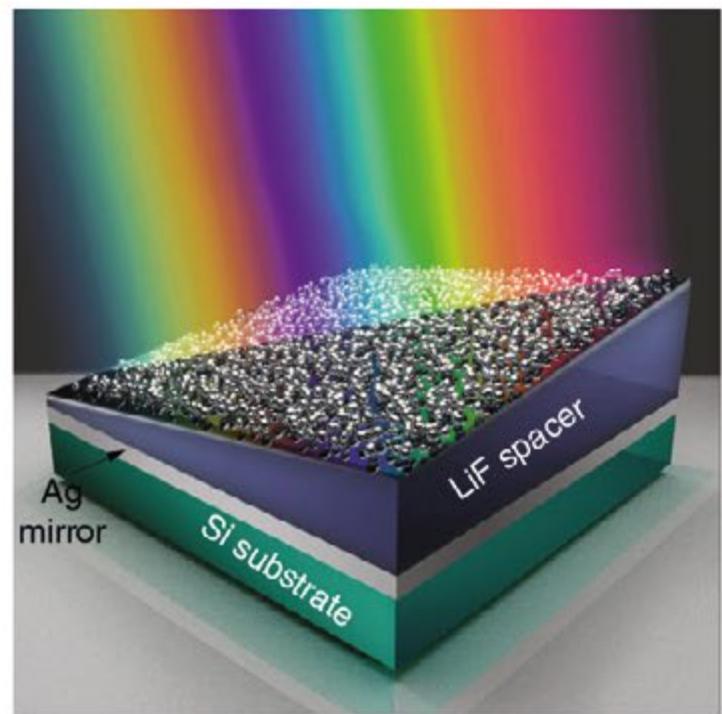
# Meta-optics: Metasurfaces and metafibers



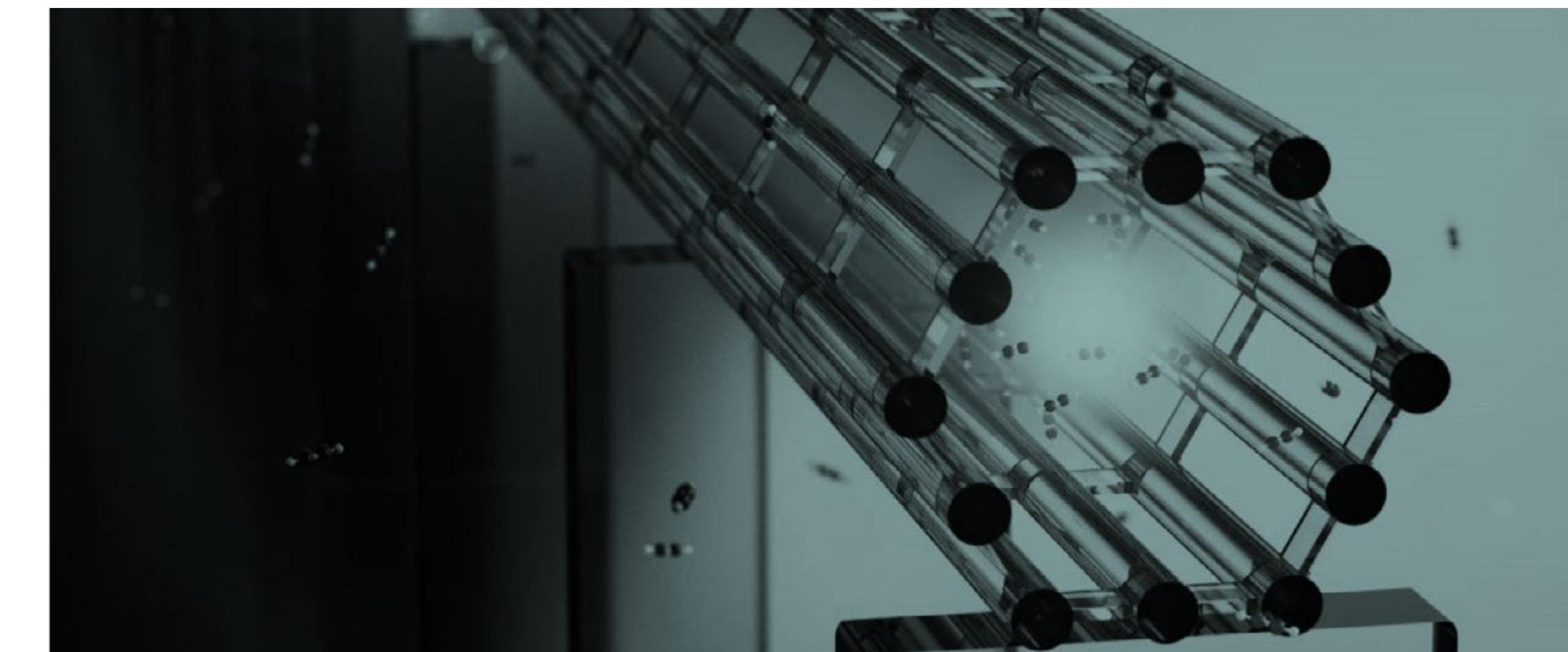
Holography



Telecommunications and fiber optics



Light harvesting with disordered systems



Light cages for sensing and spectroscopy

# Research groups at Monash and Imperial College London



Melbourne group — meta-optics



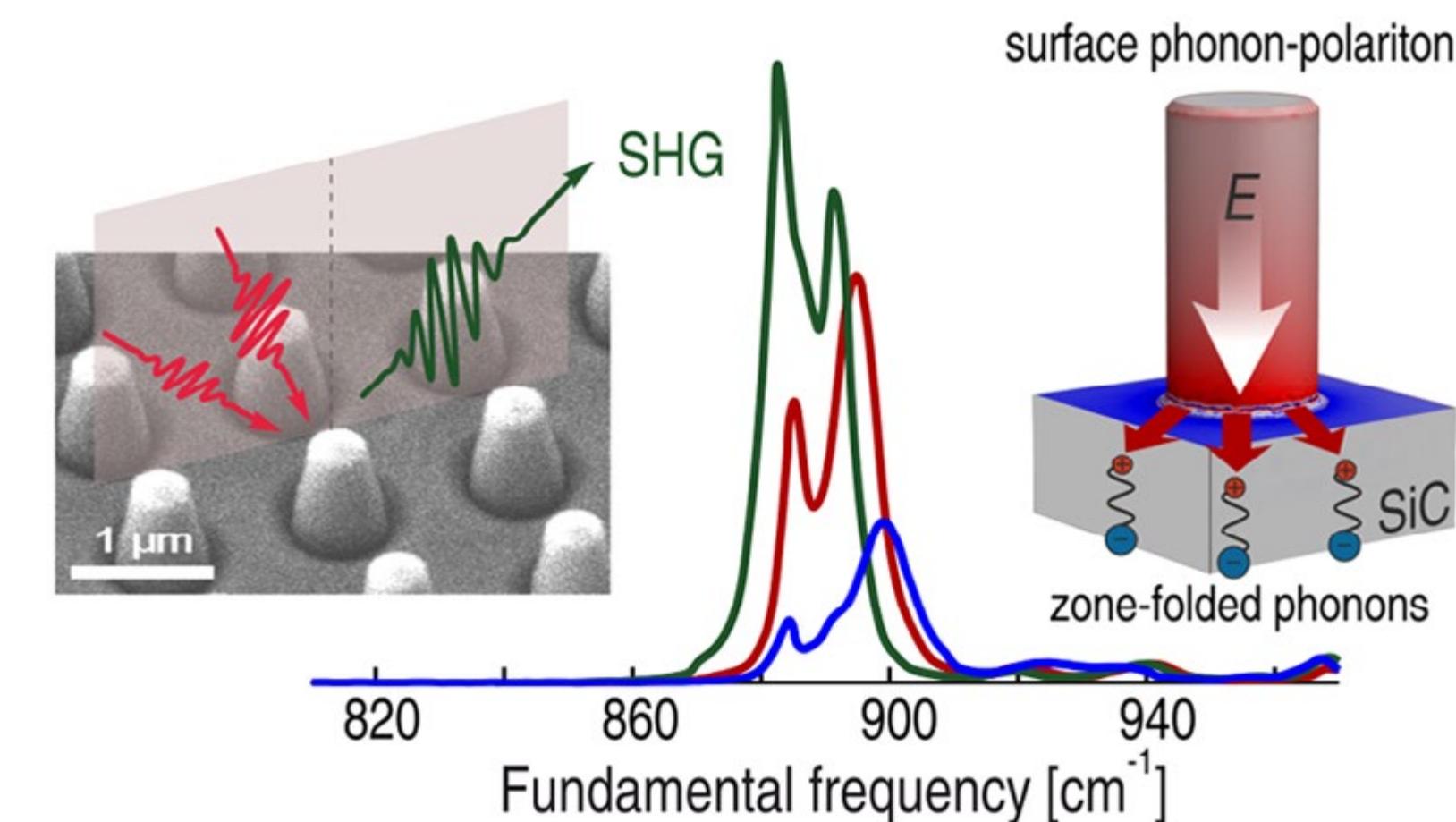
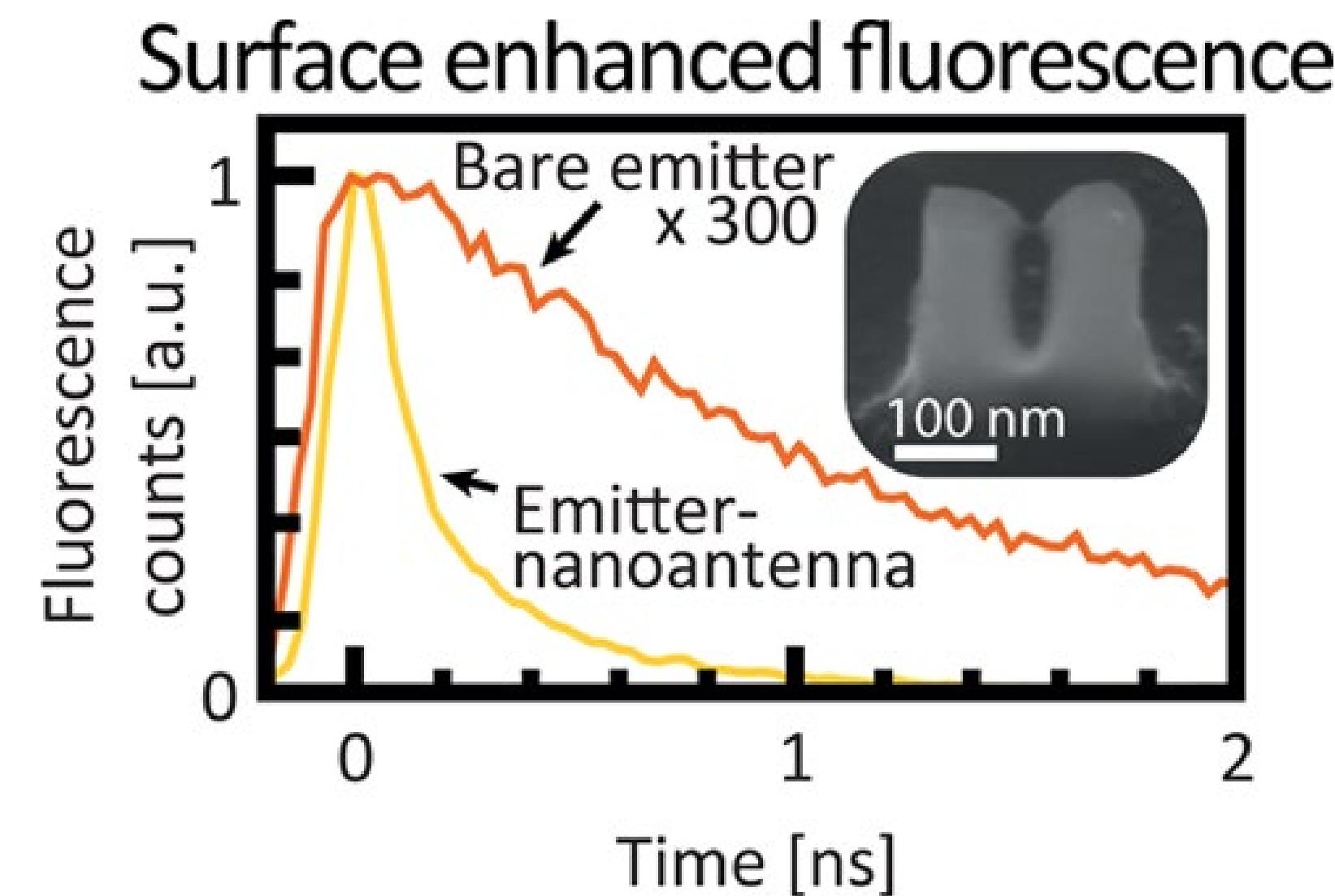
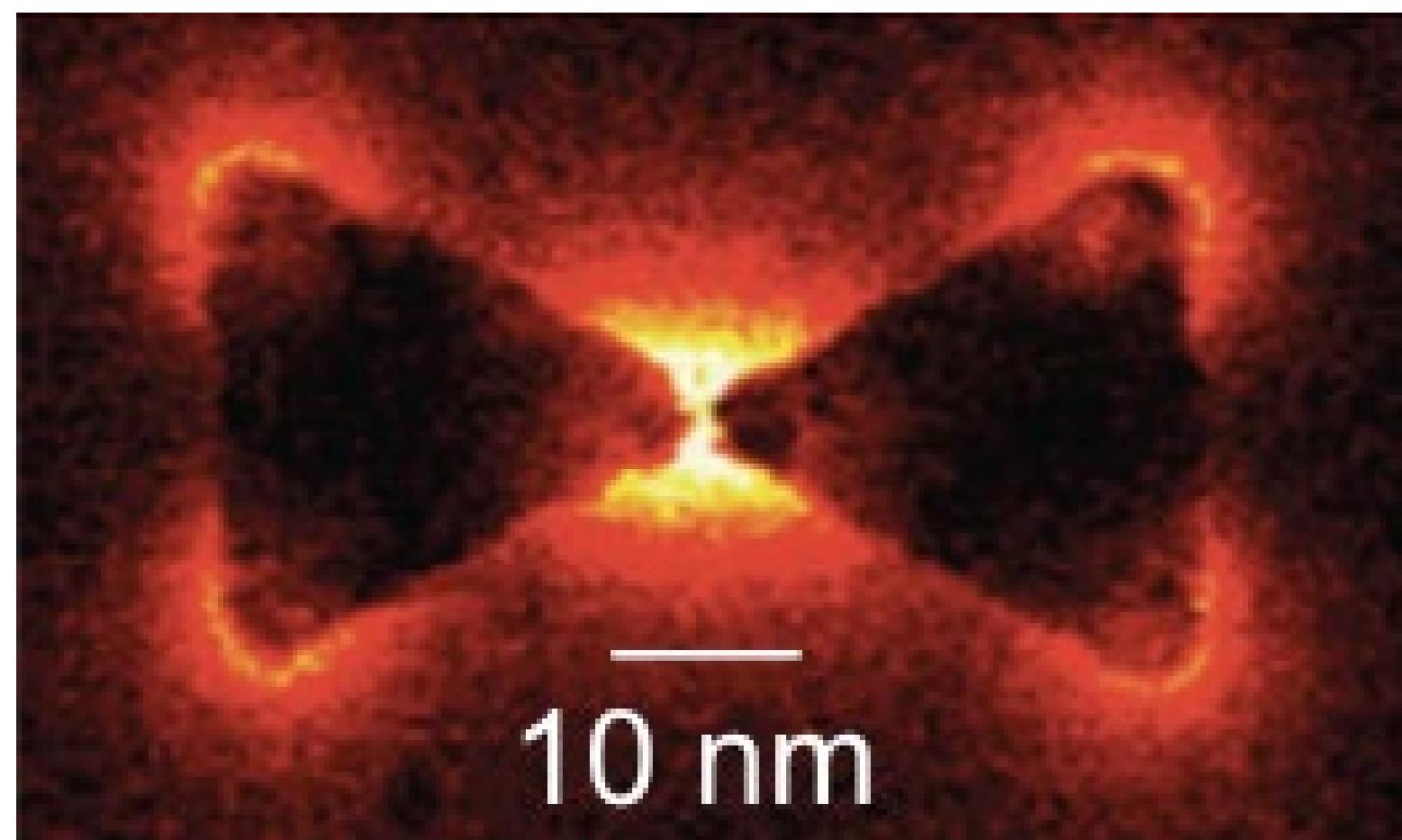
London group — catalytic plasmonics

# Catalytic Plasmonics Programme Grant in UK

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Interaction planned with Monash (photo)catalysis groups

# Polaritonic vs dielectric confinement in nanophotonics



## Plasmon polaritons

- ultimate field confinement via mixed light/matter modes
- significant absorption losses
- noble metals
- new materials, 2D systems

## High-index dielectrics

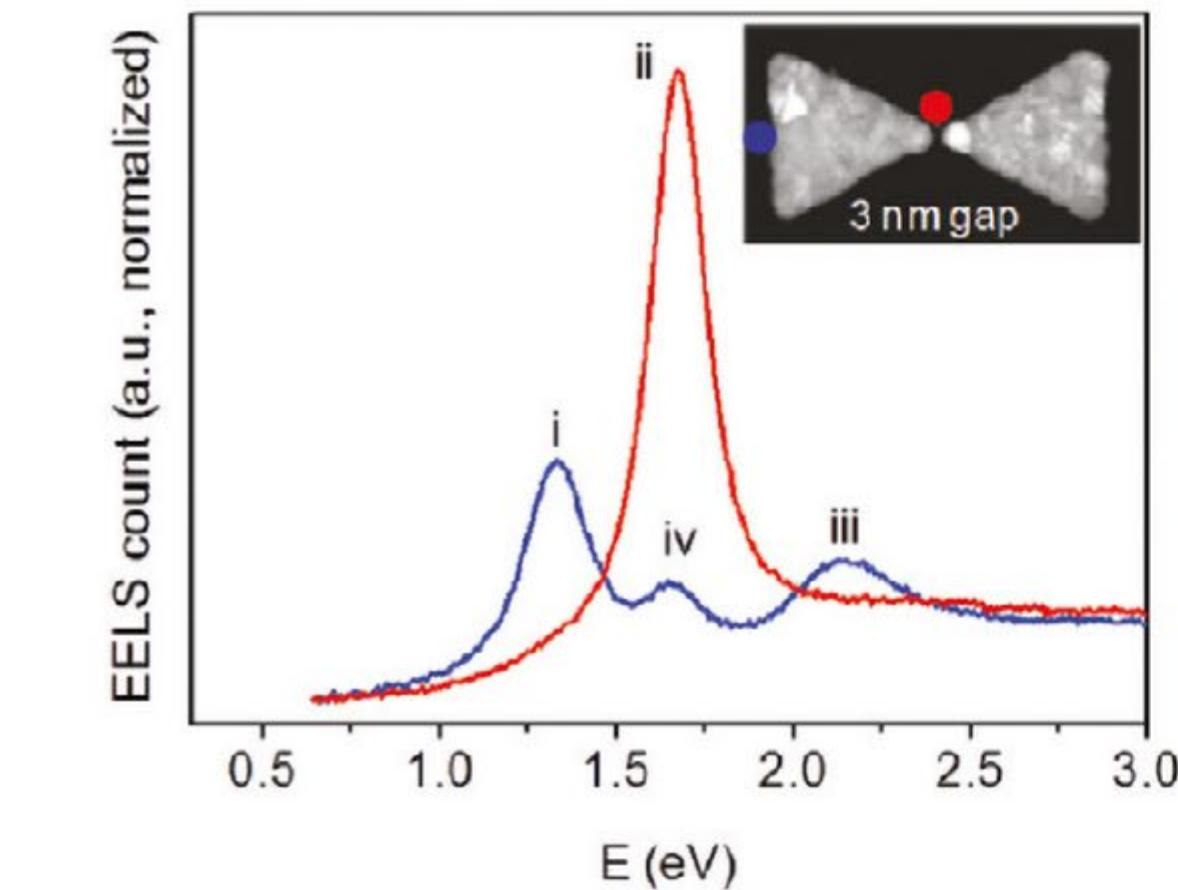
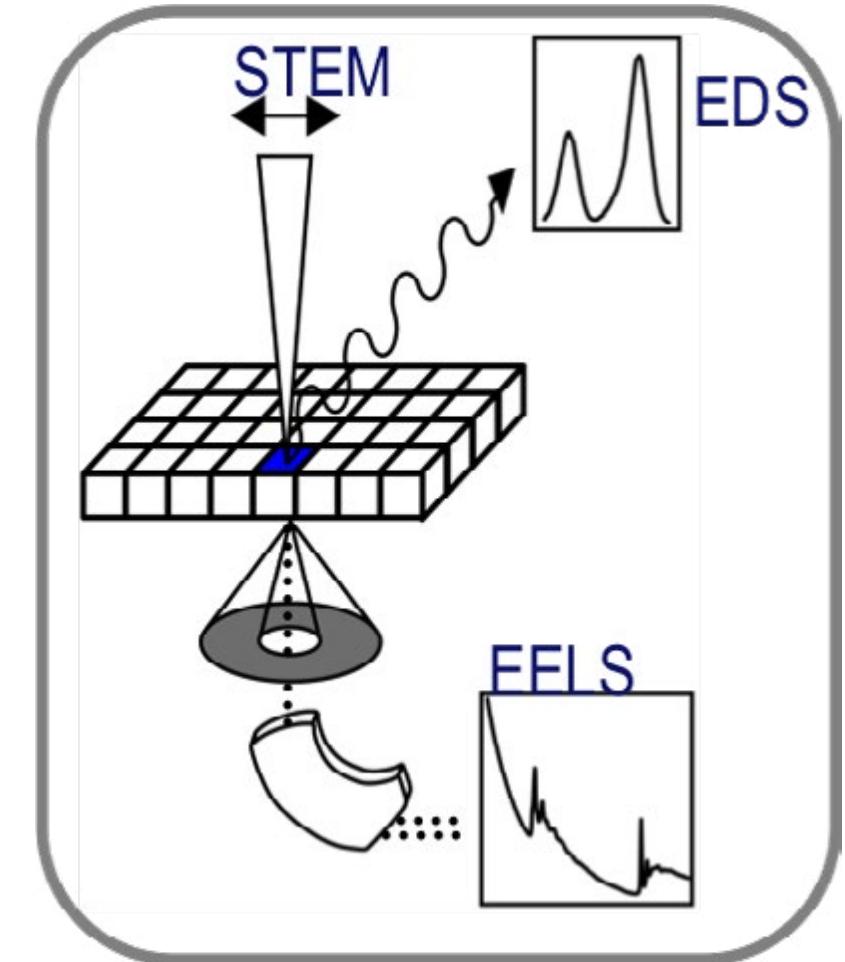
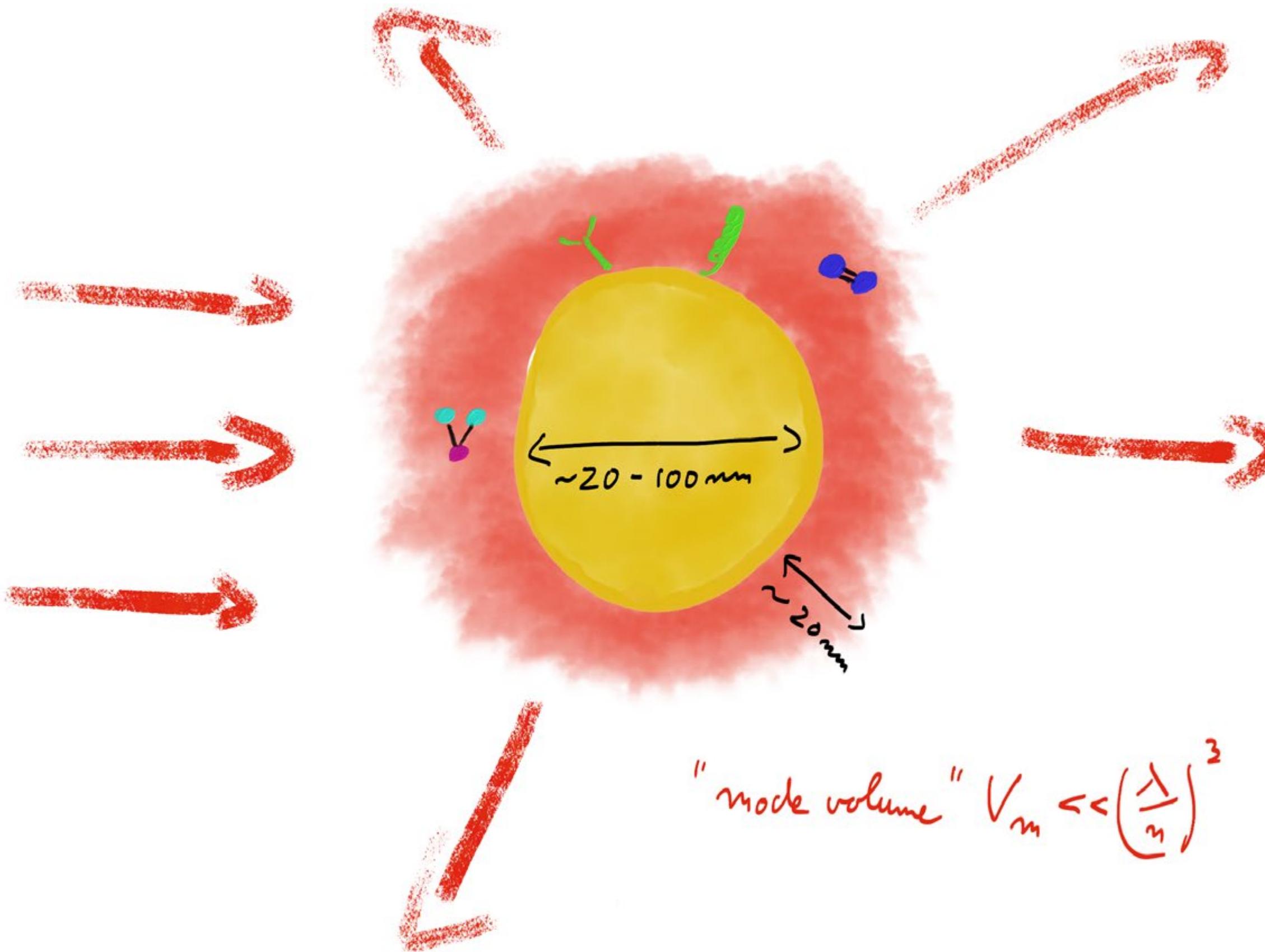
- field confinement via electric and magnetic Mie modes and anapole excitations
- low absorption and low non-radiative coupling
- large non-linear susceptibilities
- semiconductors and oxides
- nanogaps crucial for high enhancement

## Phonon polaritons

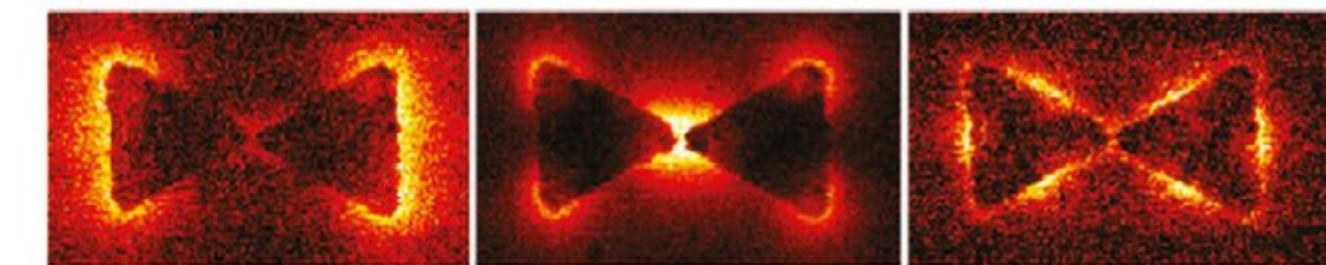
- mixed light/matter modes enable extreme field confinement
- low absorption losses
- polar dielectrics
- operation range in mid-infrared

# Breaking the diffraction limit and enhanced near fields

Nano Letters 11, 1323 (2011)



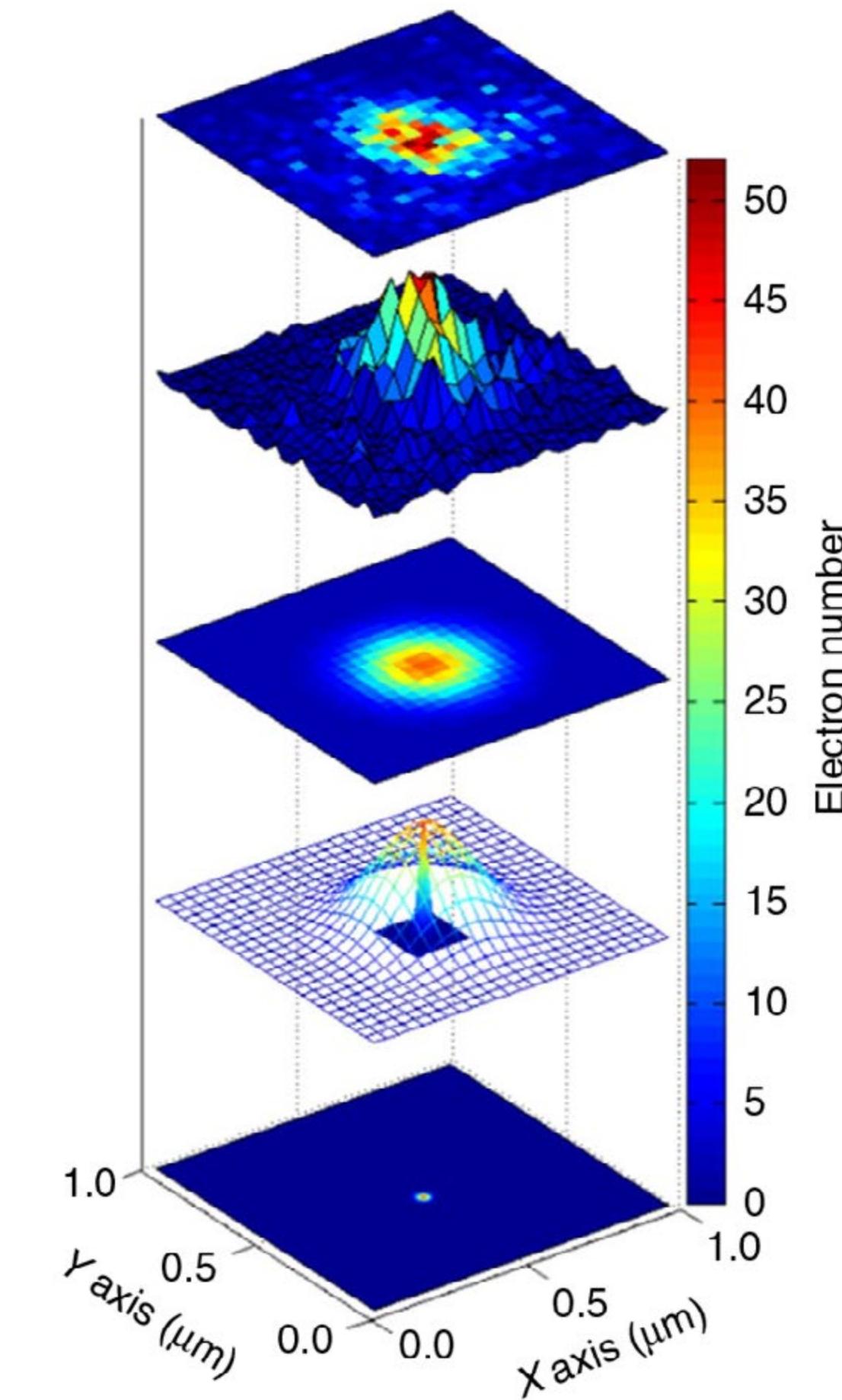
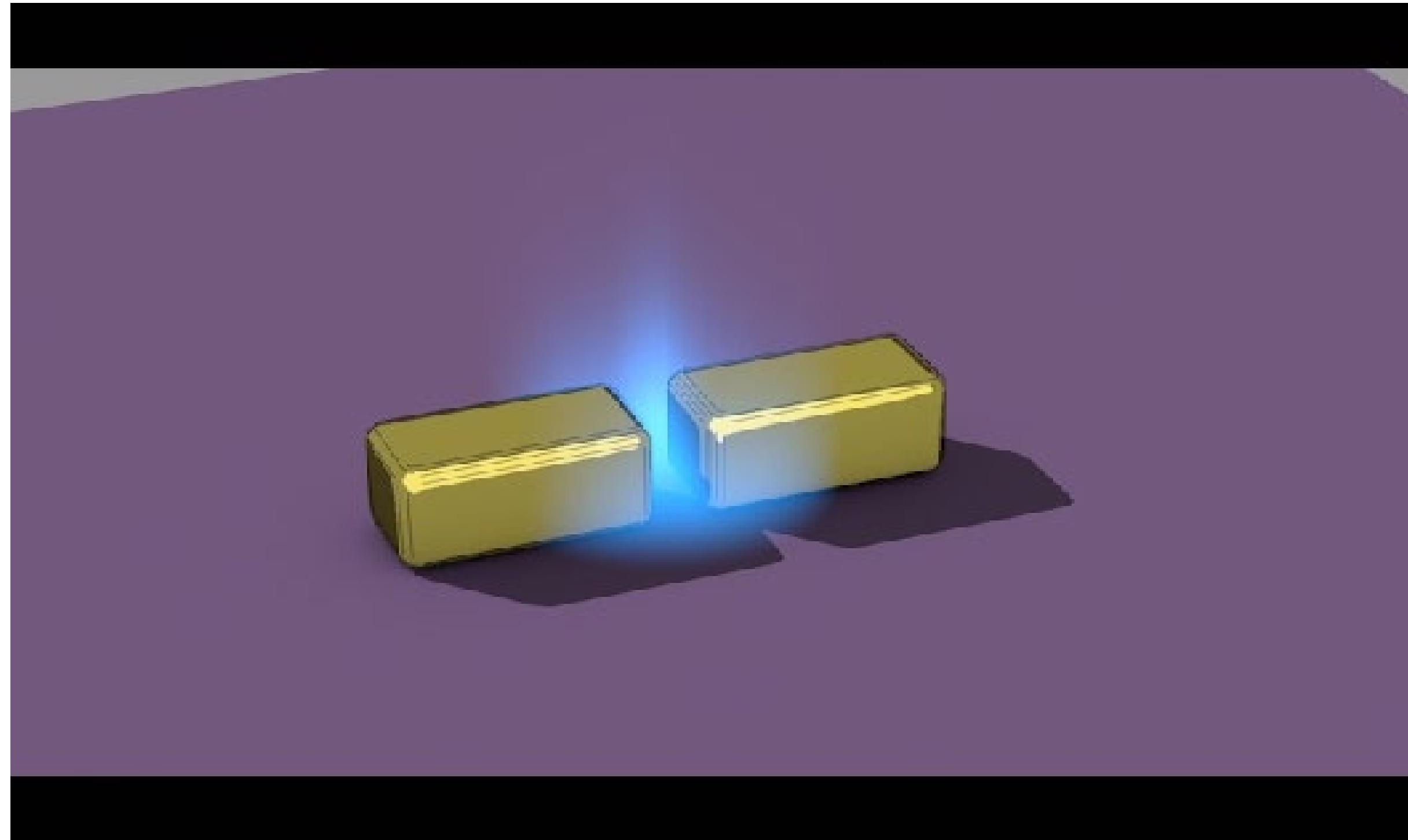
Resonances i, ii, iii



Particle plasmons enable electromagnetic field hot spots with enhancements 10x-1000x.

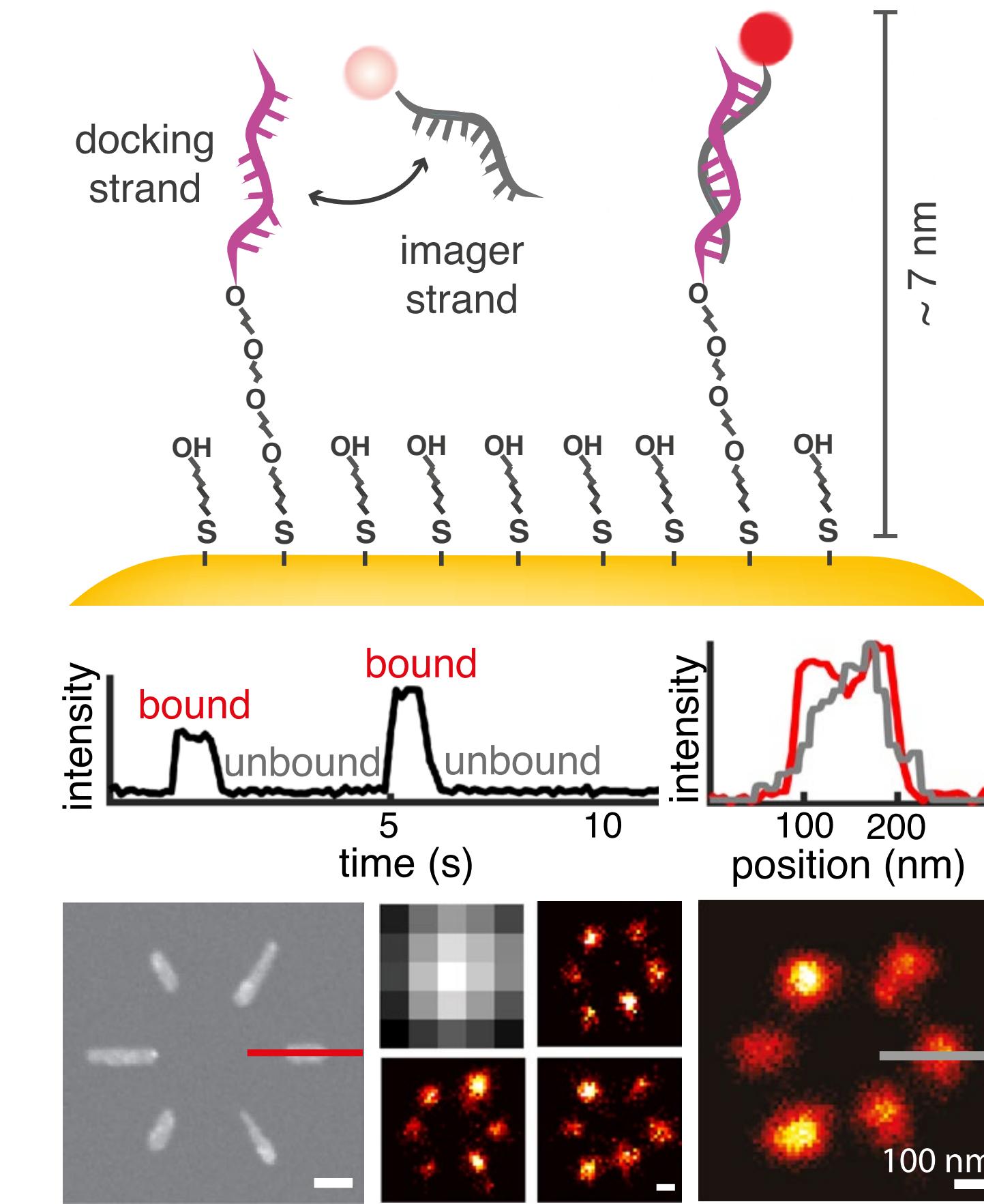
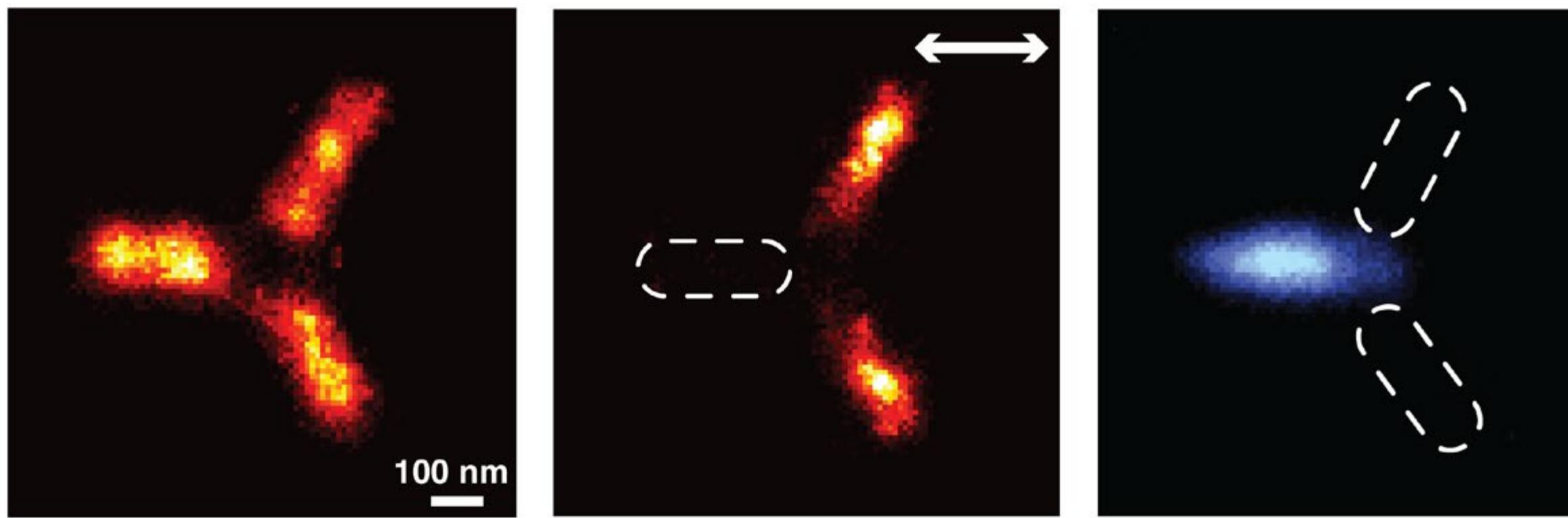
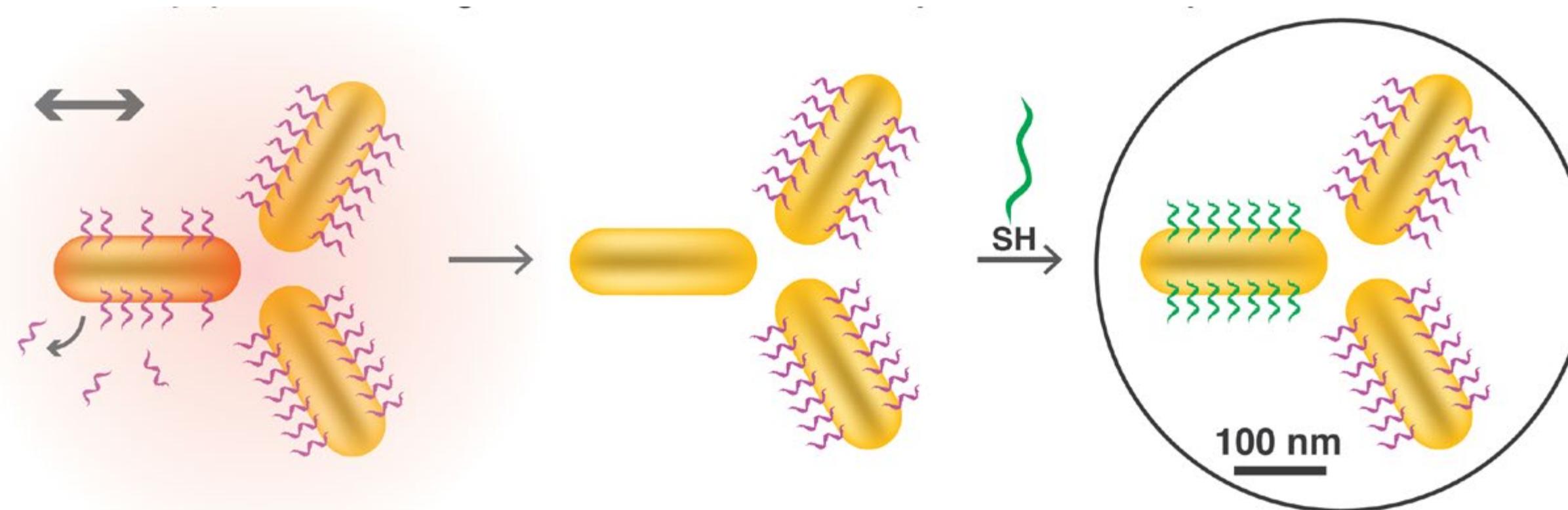
# Localization microscopy for hot spot imaging

Nature Communications 8, 14513 (2017)



# Control of molecular self-assembly

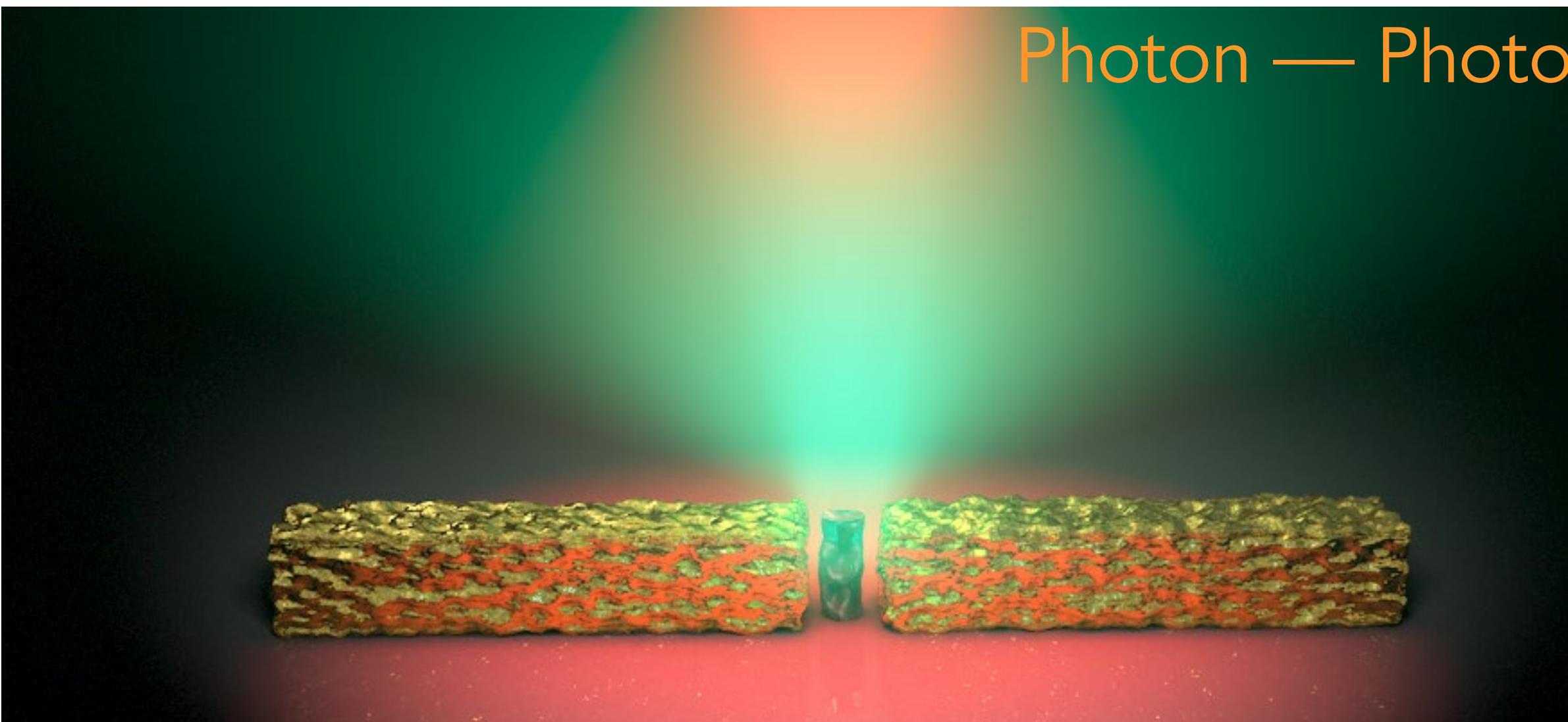
ACS Nano 12, 2184 (2018)



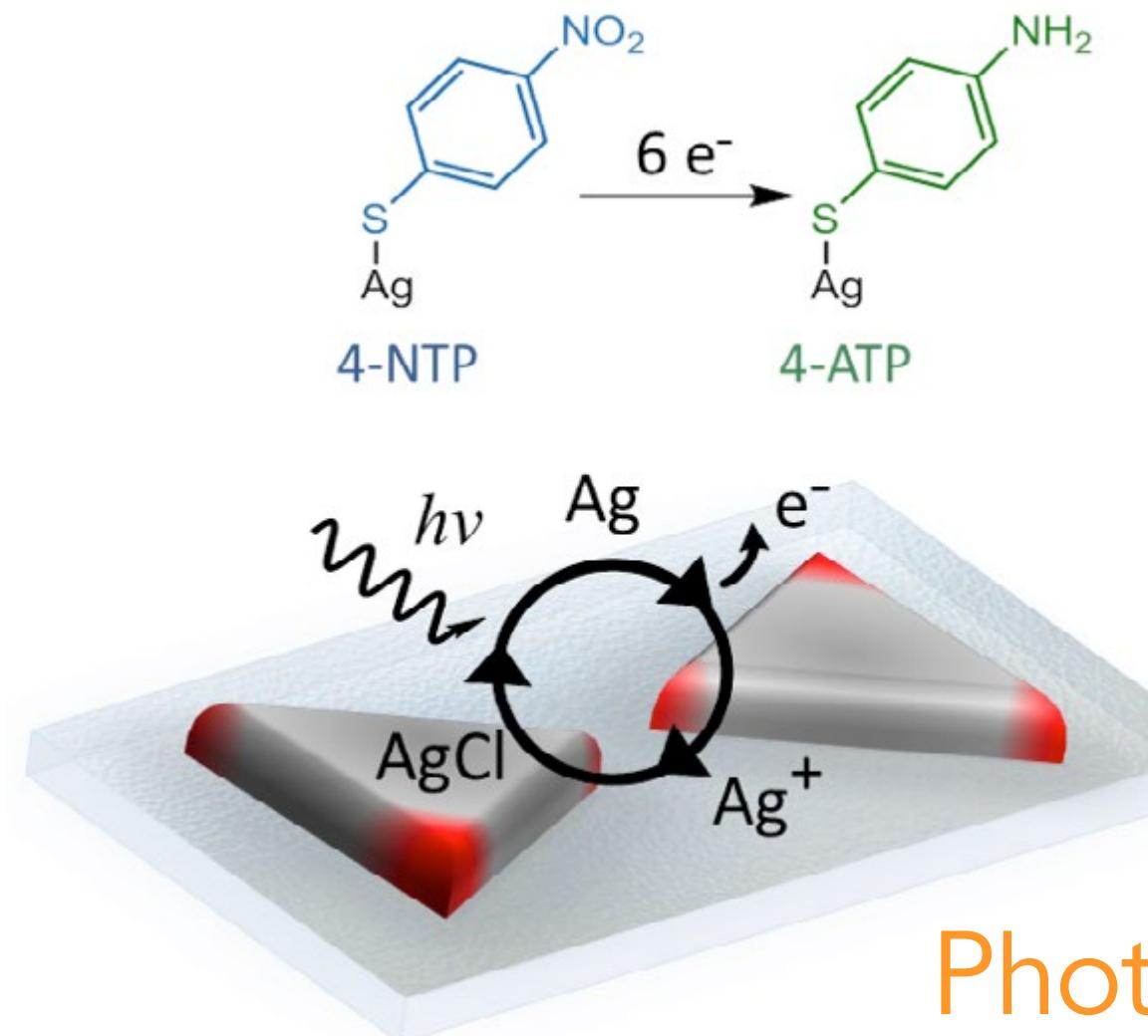
Laser-pulse-induced thiol bond cleaving

m-PAINT for sub-diffraction imaging

# Localized plasmons as nanoscale energy converters



*Nature Nanotechnology* 9, 290 (2014)

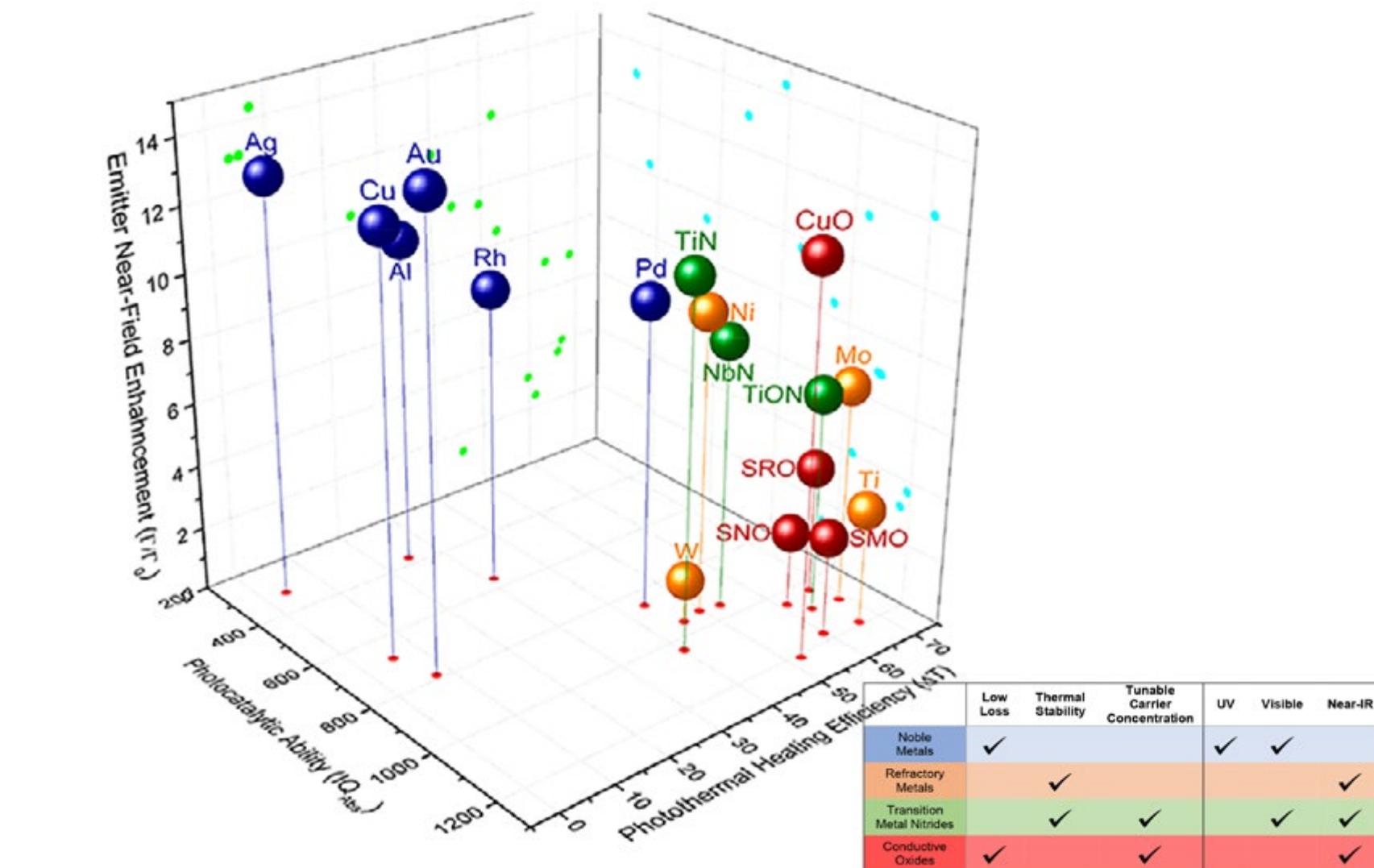


Photon — Redox

*Nature Communications* 8, 14880 (2017)



*Physical Review Letters* 121, 253902 (2018)



*ACS Photonics* 6, 240 (2019)