

# Controlling Light at the Nanoscale: from Metallic Nanoparticles to Novel Artificial Materials

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Cosmic rays

Gamma rays

X-rays

Ultraviolet (UV)

VIS

Infrared (IR)

Microwaves

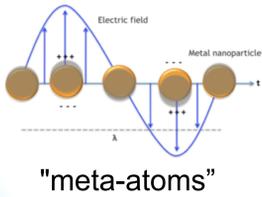
Radar

Radio

Broadcast band

## What is Plasmonics?

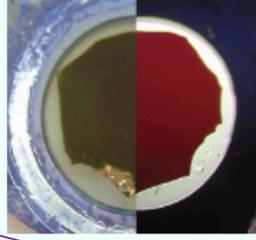
- Subwavelength
- Shift of resonance
- Strong field localization in peaks



## Metamaterials

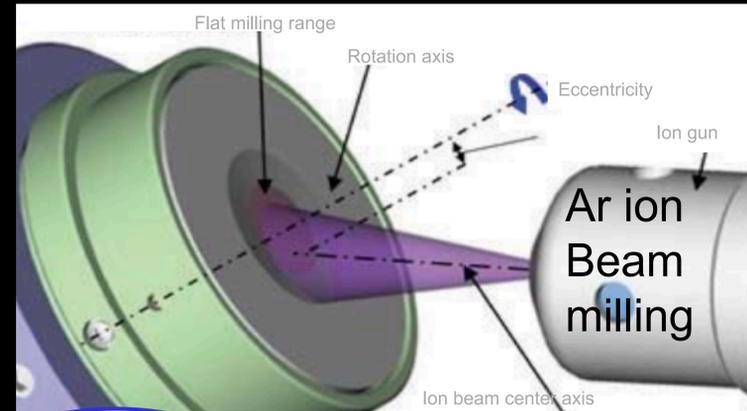
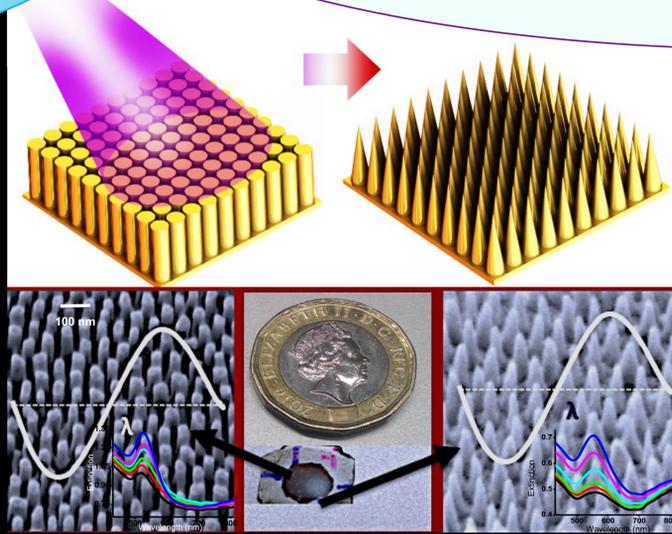
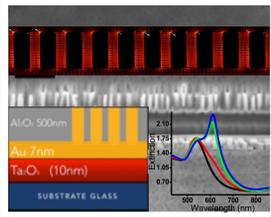
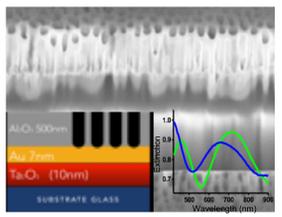
Individual particles assembled in an array with spacing subwavelength perceive light as a homogeneous medium composed of coupled "meta-atoms" called metamaterial with engineered optical properties.

Nanorods and Nanocone array: Anisotropic metamaterials, effective medium in function of the filling fraction (periodicity and diameter).



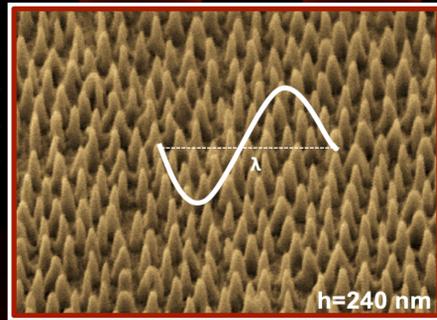
## Metamaterials Fabrication

- Self-assembled
- Large area
- Non expensive technique
- Strong field localization
- Engineered optical properties

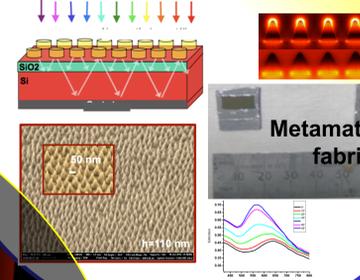


## What can we do with this?

Tunability, sensitivity to the material environment and high field localization achieved with such metamaterial can lead to enhanced optical functionalities and opens prospects for applications related to hot electron generation, sensing and photocatalysis.

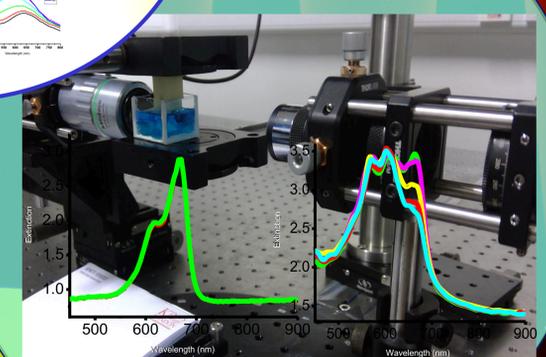


## Plasmonic solar cells

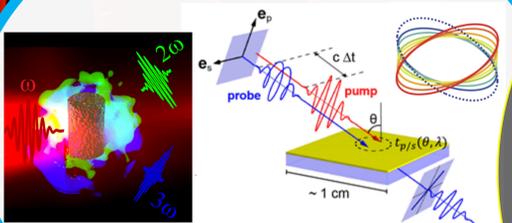


Metamaterials fabricated on Si

## Photocatalysis

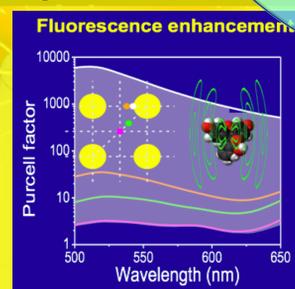


## Nonlinear optics

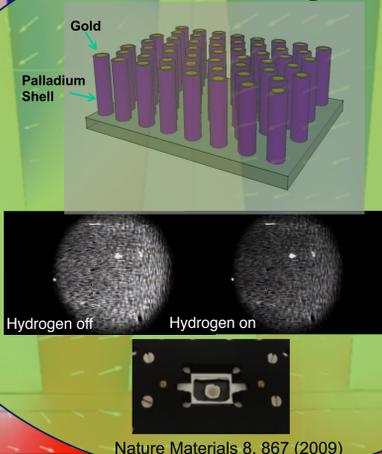


Nature Photonics 11, 628-633 (2017)

## Quantum light sources

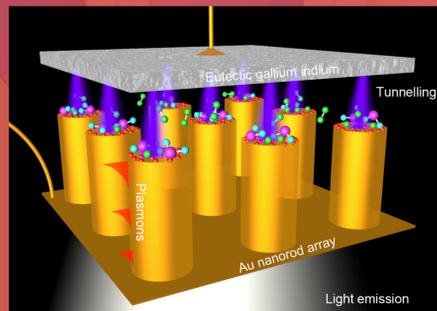


## Biosensing



Nature Materials 8, 867 (2009)

## Hot electron generation



Nature Nanotechnology 13, 159 (2018)

Nanophotonics is a field of science and engineering which explores the confinement and control of light over sizes on the order of the wavelength or smaller, i.e., on the nanometer scale. Plasmonics, a fascinating branch of nanophotonics studying the interaction of light with metallic nanostructures, is an emergent field of study motivated by the rapid advance of nanotechnology, into which interest is lately surging due to its enormous potential applications. The unprecedented ability of plasmonic structures to concentrate light into deeply subwavelength volumes promises a wide variety of new nanophotonic technologies as well as improving already existing ones.