Photonics for life:
Optical antenna and light-induced organization.

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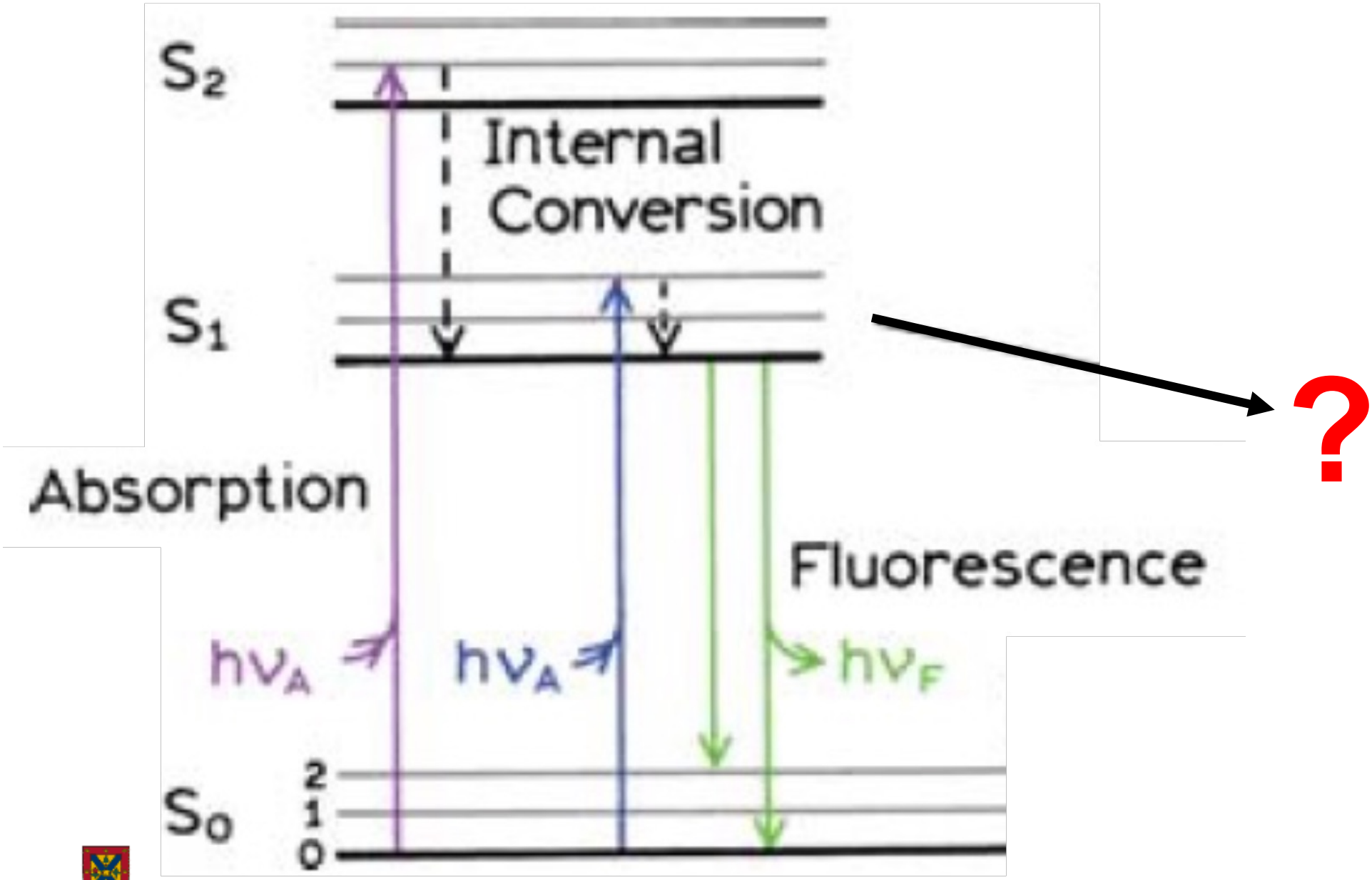
Light interacts with ordinary matter.

What does light do for us ?

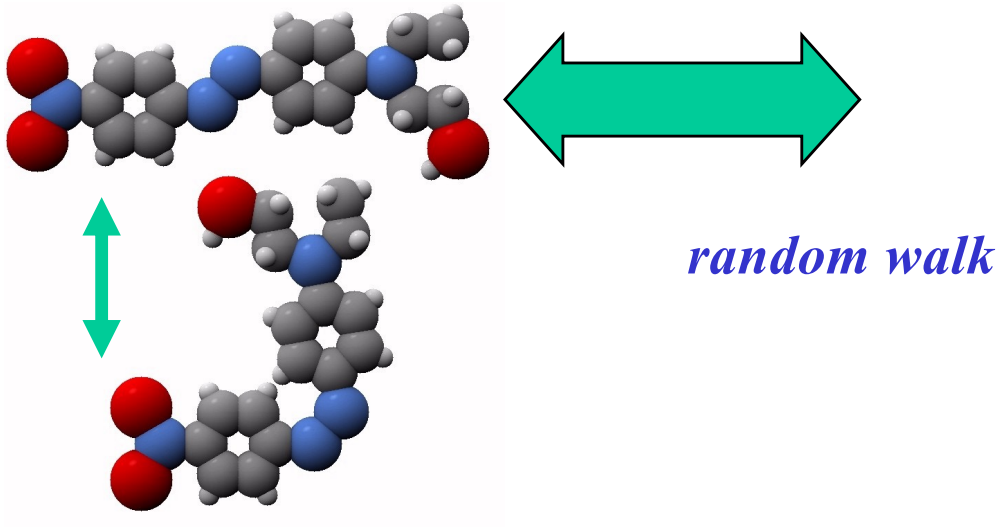
What do we get from the sun ?

Light matter interaction



Photophysics

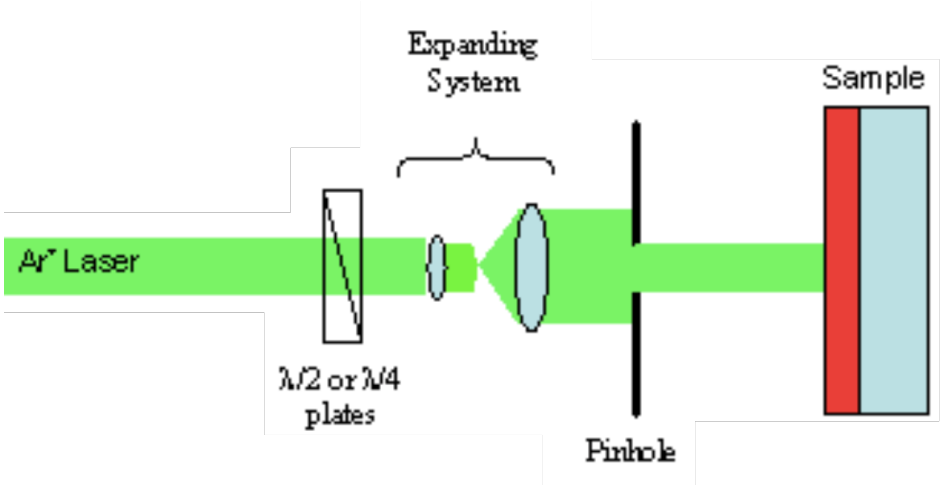
1. Movement (rotation, translation)

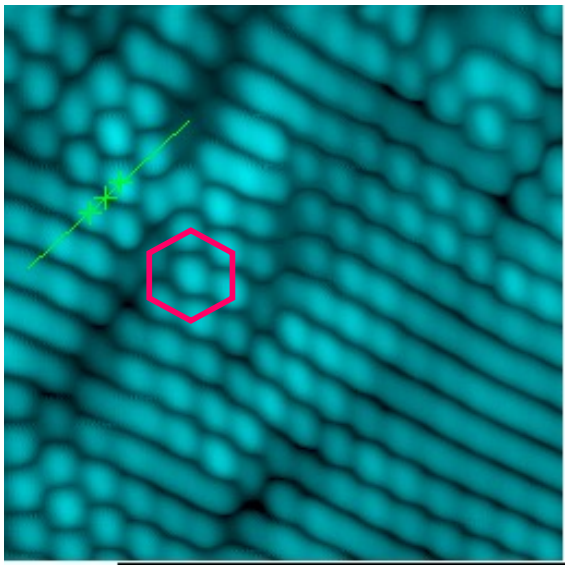


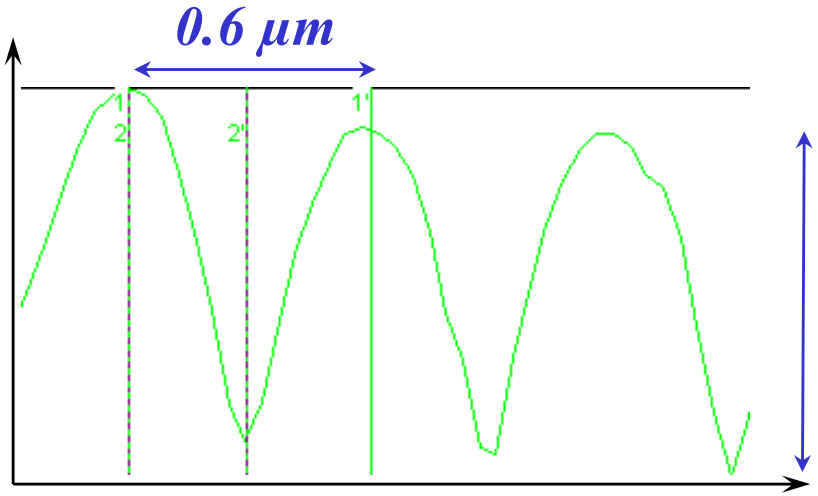
2. Photocatalysis of chemical reactions

3. Energy (heat, PV)

Single-beam self-patterning of a polymer film surface



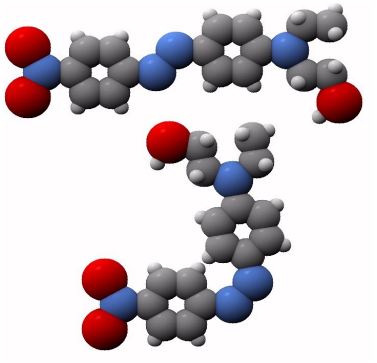


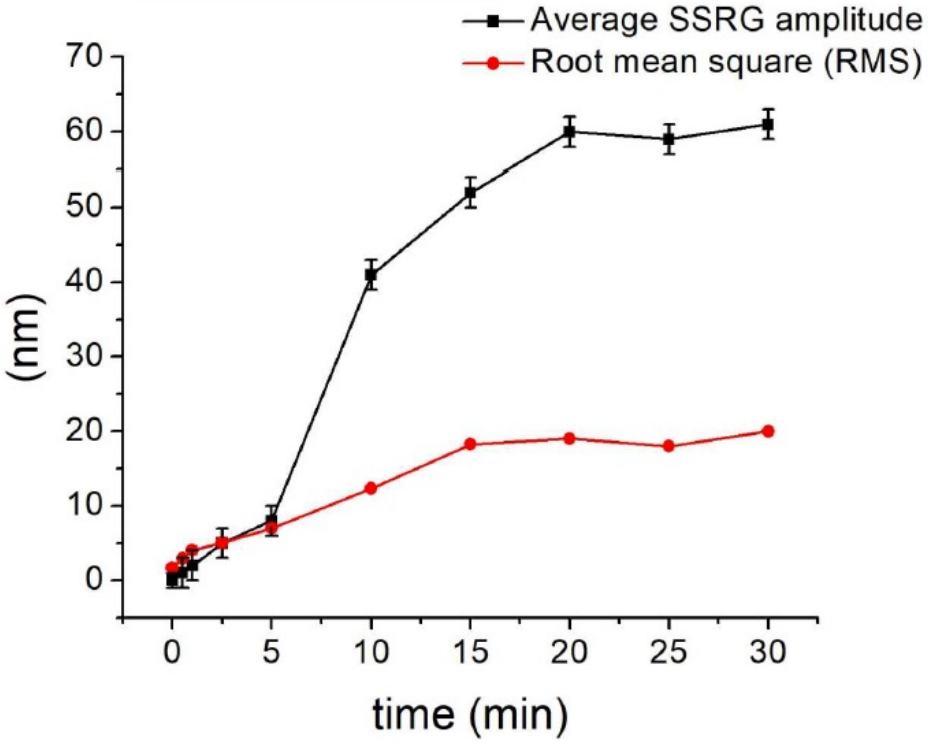


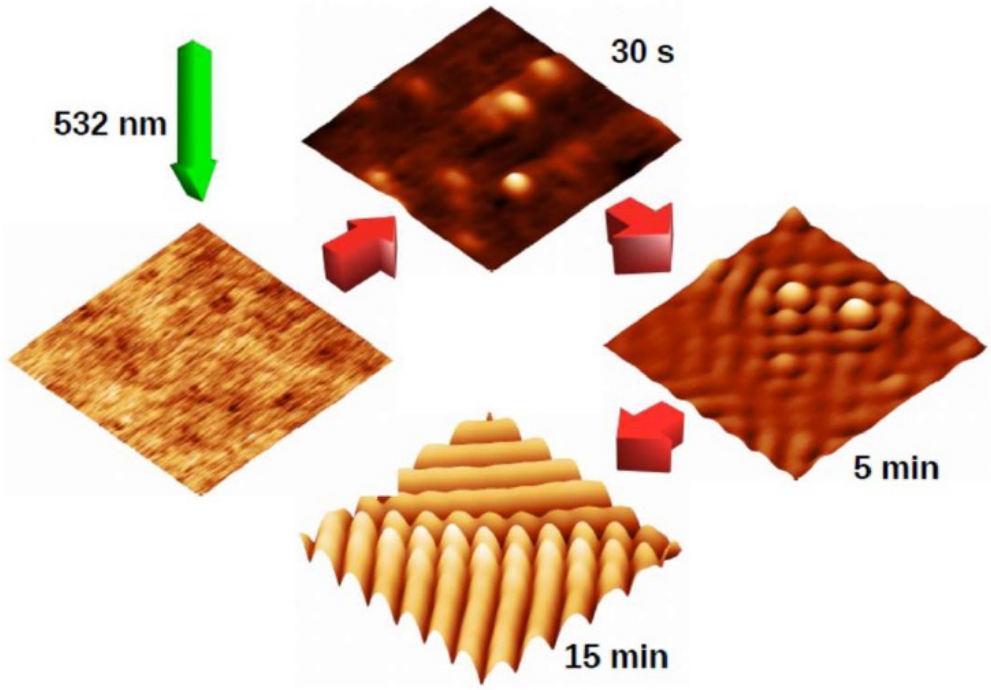
50 to 100 nm

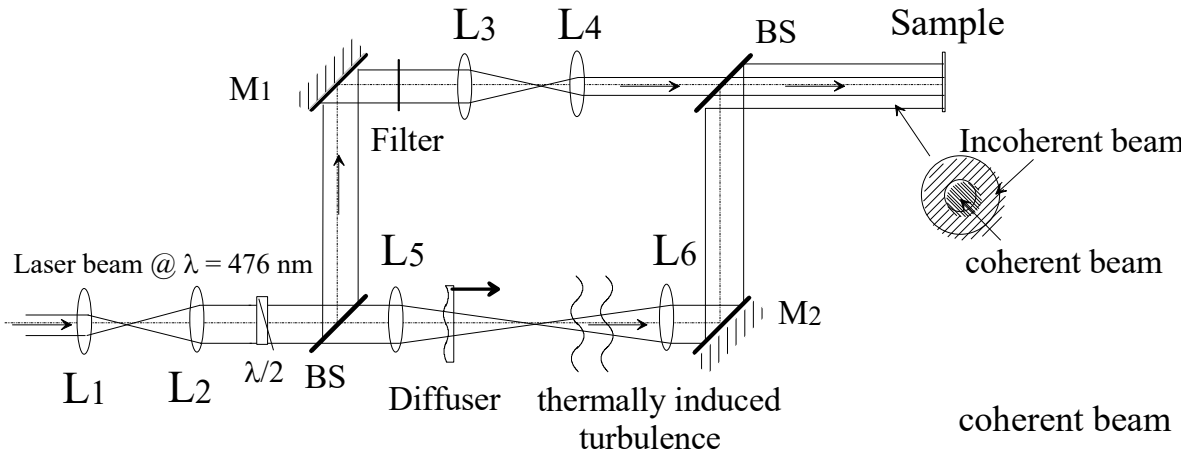
C. Hubert, Adv. Mater. 2002

Nucleation and growth of self-diffraction gratings

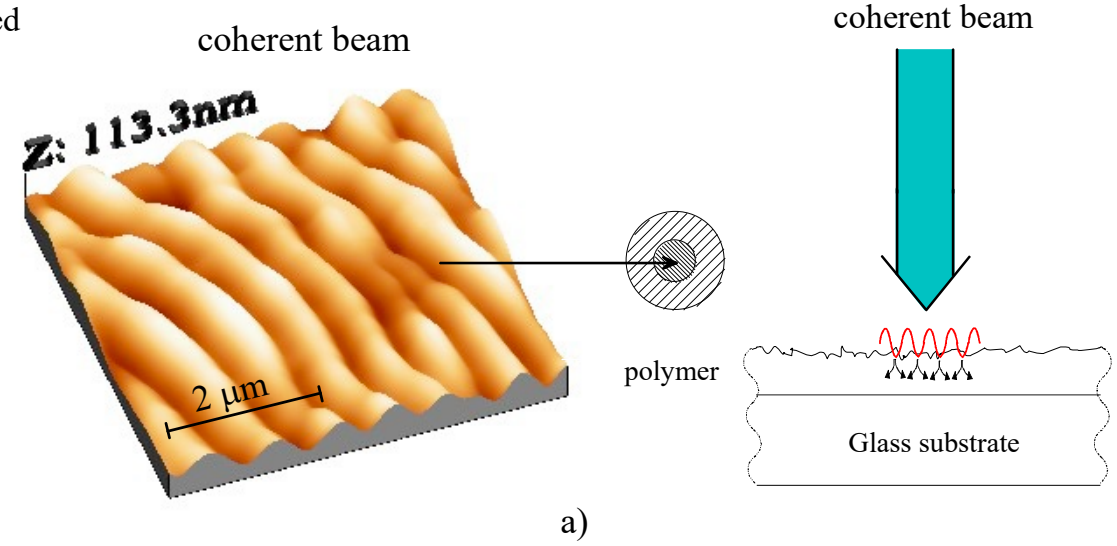




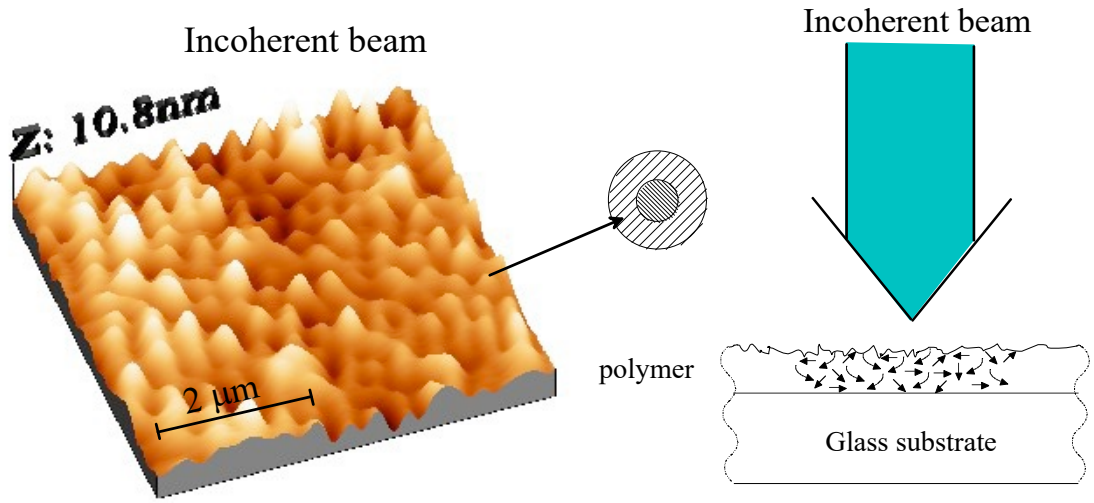




Decoupling of energy (motion) and information (structure)

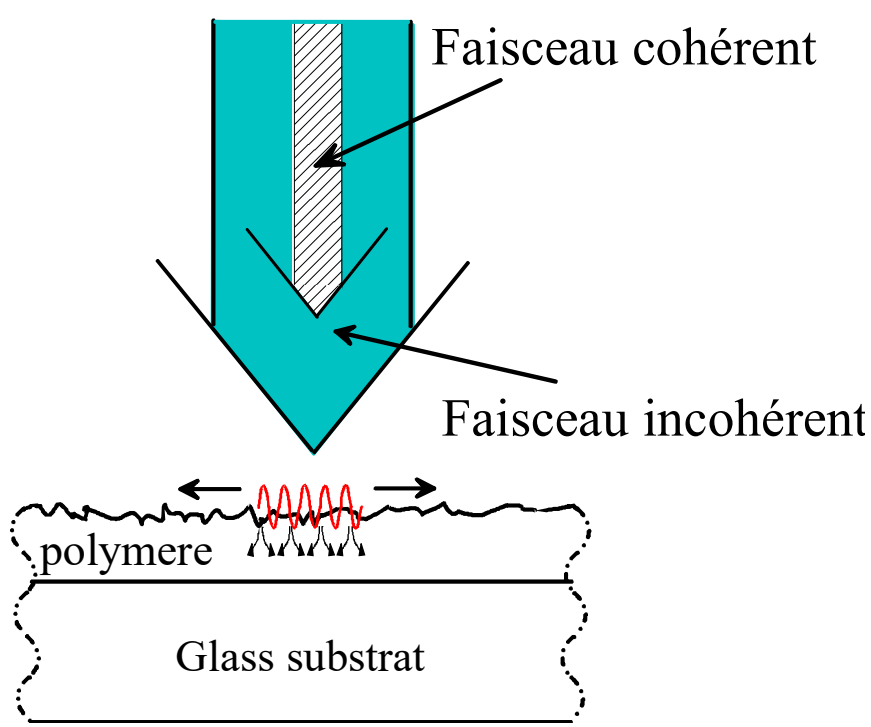


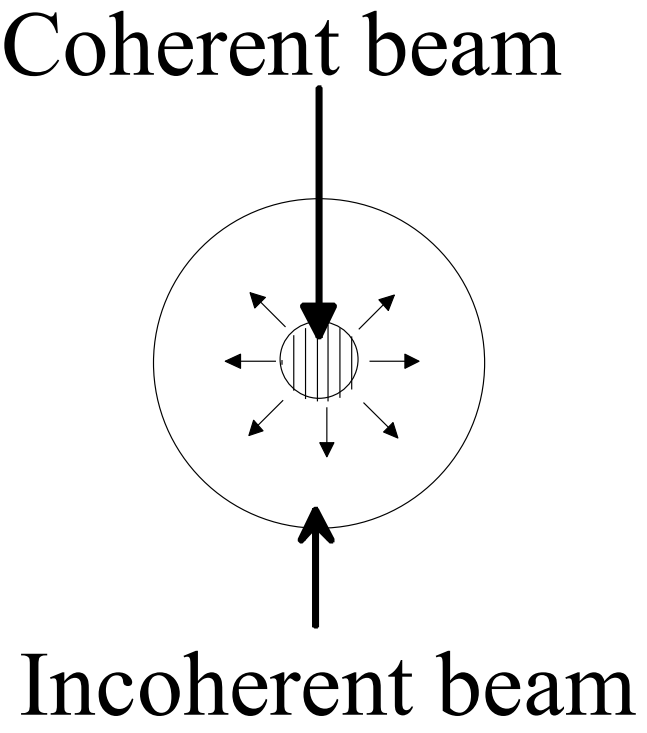
a)

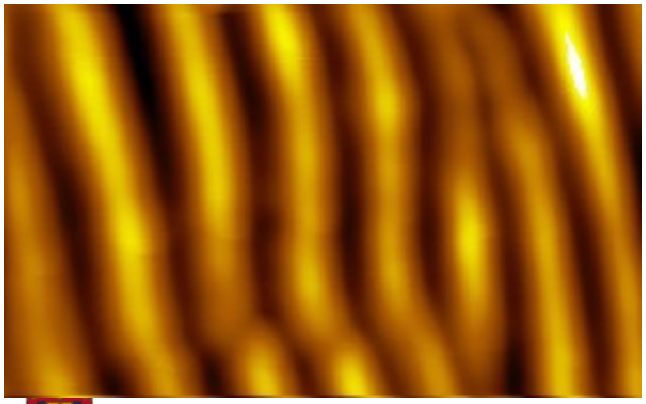


b)

Information transmitted to « incoherent » regions

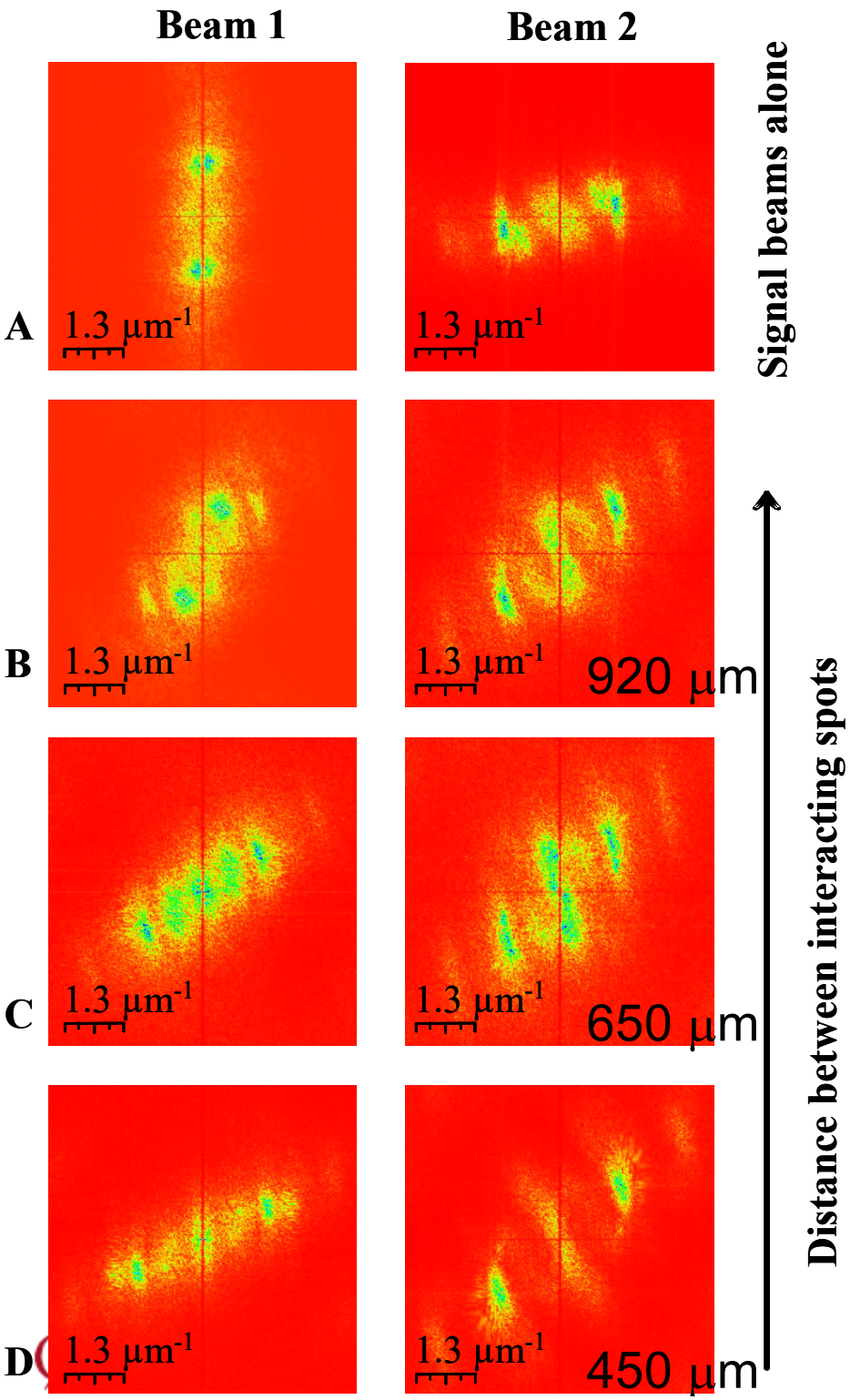




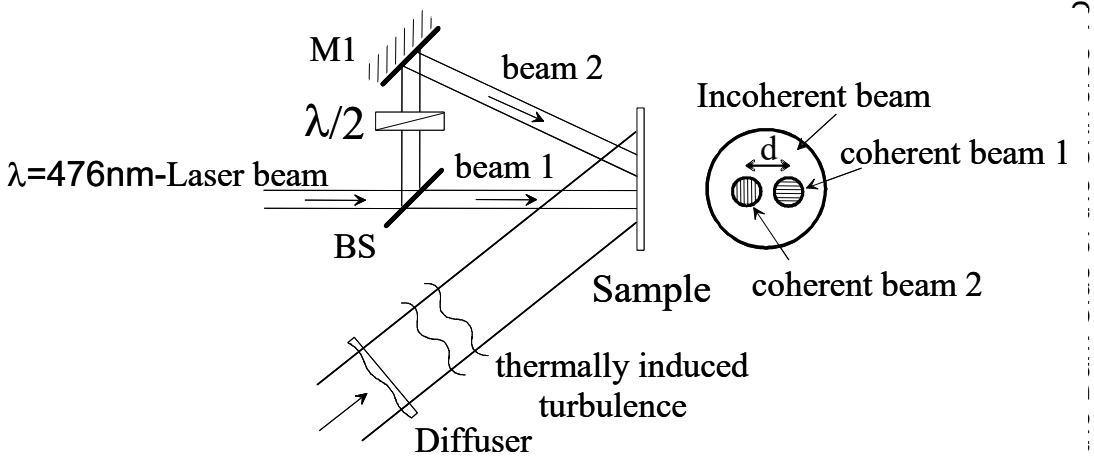


Molecules communicate
information about the grating
to their neighborhood*.
(explained by coupled mode theory**)
Same happens under white light excitation!

*Opt Letters 30, 3177 (2005); **J. Phys. B (2009)



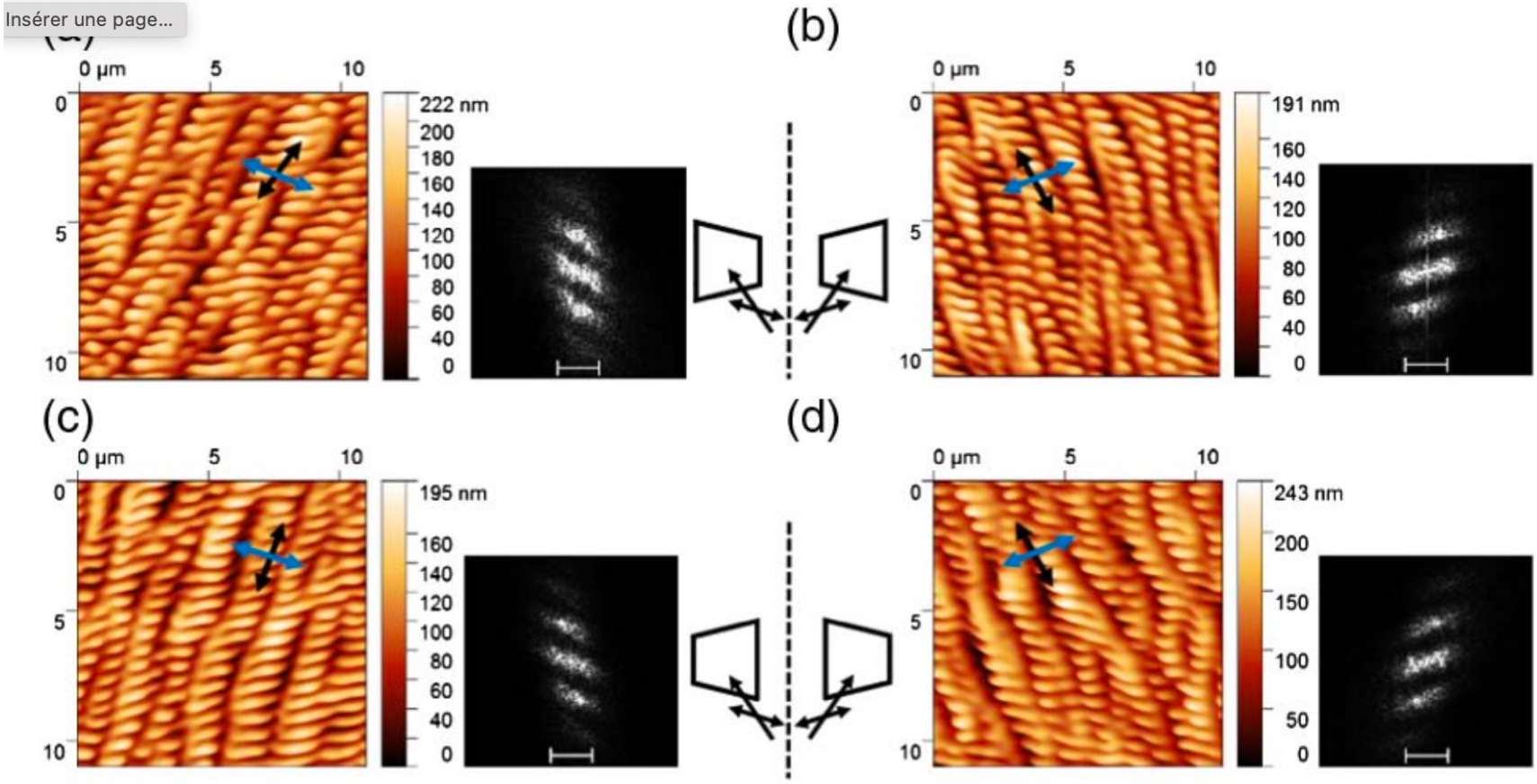
Non-local communication through scattered amplitudes

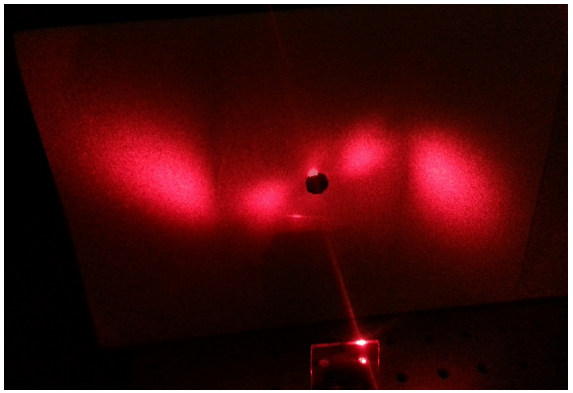


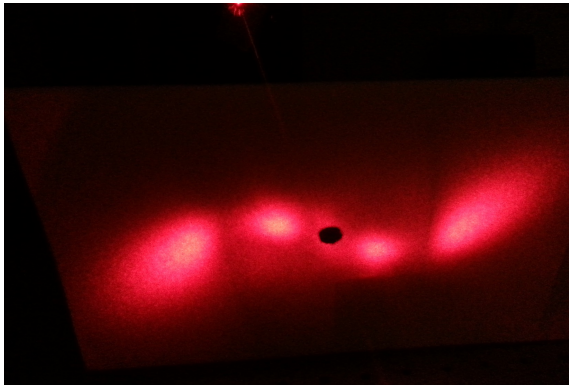
Opt. Express (2005)

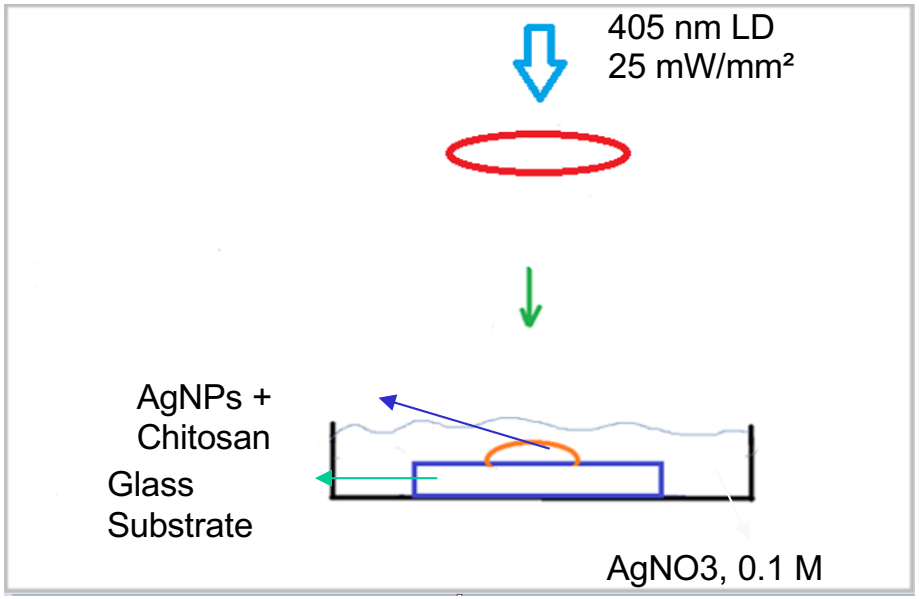
Leila Mazaheri, Opt Lett (2017)

Induction of Chirality from a linear polarization

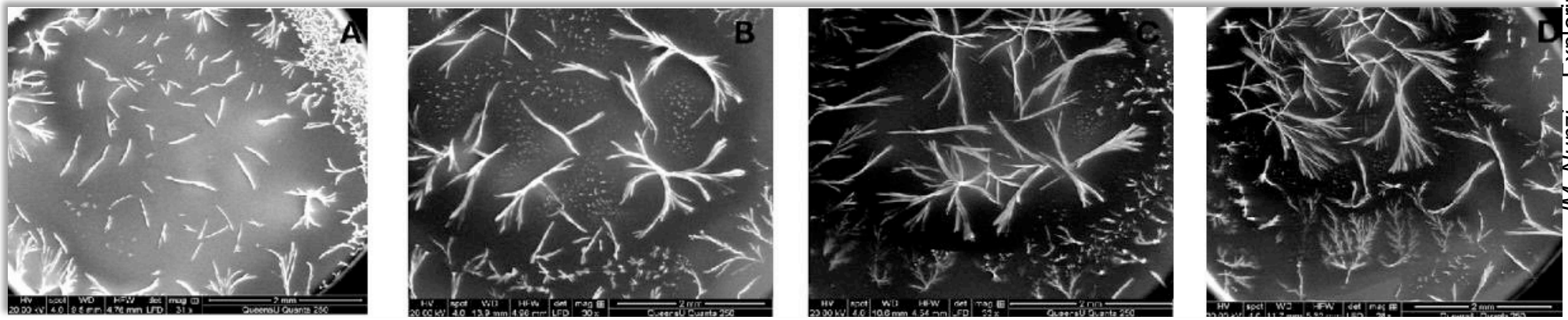








2) Photocatalysis

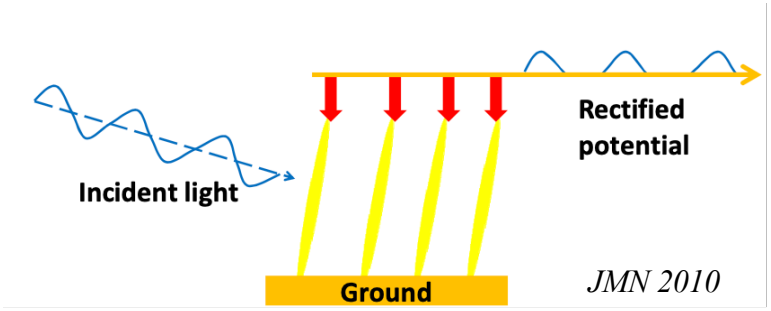


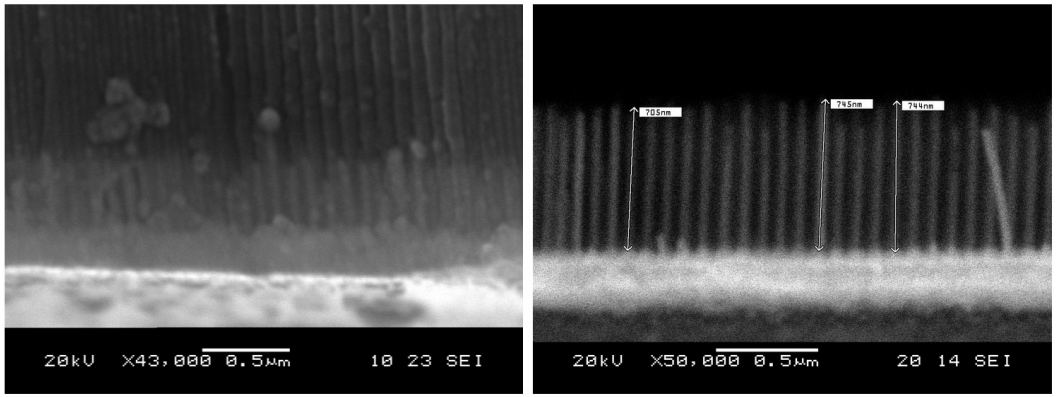
0 s 10 s 18 s 26 s

exposure time

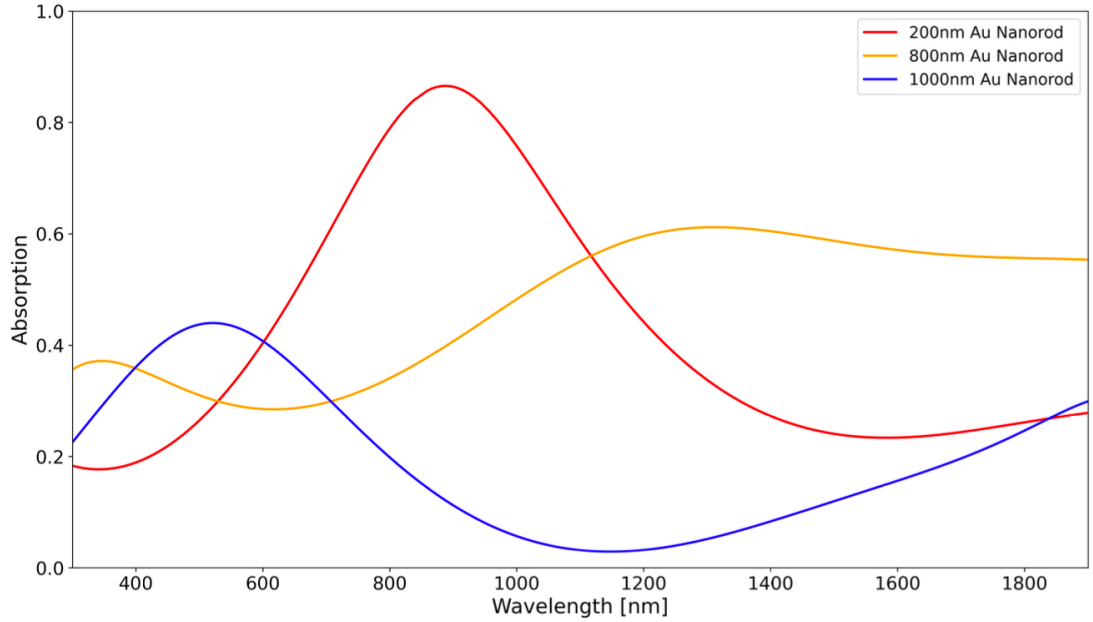
Mehrnoosh Paziresh, in progress

3) Optical antenna photodetectors

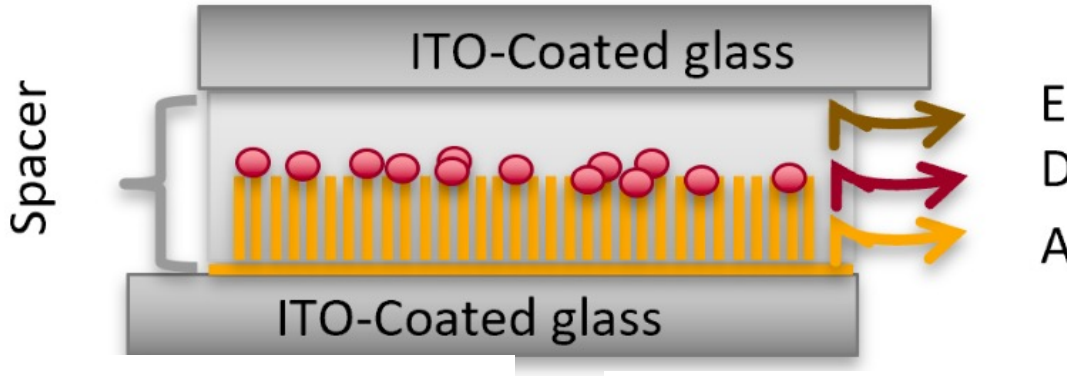


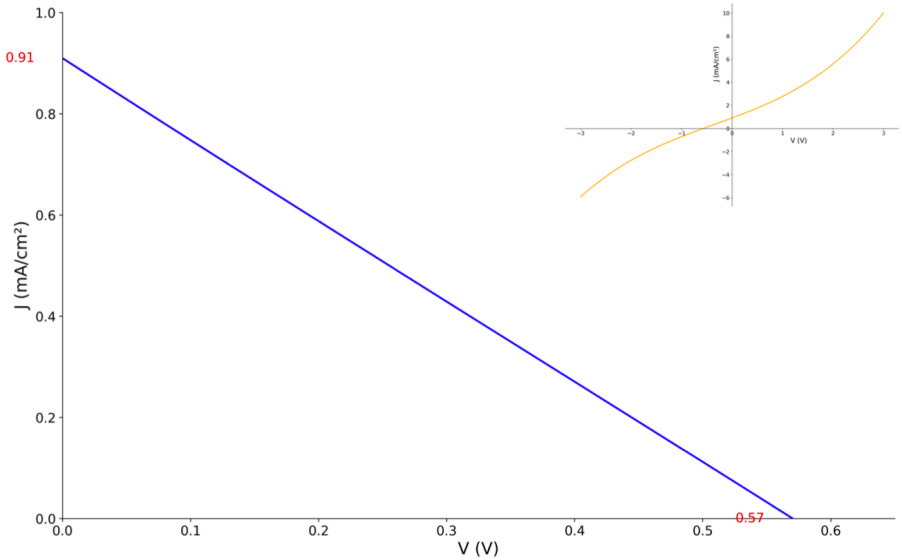


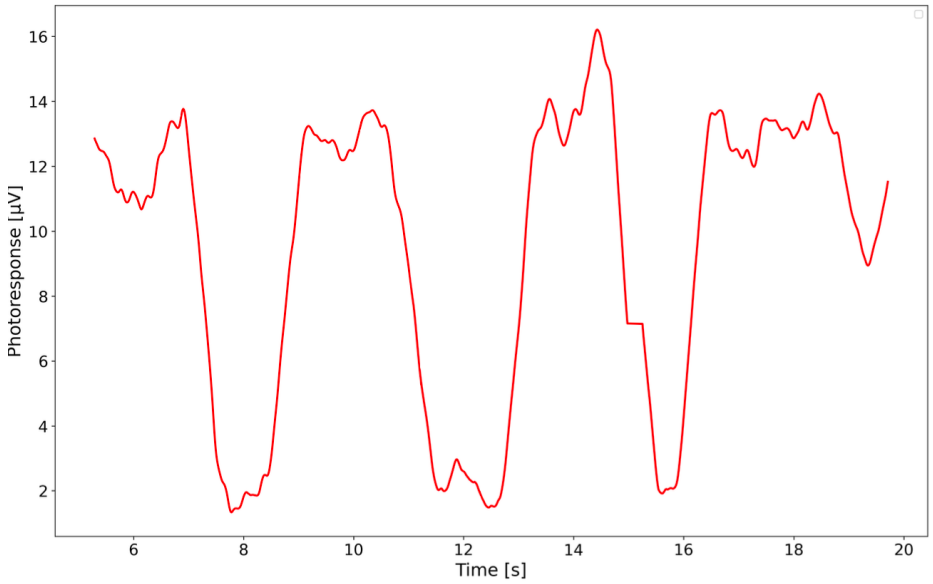
(a) Short ($\approx 200nm$) **(b)** 700-800 nm



Band gap less solar cells*
Plasmonic Hot-electron emission Photodetectors**







Rana Poushimin, PhD thesis (2023)
*** Somayeh Mirzaee, ACS AMI (2018)*

Thanks to NSERC, CFI, CRC, FCRF

Photonics - self-assembling – sustainability

- Nanostructured sensors, detectors & solar-cells
- Parallel nonlinear optical processing (‘neuro-computing’)
- Light-emitting devices (OLEDs, lasers, solar concentrators)

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