UMONS
Université de Mons

Photonic modeling of thin-film solar cells

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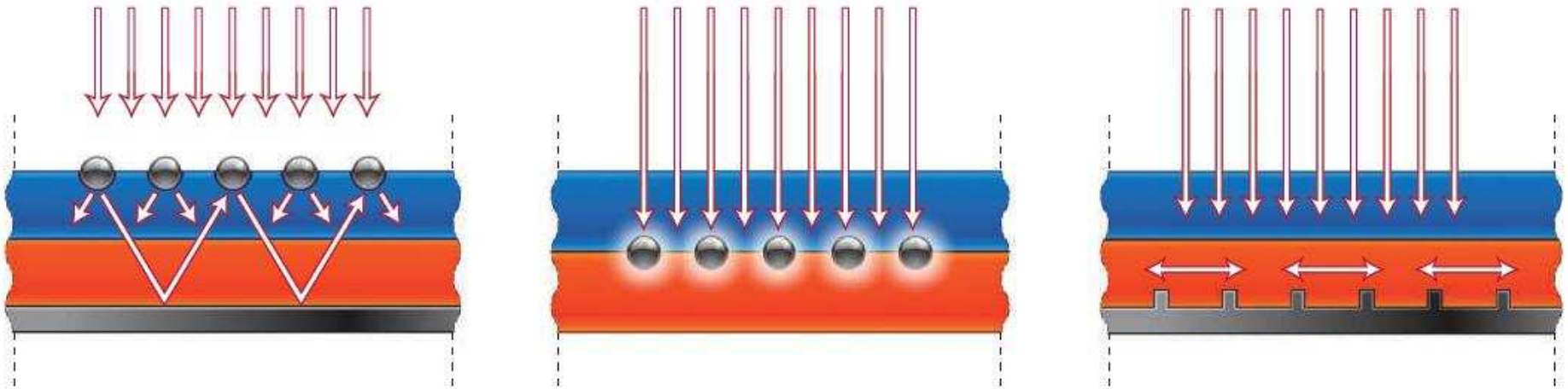
Challenge: absorb as much as possible…
in a layer as thin as possible

Metallic and dielectric structures

(Sub) λ-scale devices



Atwater, Polman, Nature Materials, 2010.

Expertise: Maxwell equations

Simulations

Several tools available:

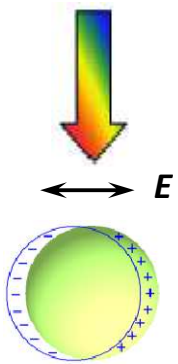
- FDTD (MEEP)
- Eigenmode expansion (CAMFR)
- FEM (COMSOL)

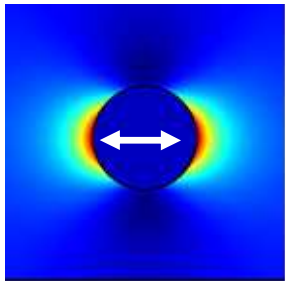
(Sub)-λ photonics

Plasmonics

Photonic crystals

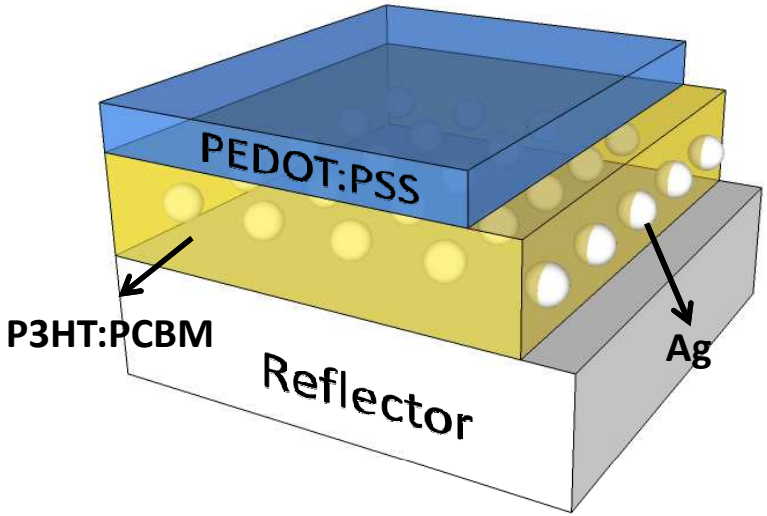
Particles

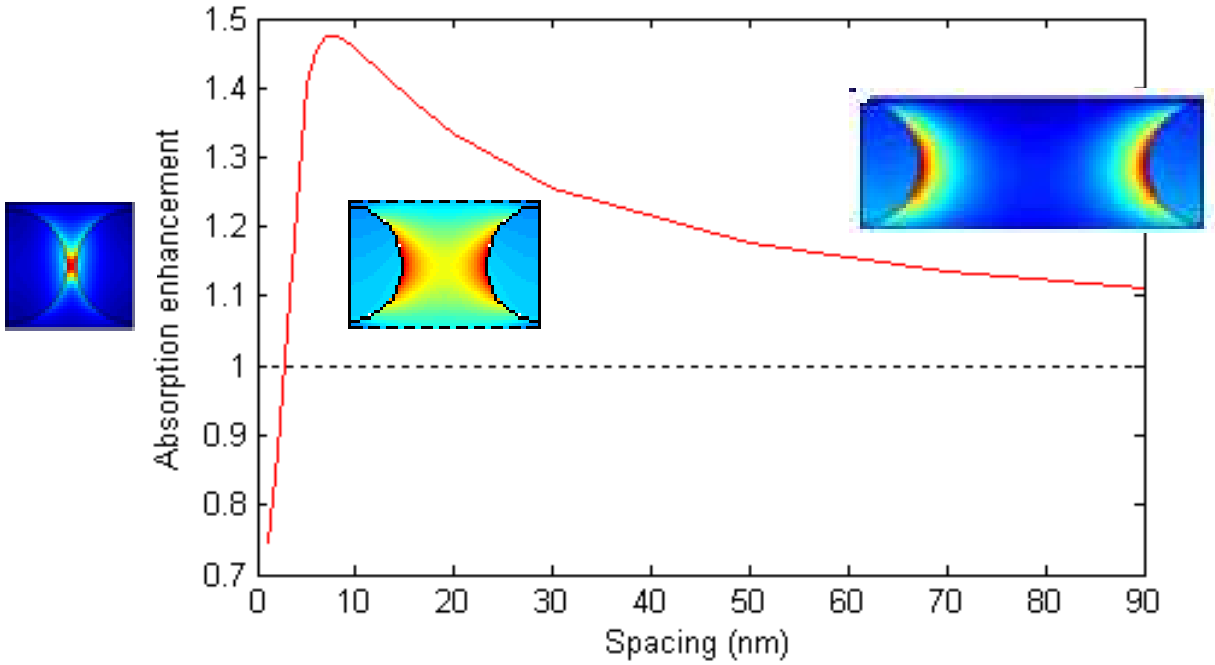




Localized plasmons

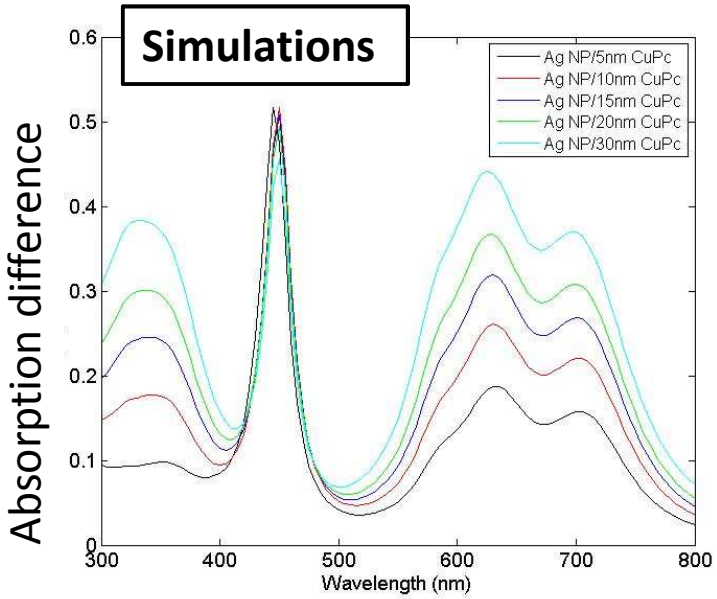
Example: near-field scattering

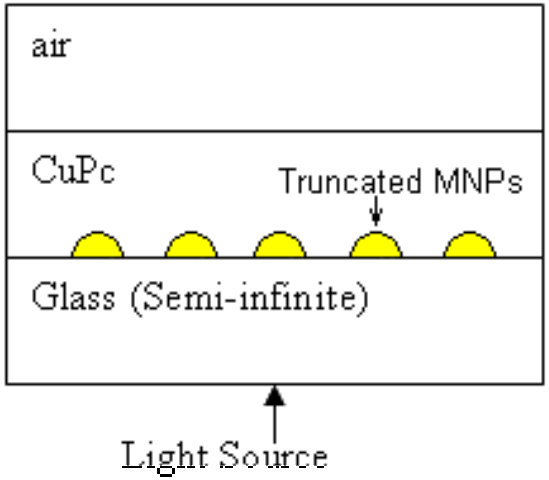


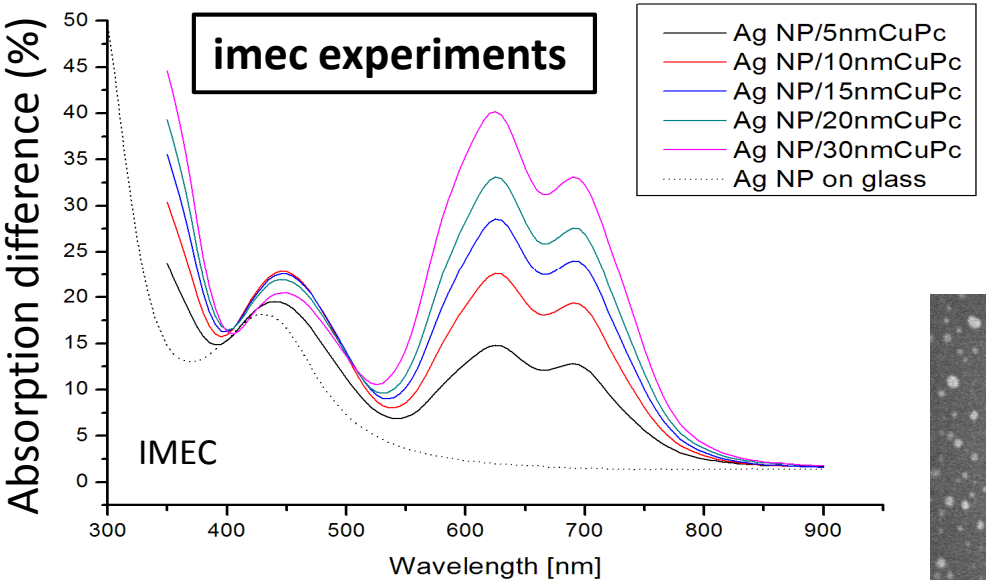


Shen *et al*, Opt. Exp. 2009

Example: disks on surface

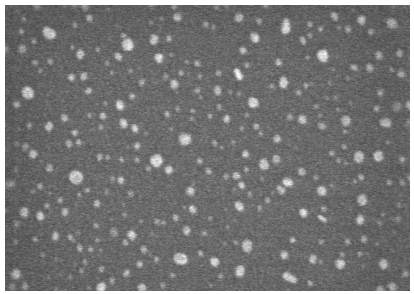






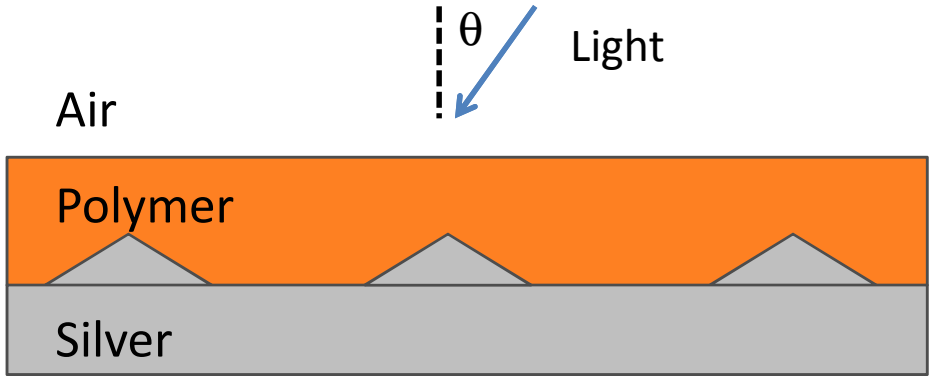
Very similar spectra

Simulations provide more details

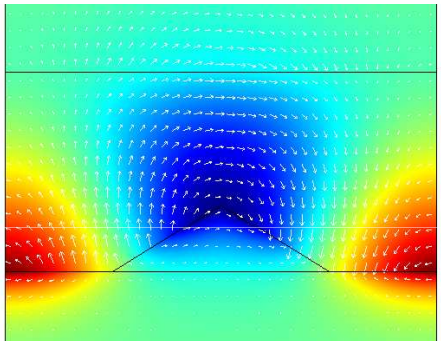


Example: back-grating

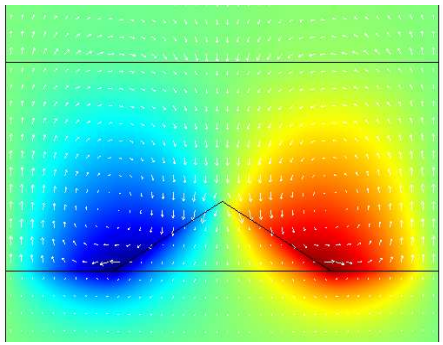
Efficient scattering

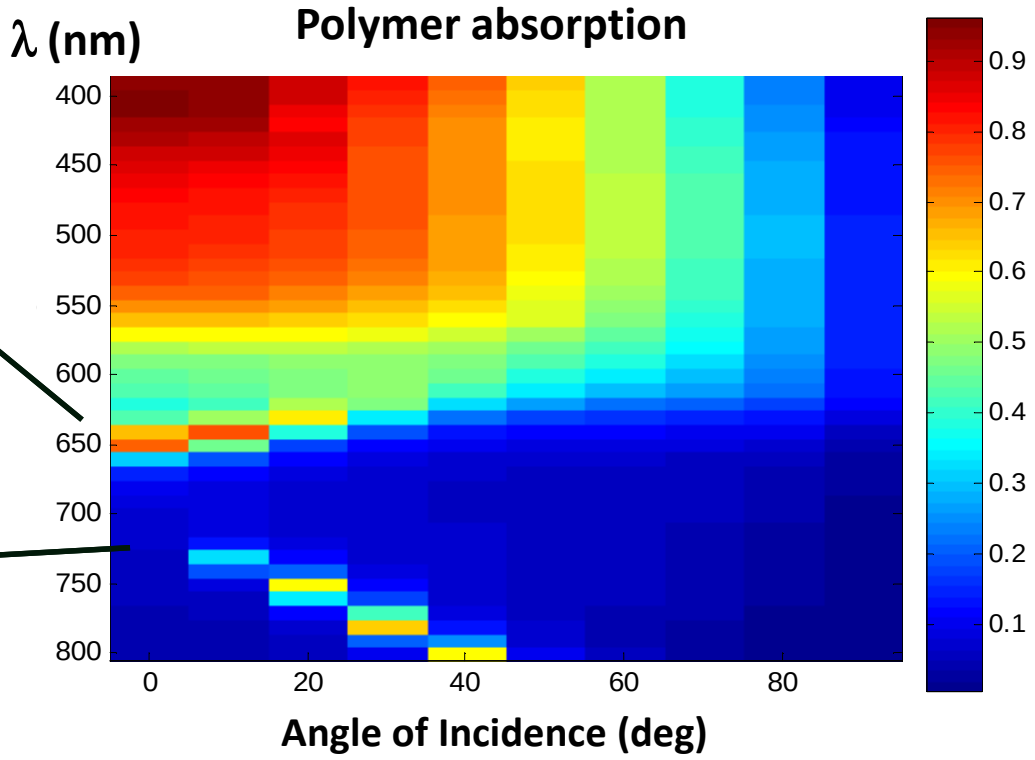


Bright mode



Dark mode

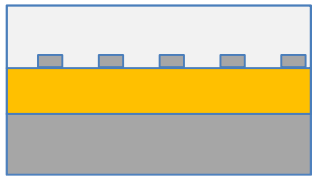
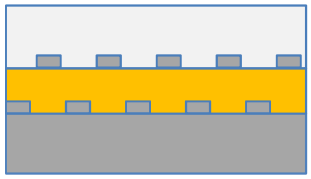
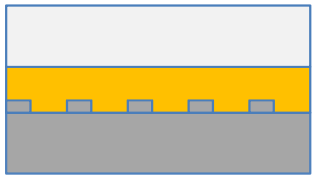




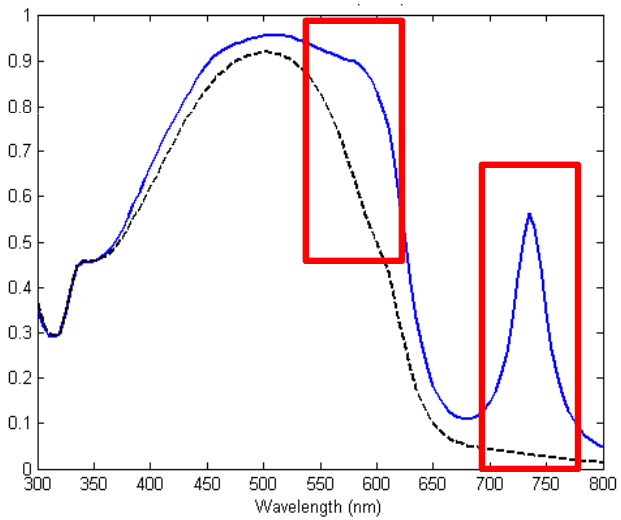
Abass *et al*, Journ. Appl. Phys. 2011

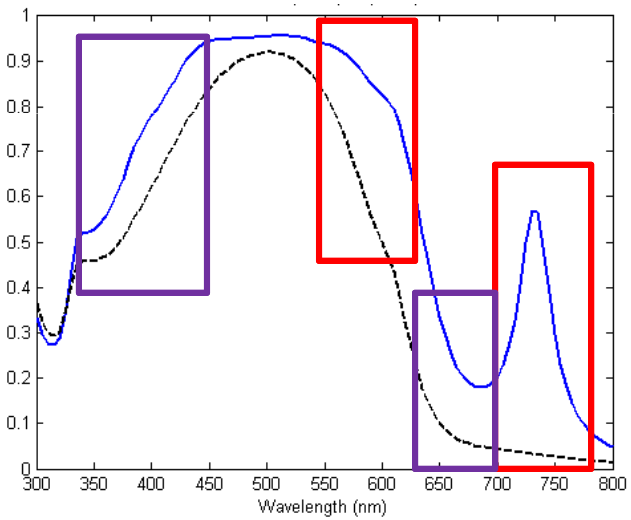
Example: Grating at front and back

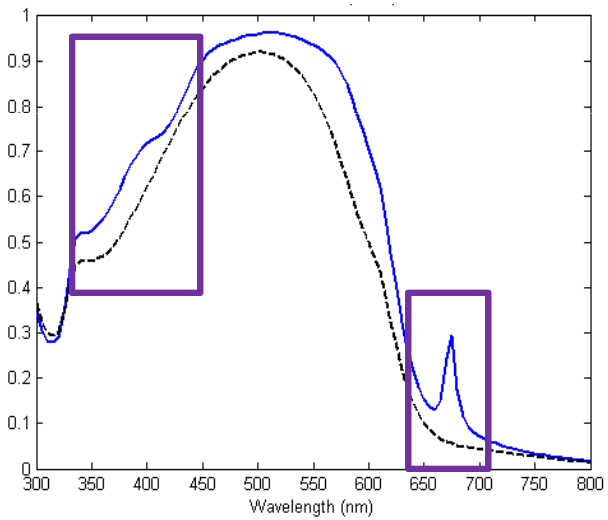
Superposed enhancements

Abs.







⇒ Integrated absorption enhanced from 48% to 65%

Shen *et al.*, Opt. Exp., 2011

Conclusions

Photonic expertise

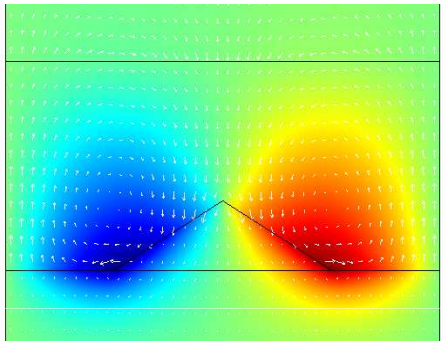
- Simulations/understanding Maxwell
- (Sub)-λ phenomena

Applications

- PV, sensing, LED…

Collaborations

- Experimental groups



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