

Journées Annuelles PEPR LUMA

Plasmon-Activated Molecular Catalysis Applied to Orthogonal Relay Catalysis

PACTE, projet de l'axe Photochimie & Matériaux

Clémence Queffélec

CEISAM, Nantes

*“There are two ways of spreading light: to be
the candle or the mirror that reflects it”*

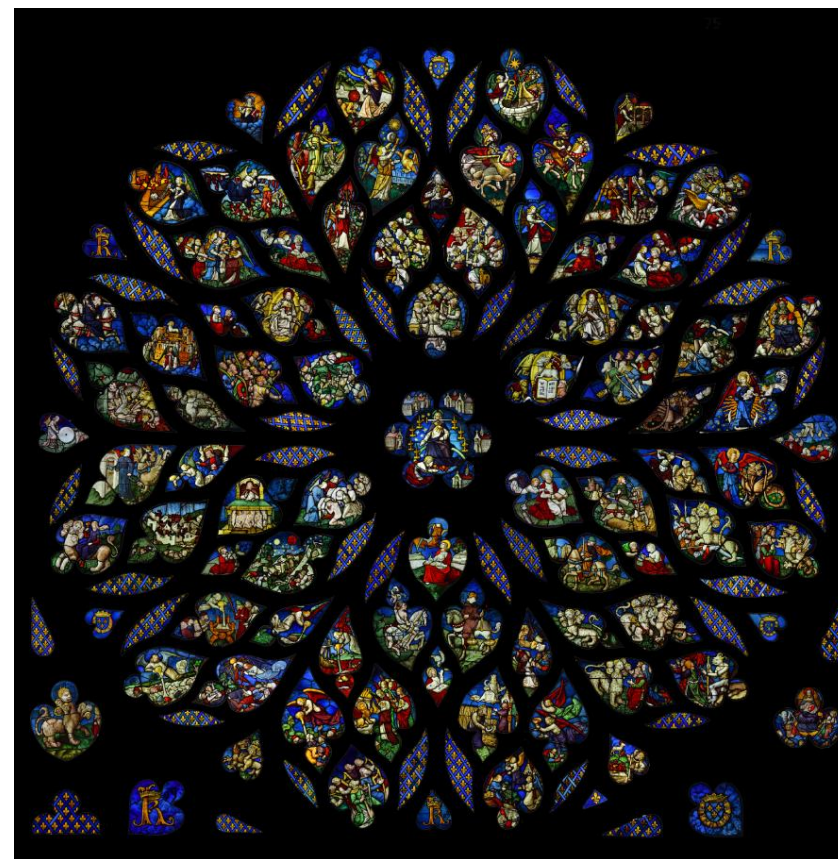
(Edith Wharton)

*“Light is the simplest thing known,
yet the most complex”*

(Johann Wolfgang von Goethe)

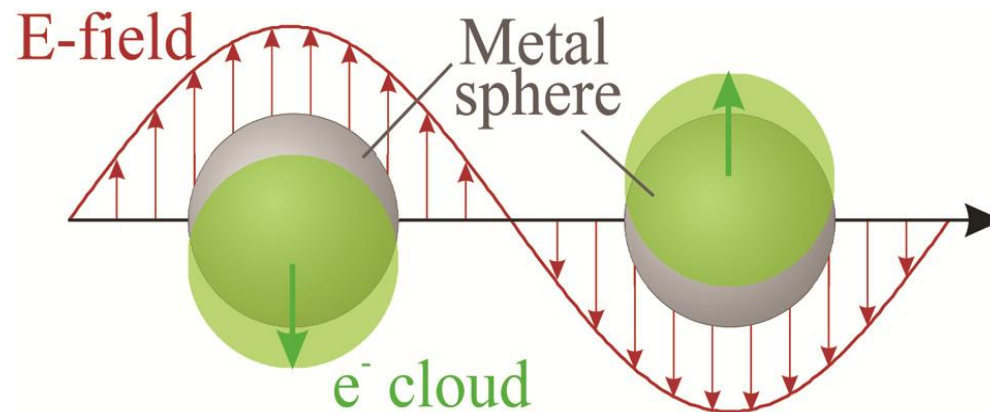


Lycurgus cup (silver and gold
NPs), IVth century



Stained glass window, Paris

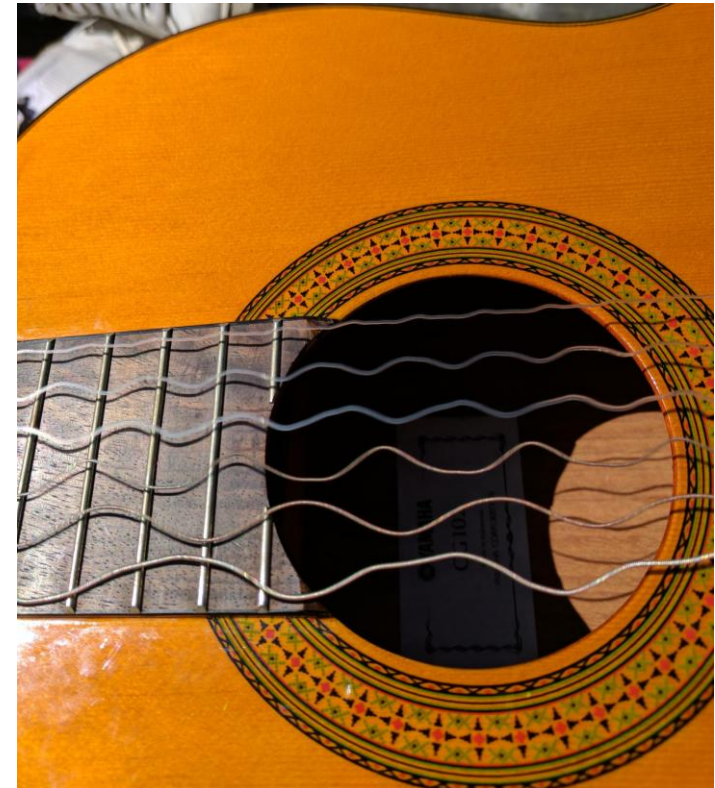
Localized surface plasmon resonance



Schematic of plasmon oscillation for a sphere, showing the displacement of the conduction electron charge cloud relative to the nuclei.

J. Phys. Chem. B. 2002, 107, 668-677 (doi:10.1021/jp026731y)

Plasmon and localized surface plasmon resonance



Plasmon and localized surface plasmon resonance

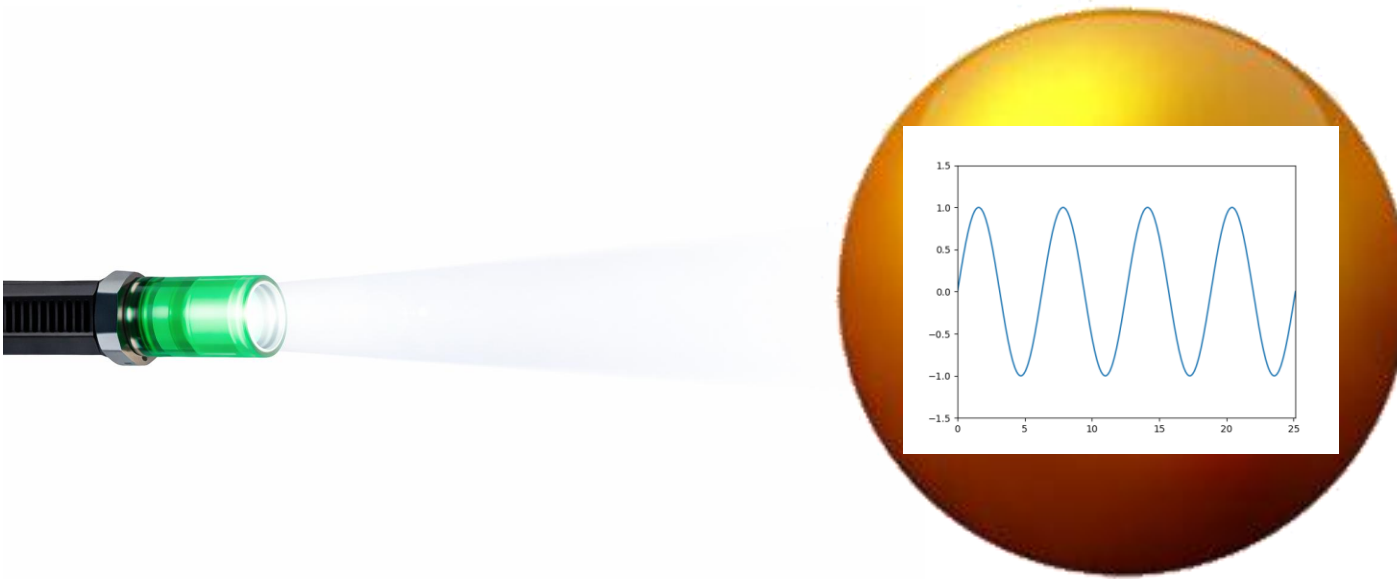


Plasmon and localized surface plasmon resonance



Plasmon and localized surface plasmon resonance

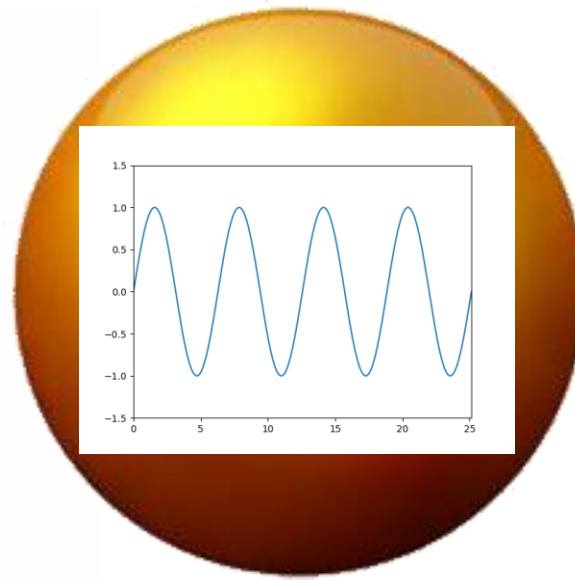
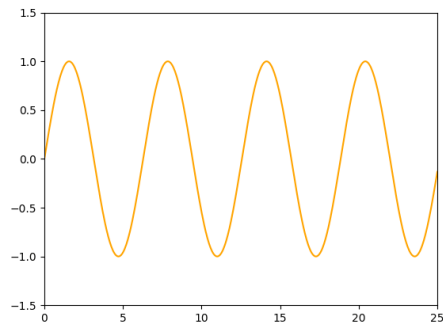
Plasmon: collective oscillation of the free electrons inside a metal



Danse of the electrons !

Plasmon and localized surface plasmon resonance

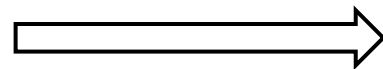
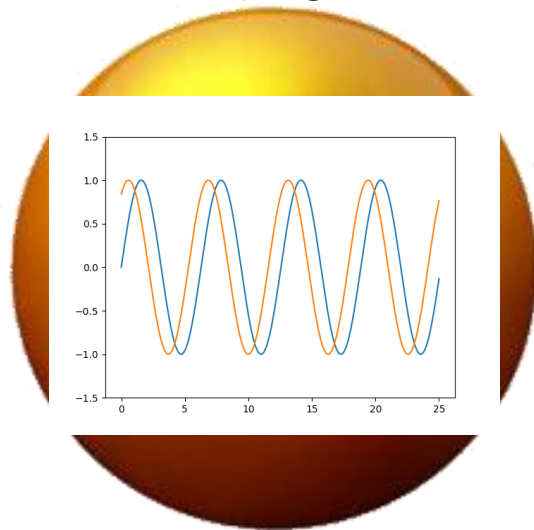
Plasmon: collective oscillation of the free electrons inside a metal



Plasmon and localized surface plasmon resonance

Plasmon: collective oscillation of the free electrons inside a metal

Tuning the wavelength/frequency
of the light



Localized surface
plasmon resonance
(LSPR)

RESONANCE PHENOMENON

Plasmon and localized surface plasmon resonance

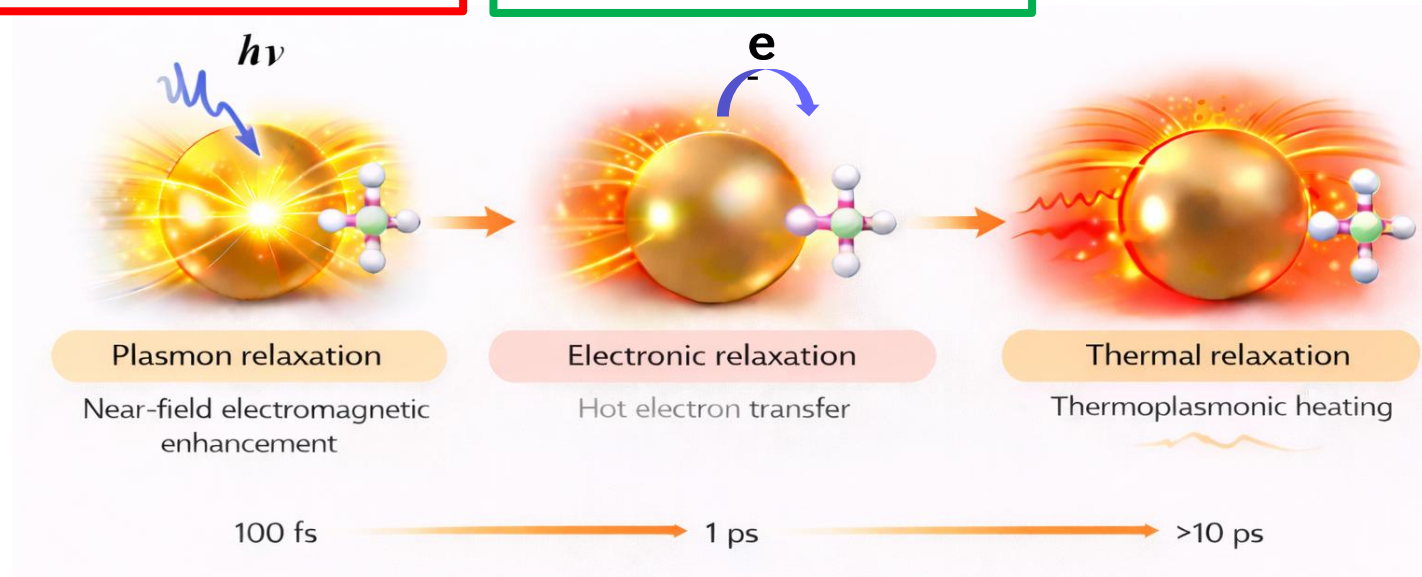
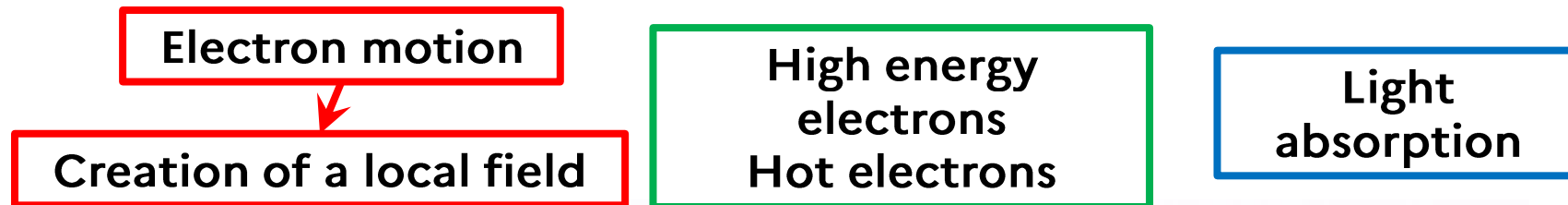




Plasmon and localized surface plasmon resonance



Plasmonic (LSPR) processes



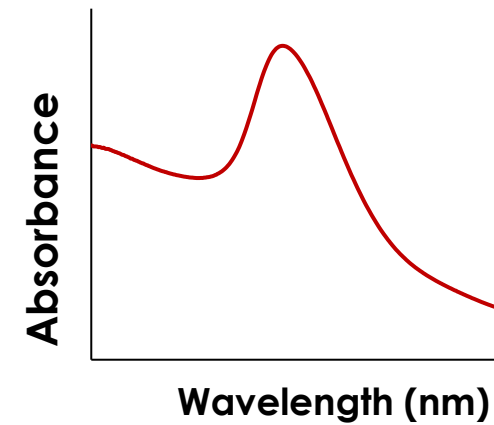
Chem. Rev. 2024, 124 (14),
8597-8619

Image generated by AI

Plasmonic (LSPR) processes



Plasmonic absorption band



Localized surface plasmon resonance



nanosphere



nanocube



nanorod



nanotriangle



nanodisk



nanoring

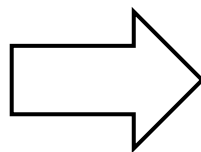
Visible spectrum

Infrared spectrum

500
nm

760
nm

Nature, size and shape



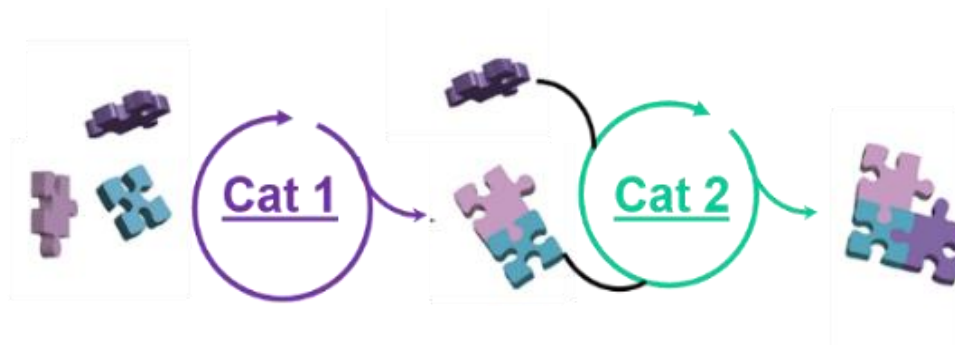
Various absorption features
and properties

PACTE project

**Plasmon activated molecular catalysis:
application to orthogonal relay
catalysis**

PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis

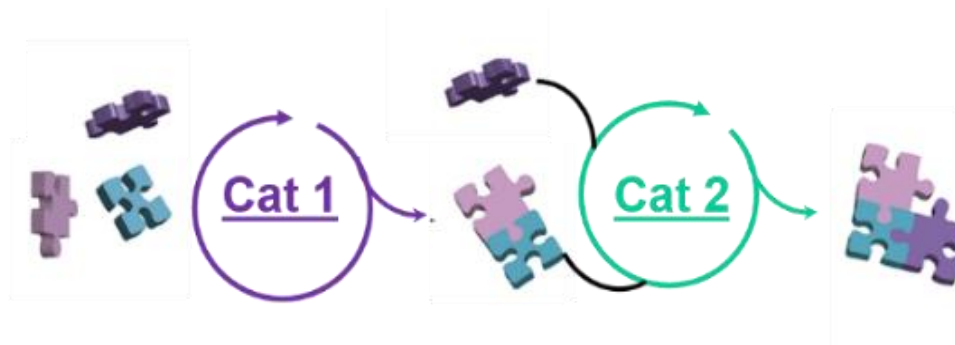


Orthogonal = because both catalysts are present since the beginning but each one catalyzes only one reaction

Relay = because there are non-interfering catalytic cycles to execute a sequence of independent reactions.

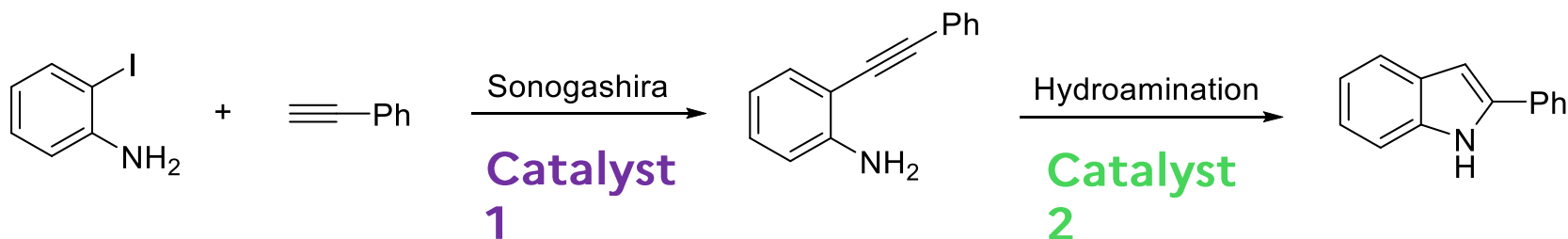
PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis



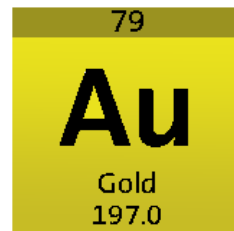
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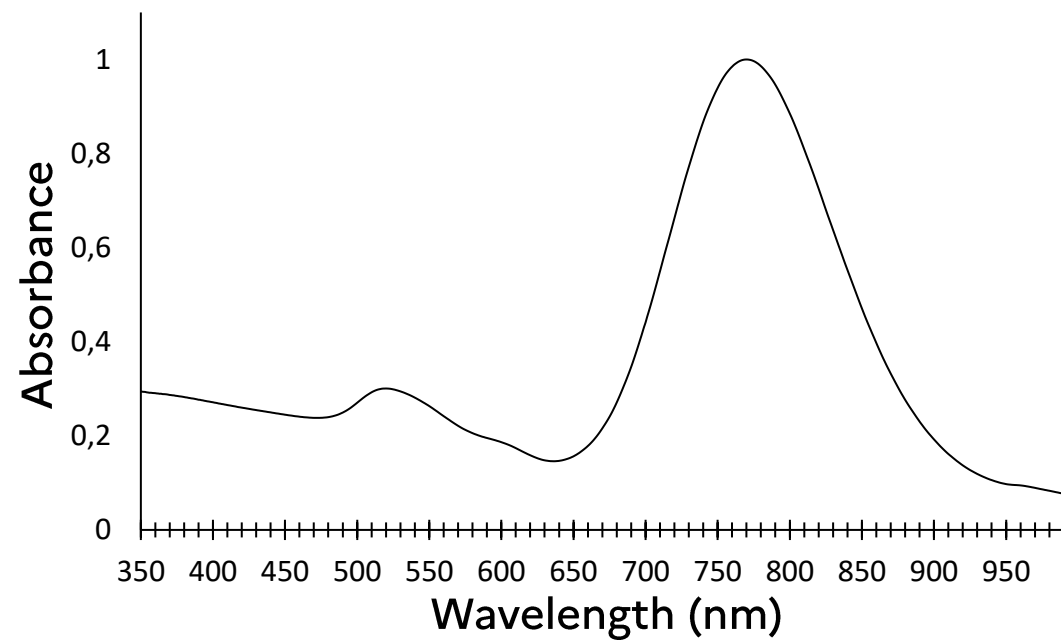




Plasmonic nanostructures



- ✓ More complex anisotropic structure: has a longitudinal axis and a transverse axis
- ✓ Two distinct modes of plasmonic resonance
- ✓ Spectral flexibility through modulation of their morphology
- ✓ Generation of hot spots at the extremities



PACTE project

Plasmon activated molecular catalysis:
application to orthogonal relay catalysis

Lithographed Au NRs

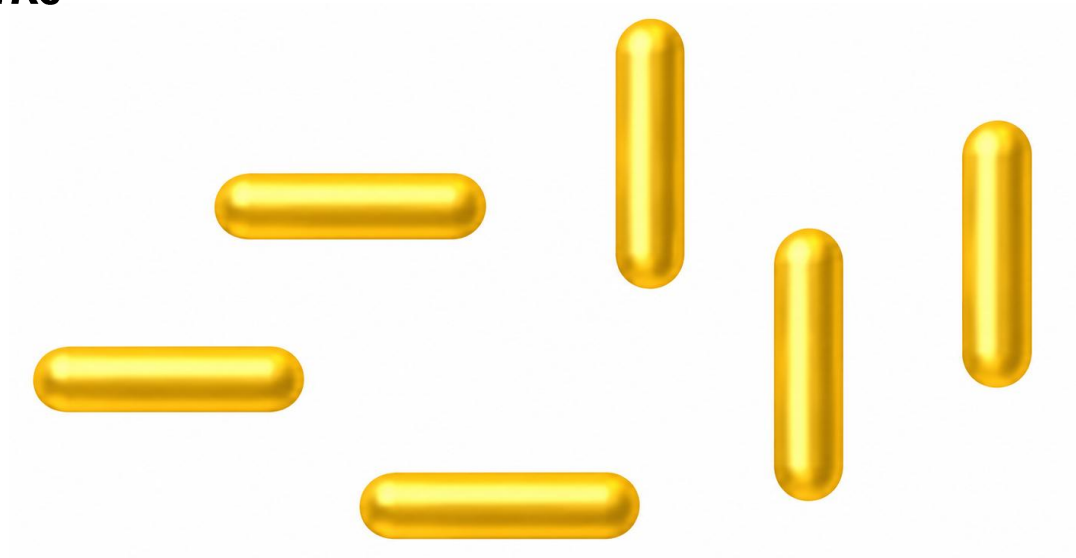
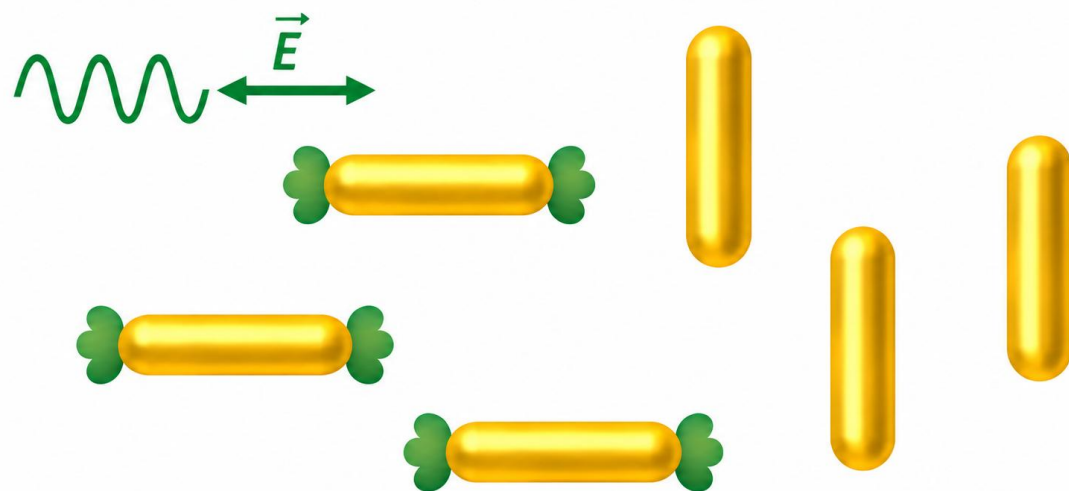


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PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis



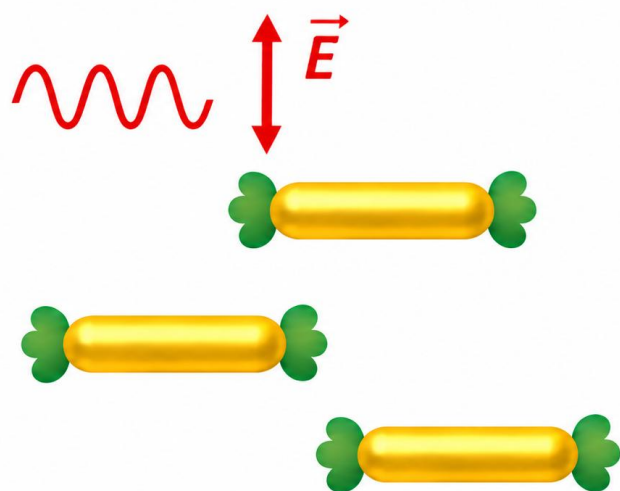
● Catalyst 1 working
for the Sonogashira
reaction

$\lambda_{\text{longitudinal}}$

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PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis



● **Catalyst 1** working
for the Sonogashira
reaction

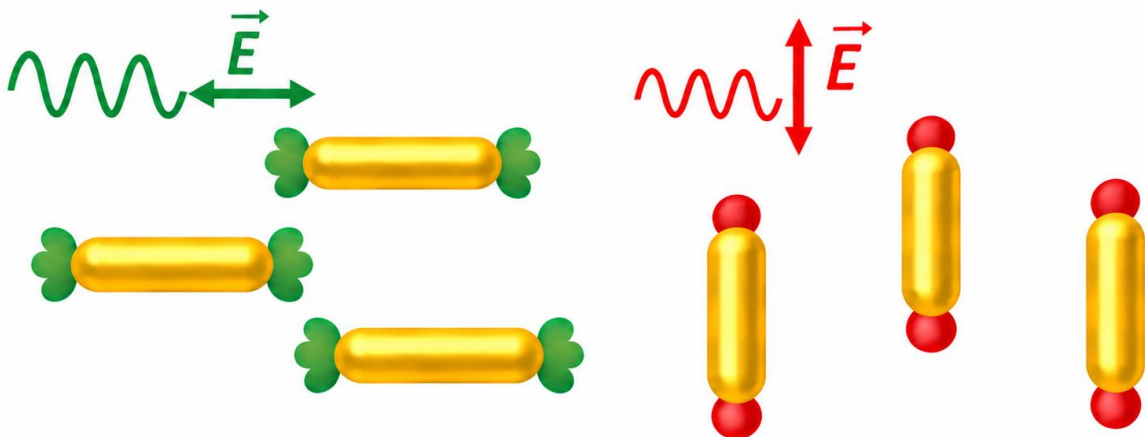
● **Catalyst 2** working for
the hydroamination
reaction

$\lambda_{\text{longitudinal}}$

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PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis



● **Catalyst 1** working for the Sonogashira reaction

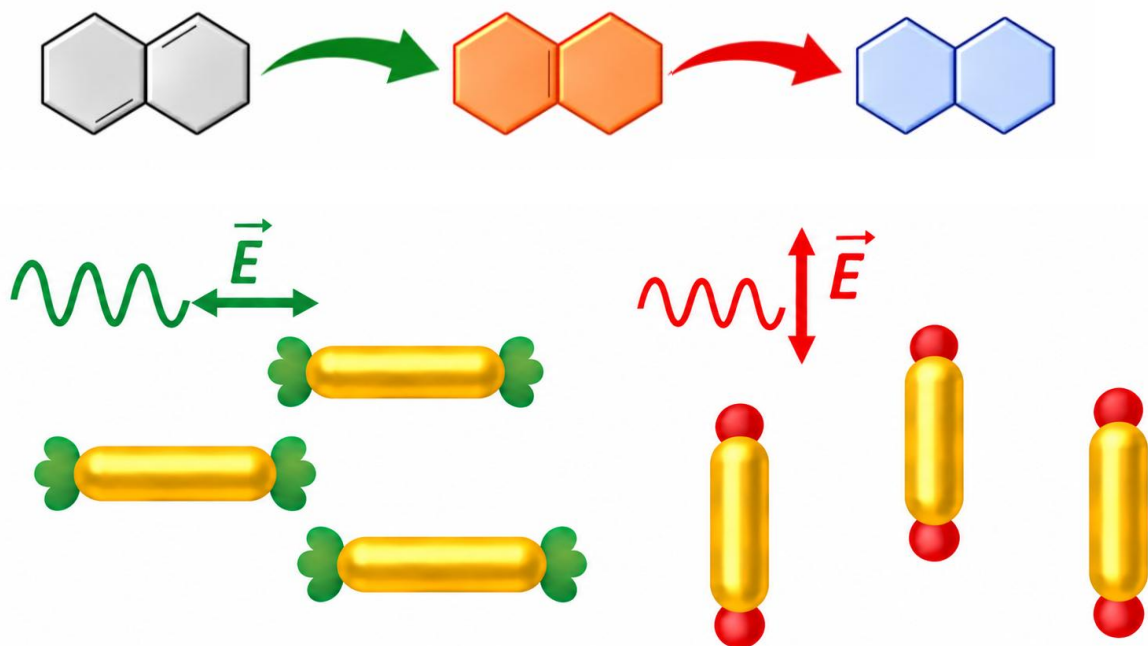
● **Catalyst 2** working for the hydroamination reaction

$\lambda_{\text{longitudinal}}$

Image generated by AI

PACTE project

Plasmon activated molecular catalysis: application to orthogonal relay catalysis



● **Catalyst 1** working for the Sonogashira reaction

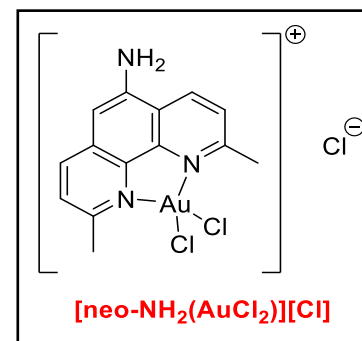
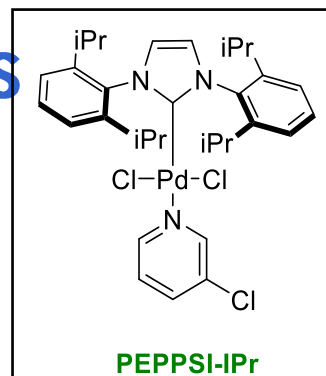
● **Catalyst 2** working for the hydroamination reaction

$\lambda_{\text{longitudinal}}$

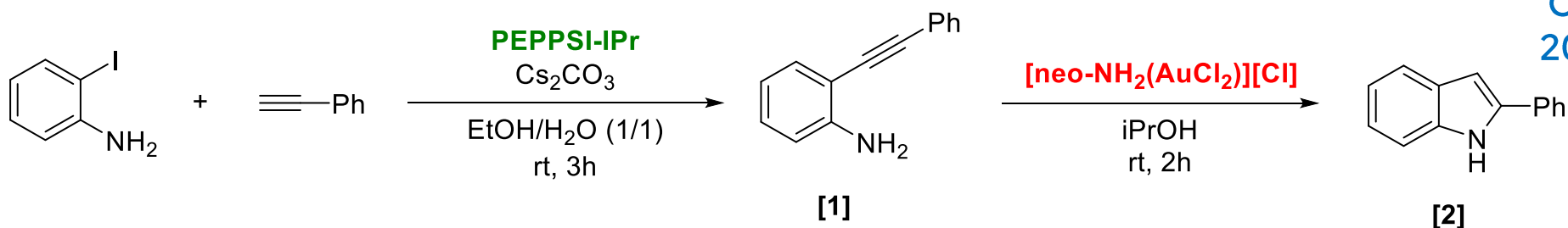
Image generated by AI



Orthogonal relay catalysis



Thèse Maxime
Cousseau
2026-2029



Catalyst	Sonogashira reaction	Hydroamination reaction
PEPPSI-iPr	50%	Traces
Neo-NH ₂ (AuCl ₂)(Cl)	Traces	99%



Perspectives

- Functionalization of the PEPSI catalyst
- Preparation of lithographed surfaces
- Grafting the different catalysts through diazonium chemistry onto Au NRs
- A lot of characterization !

