Plasmónica: Detección molecular intensificada sobre nanoestructuras metálicas

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Plasmónica: Interacción Luz-Metal

Aprovechamiento de la interacción luz-materia para:

Identificación y cuantificación de materiales

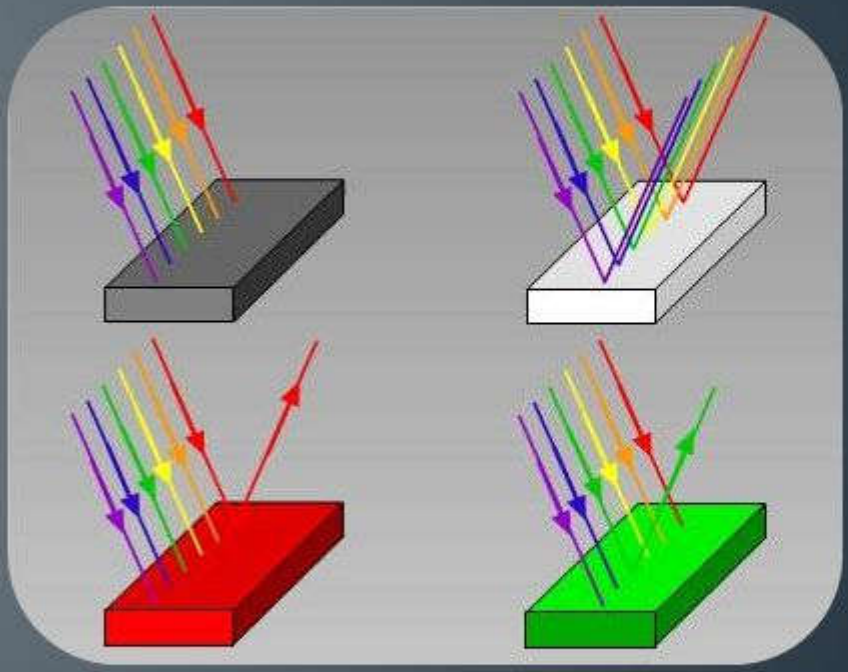
Nanofabricación

Funcionalización

Aplicaciones: Detección, Biodiagnosis, análisis del Patrimonio Histórico

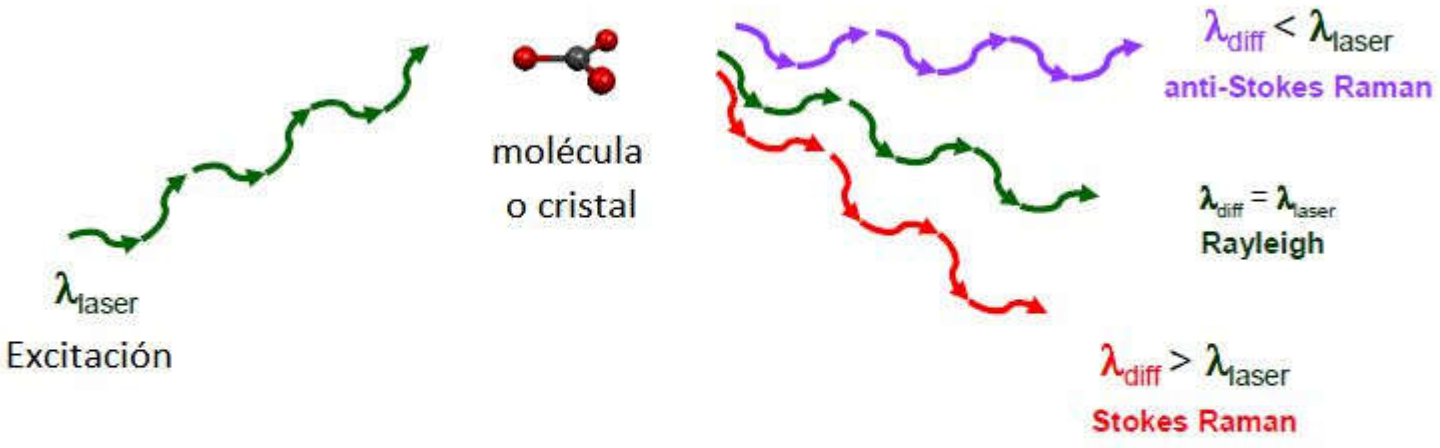
PROPIEDADES ÓPTICAS

- Absorción
- Reflexión
- Transmisión
- Refracción
- Dispersión
- Difracción



Interacción de la luz con la materia: Efecto Raman

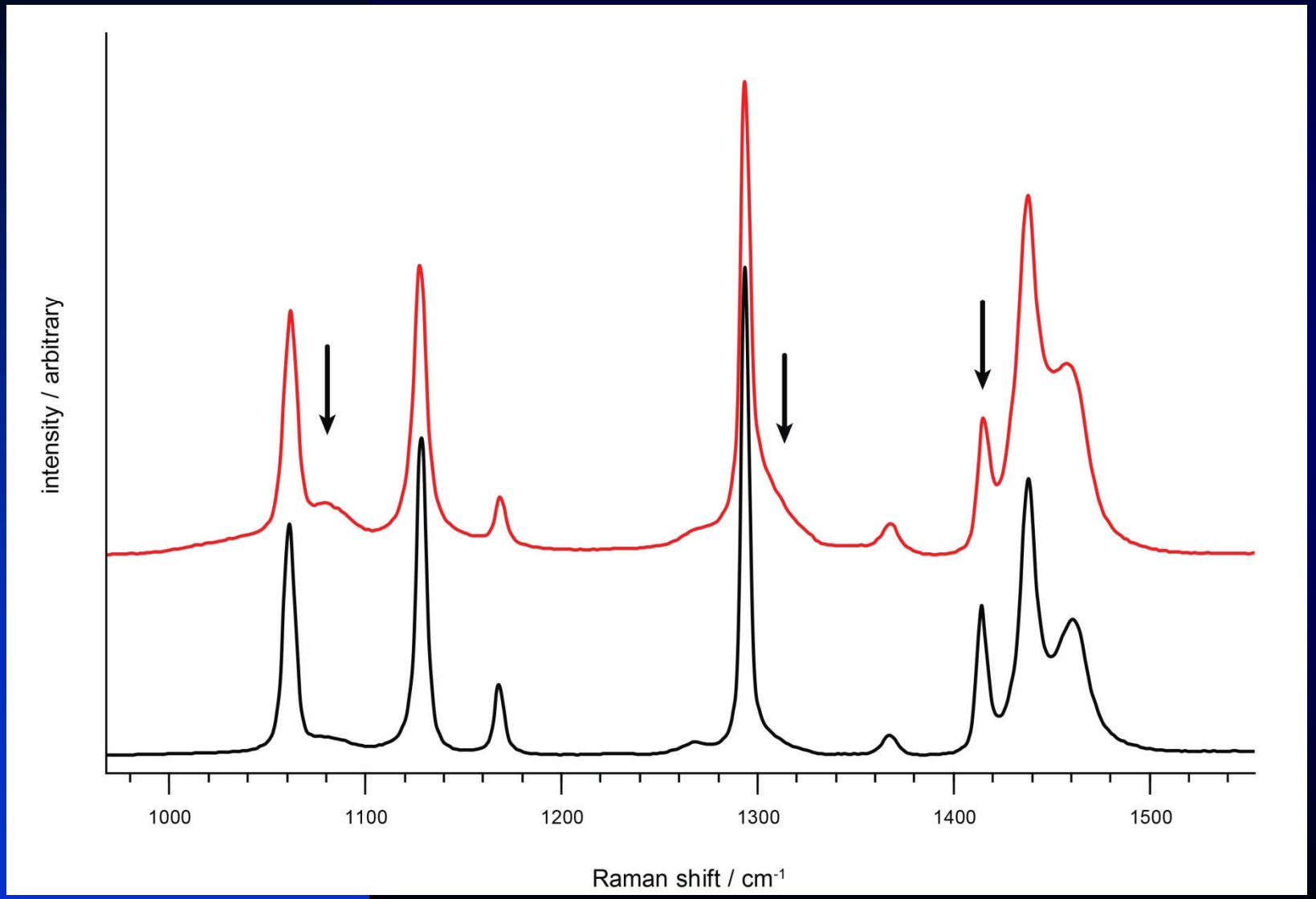
Efecto Raman = Dispersión Inelástica



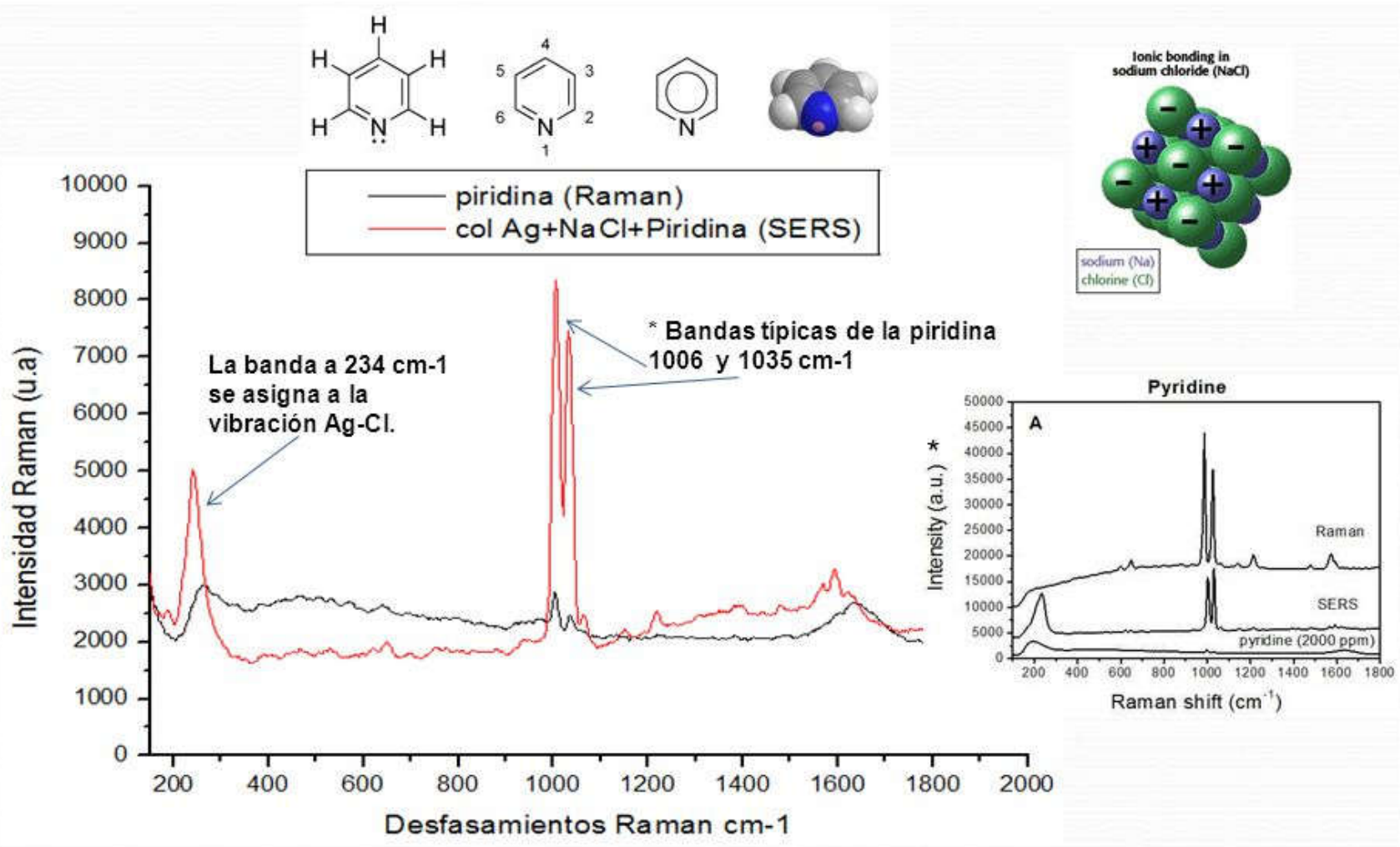
La diferencia de frecuencia entre la luz incidente y la dispersada caracteriza a la vibración de la molécula irradiada.

$$\nu_{vibración} = \nu_{laser} \pm \nu_{dispersada}$$

Espectros Raman



Espectro Raman de la piridina



Espectro Raman y SERS de la piridina diluida a 2000PPM

0,025 M

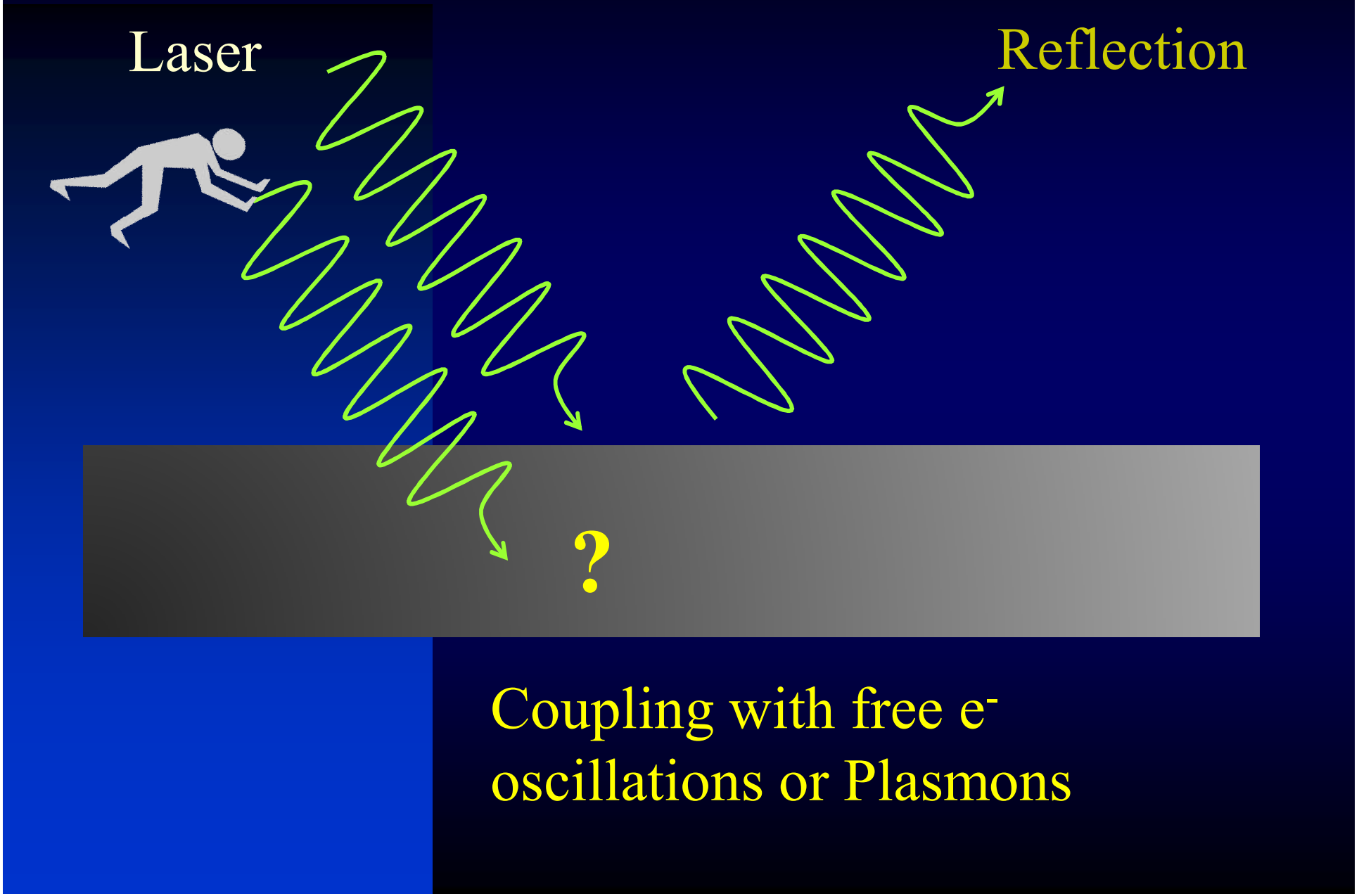
*Journal of Raman Spectroscopy Published online in Wiley Interscience: 20 October 2008 "Silver nanoparticles synthesized by direct" by Dr. Roberto Sato-Berrú

Radiation-Metal Interaction

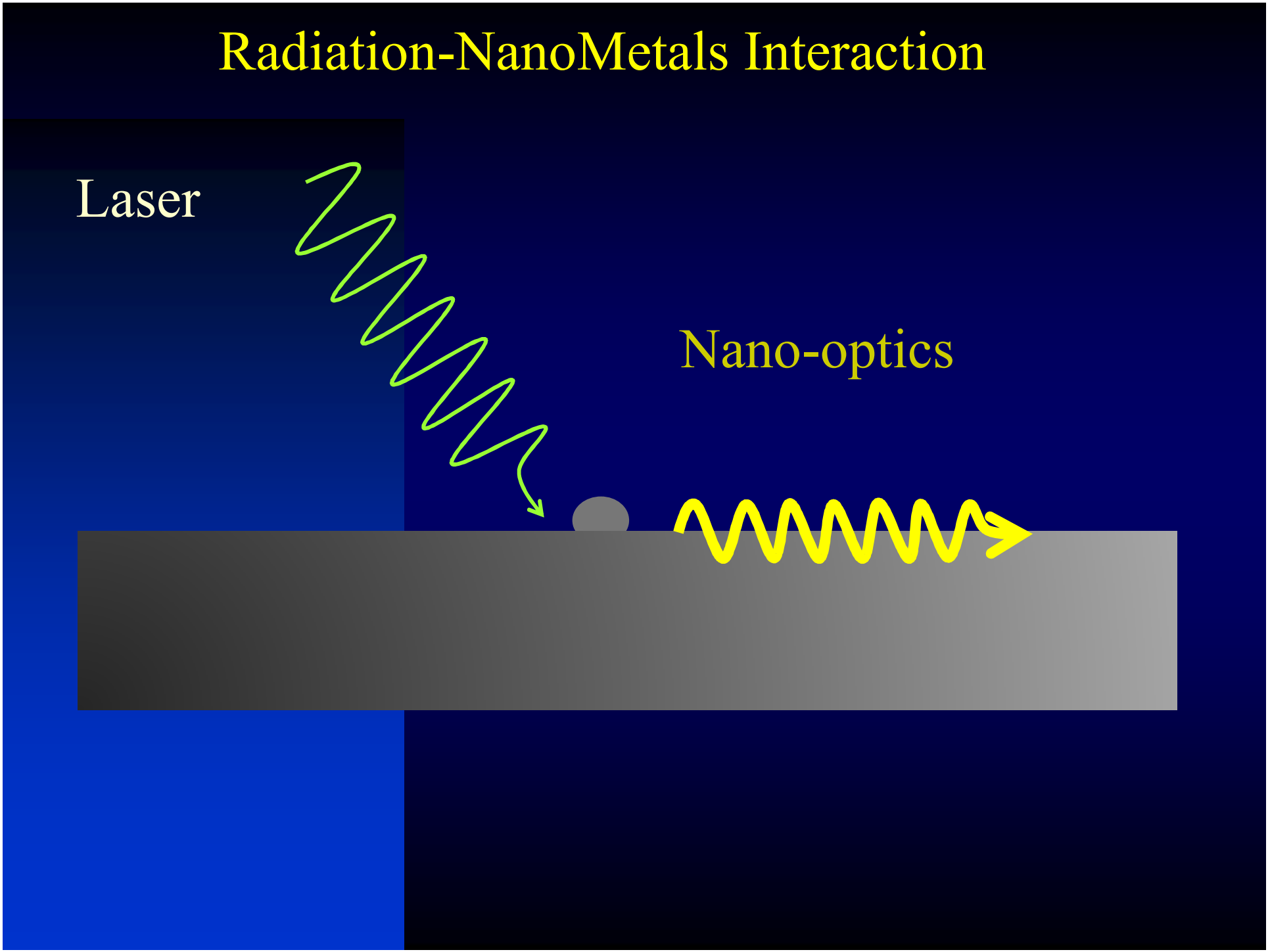
Light

Reflection

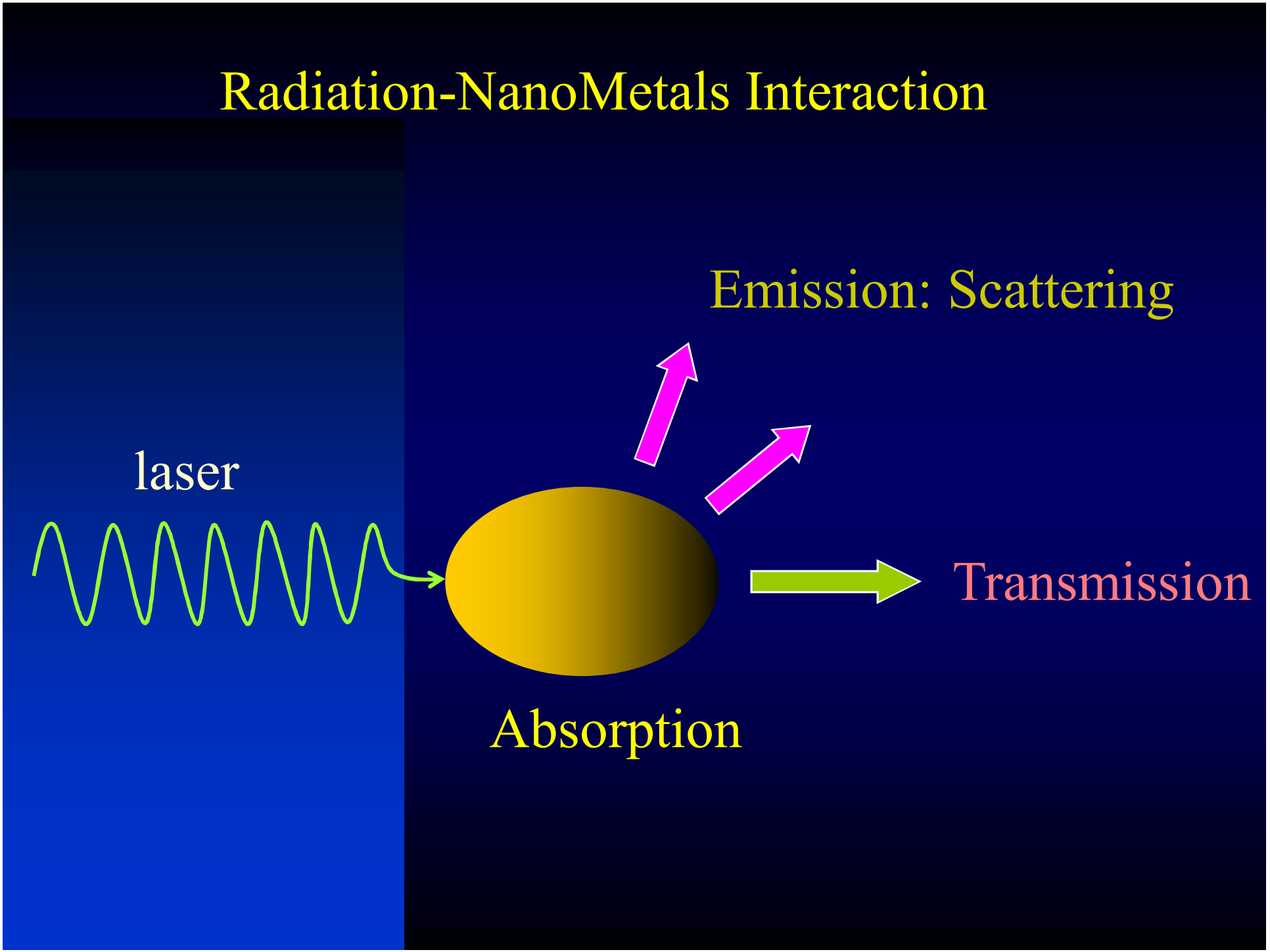
Radiation-Metal Interaction



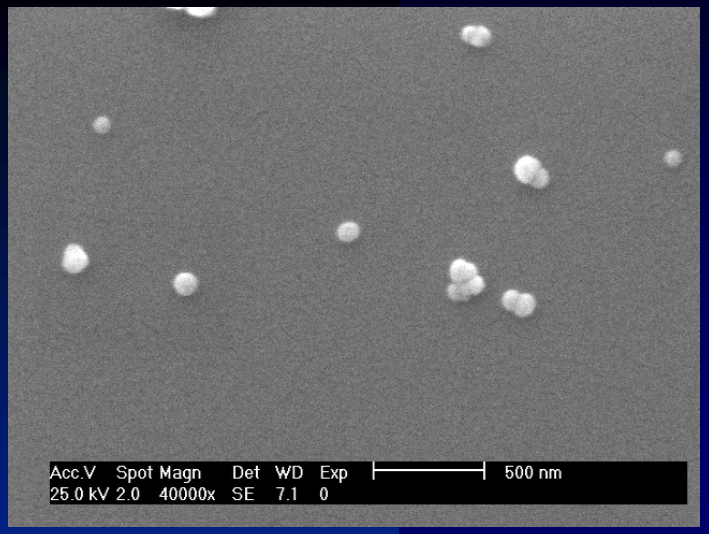
Radiation-NanoMetals Interaction

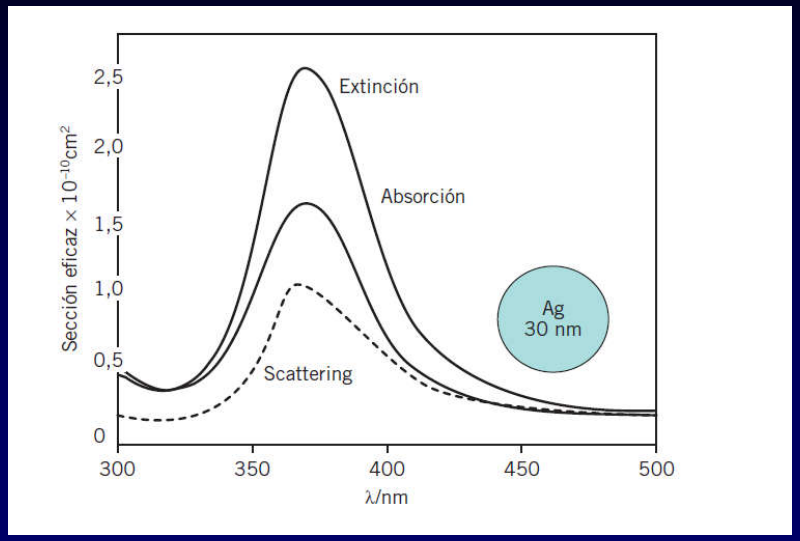


Radiation-NanoMetals Interaction

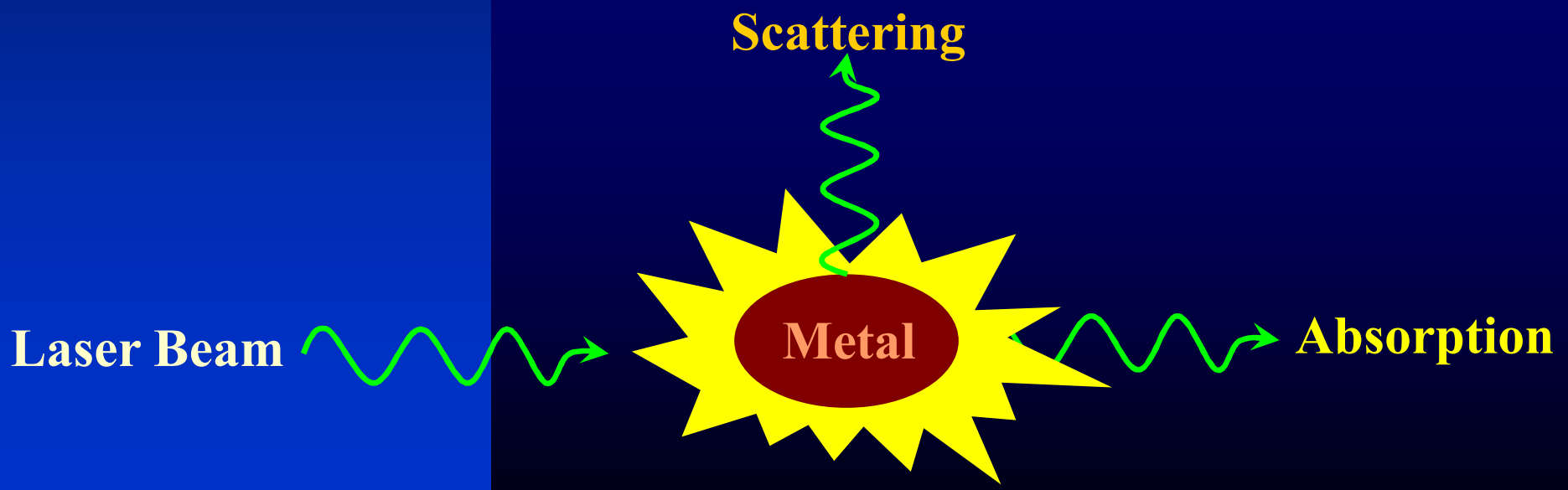


Optical properties of finely divided metals (M. Faraday)



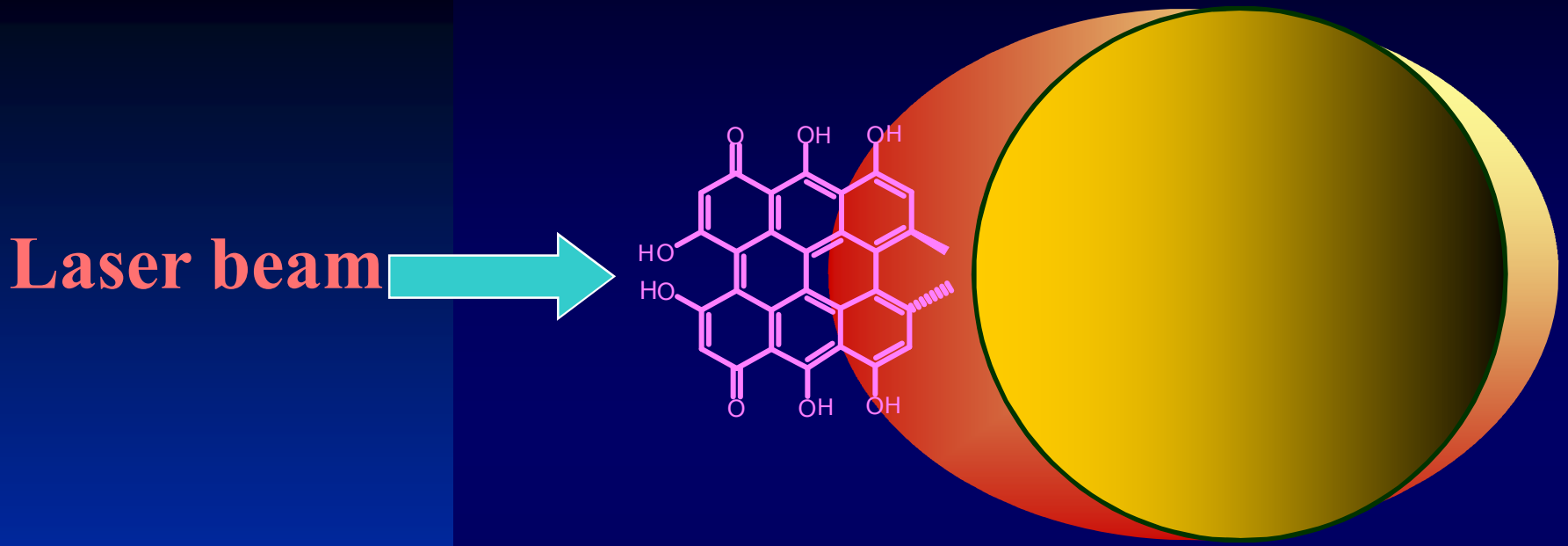


Extinction = Absorption + Scattering



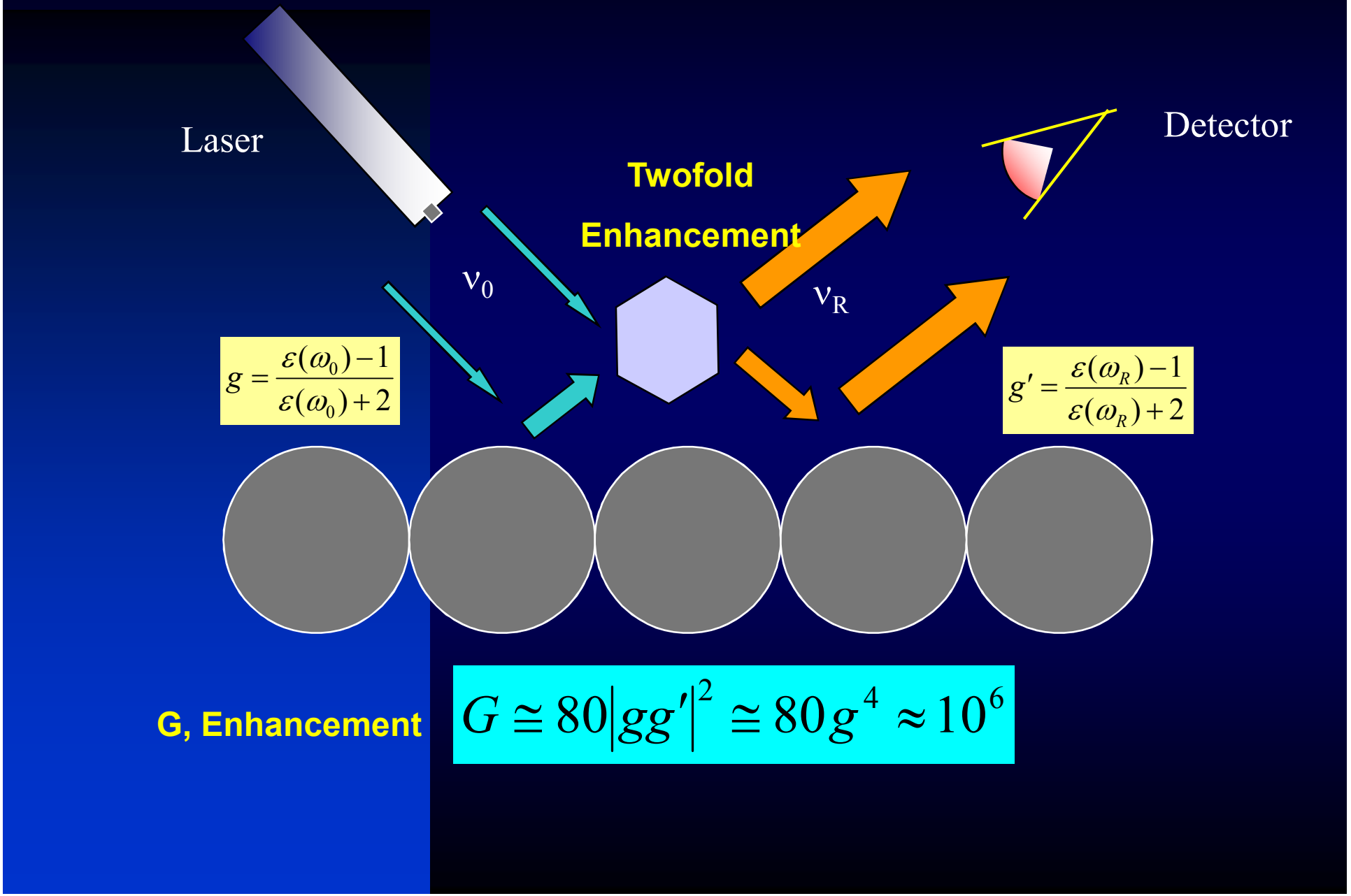
Spectroscopy on Metal Nanoparticles:

Molecule in the presence of Nanostructured Metals with LSPR



- **Two mechanisms:**
- **Electromagnetic effect (EM)**
- **Chemical charge transfer effect (CT)**

Emission Spectroscopy



G, Enhancement

$$G \cong 80\left|gg'\right|^2 \cong 80g^4 \approx 10^6$$

Important Factor:

$$g = \frac{\varepsilon(\omega) - 1}{\varepsilon(\omega) + 2}$$

$$\varepsilon(\omega) = Re[\varepsilon(\omega)] + Im[\varepsilon(\omega)]i$$

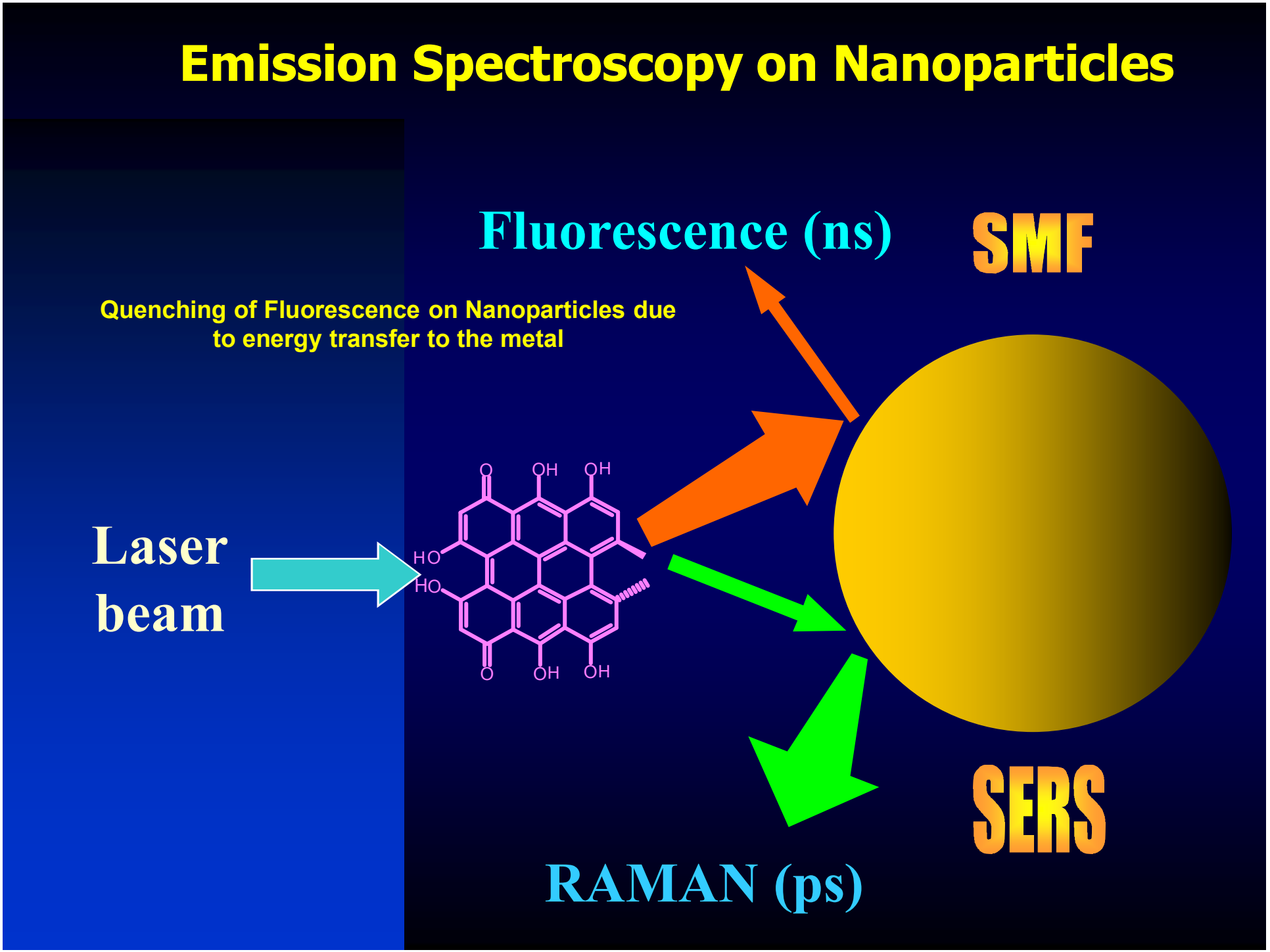
Two main conditions of plasmonic materials:

$Re[\varepsilon(\omega)] \approx -2 \quad \Rightarrow$ **Plasmon Resonance**

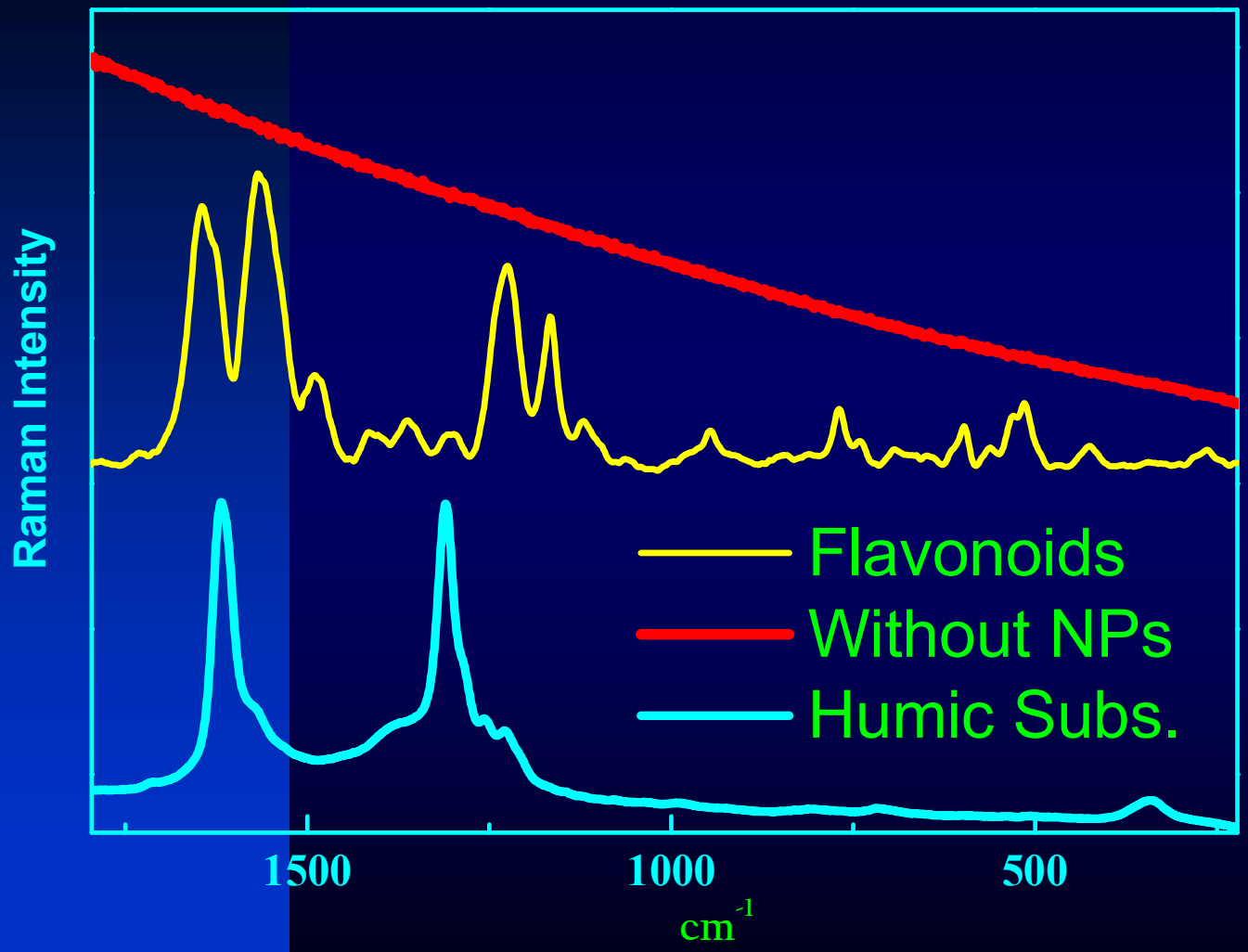
$Im[\varepsilon(\omega)] \rightarrow 0 \quad \Rightarrow$ **Minimum Resistivity**

Metals which fulfill these conditions: Ag, Au, Cu

Emission Spectroscopy on Nanoparticles

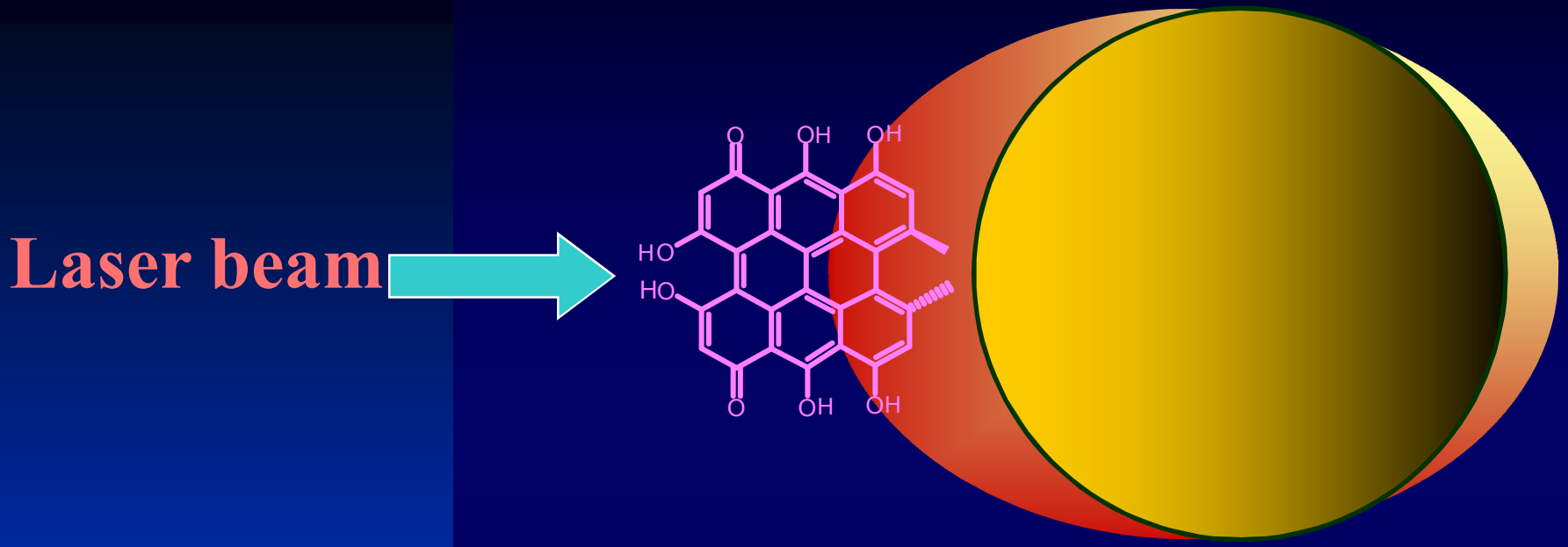


SERS: Intensity Enhancement and quenching of fluorescence



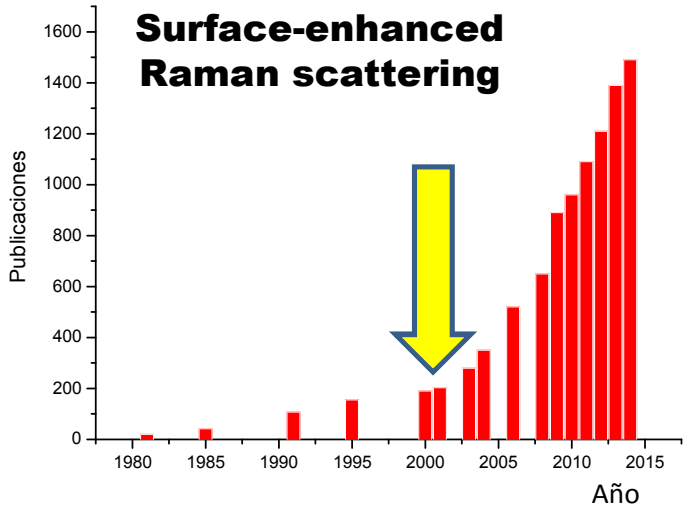
Spectroscopy on Metal Nanoparticles:

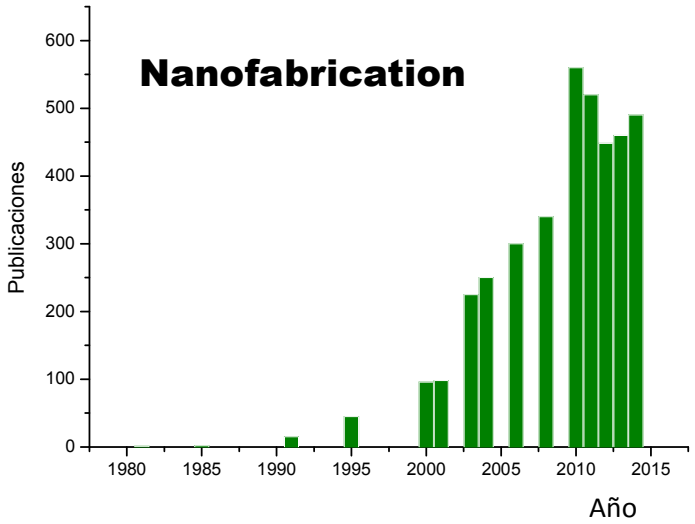
Molecule in the presence of Nanostructured Metals with LSPR

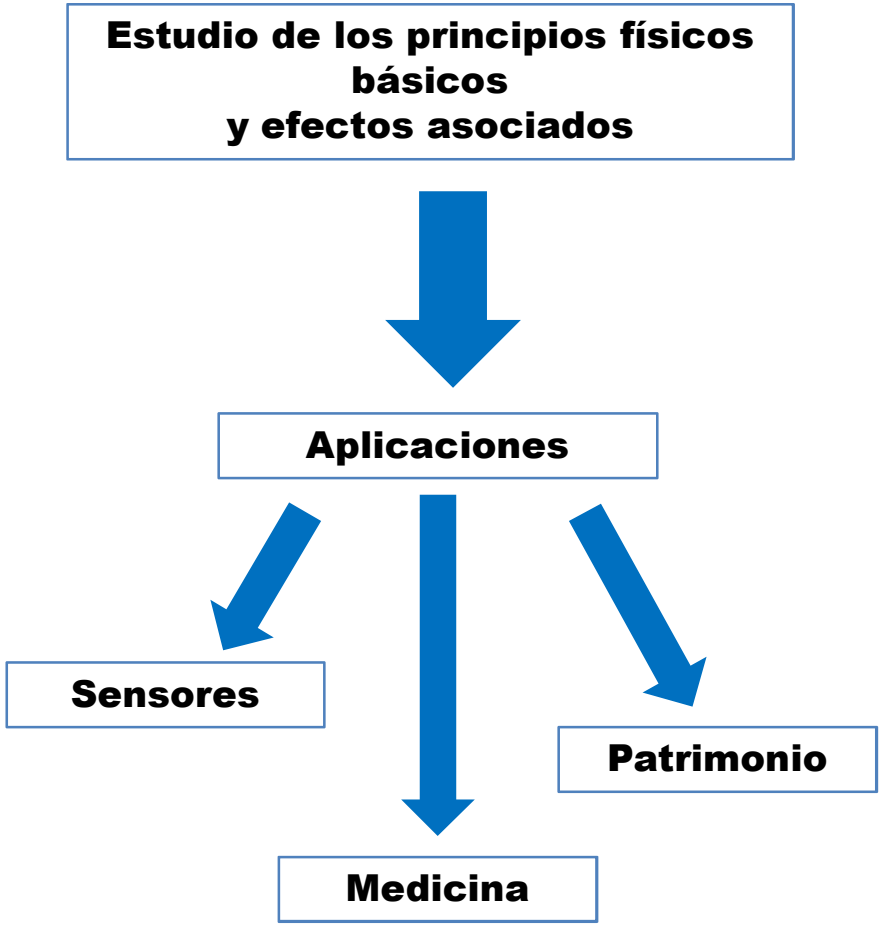


- **Spectroscopic Applications:**
  - **SERS (Surface-enhanced Raman Scattering)**
  - **SEIRA (Surface-enhanced IR Absorption)**
  - **SEF (Surface-enhanced Fluorescence) or SMF (Surface-Modified Fluorescence)**

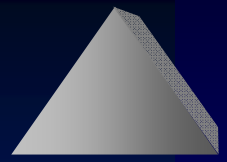
Publicaciones en el campo en los últimos 20 años y tendencias

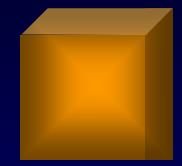


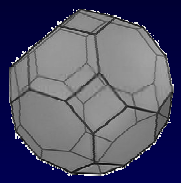


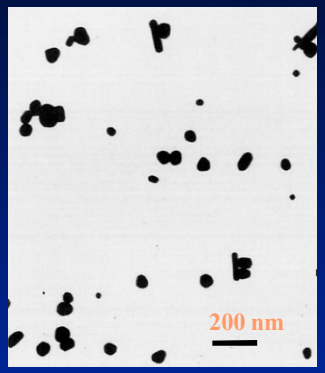


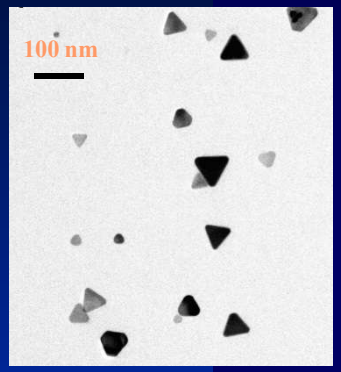
Tailoring the nanoparticle morphology

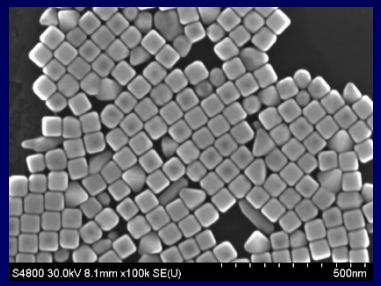


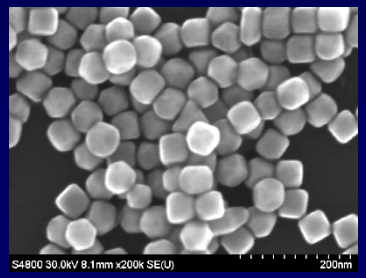


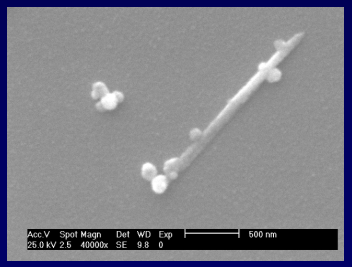


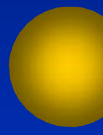


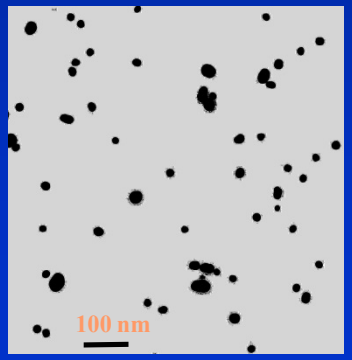


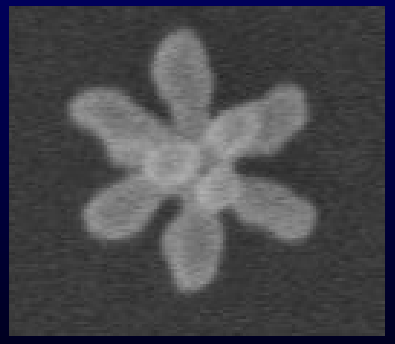




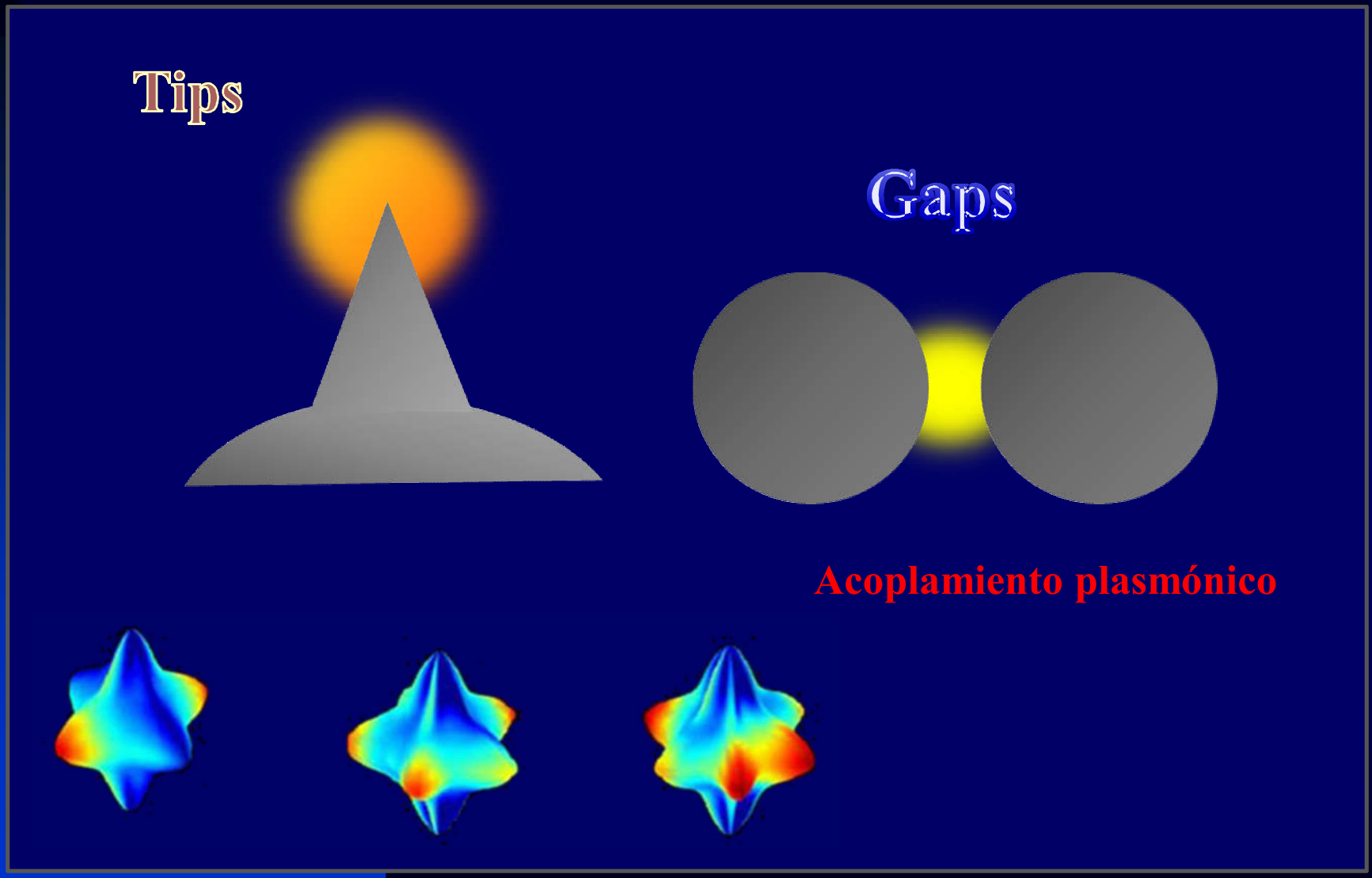




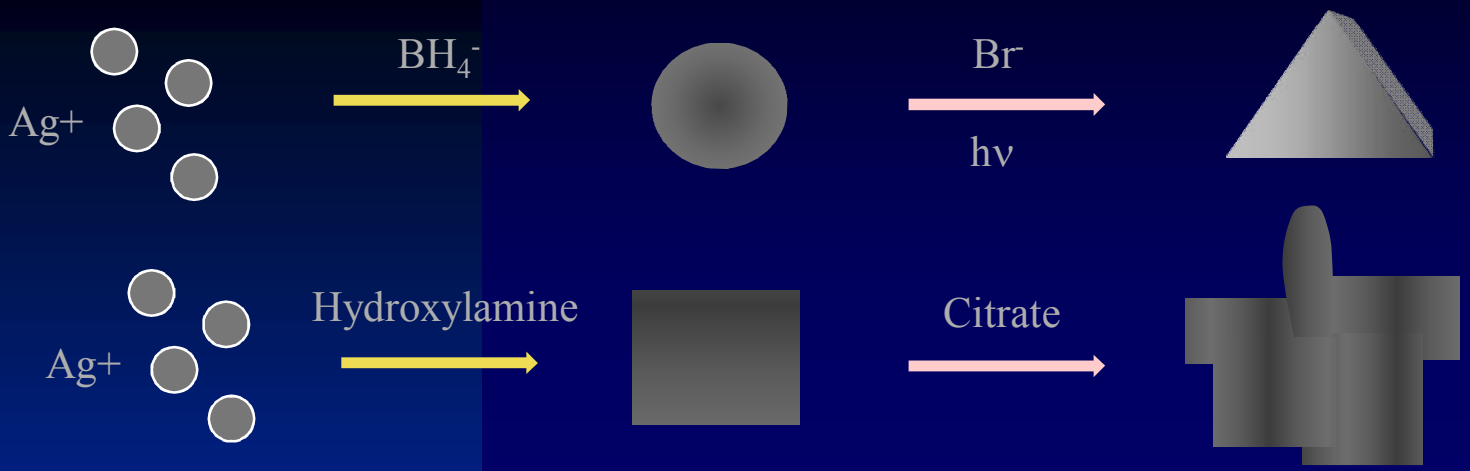


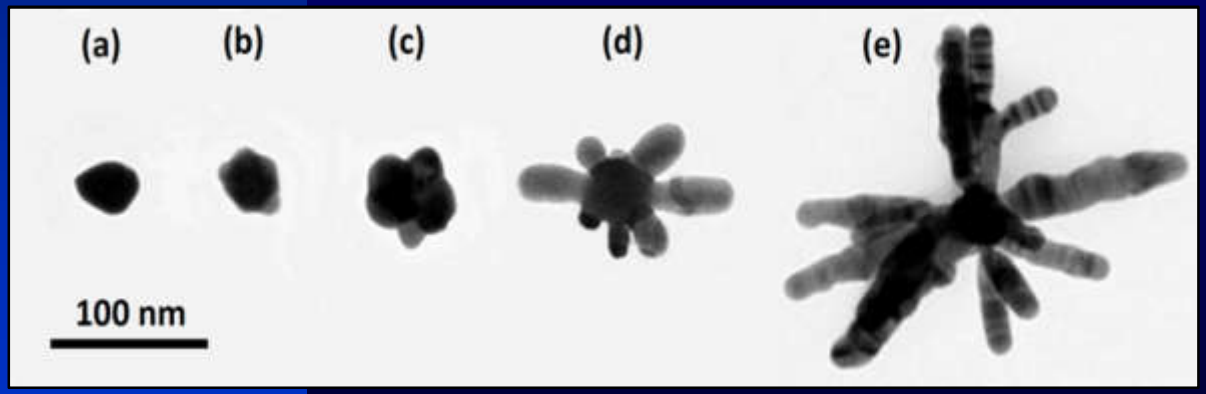


Hot Spots



Anisotropic NPs: Two step growing

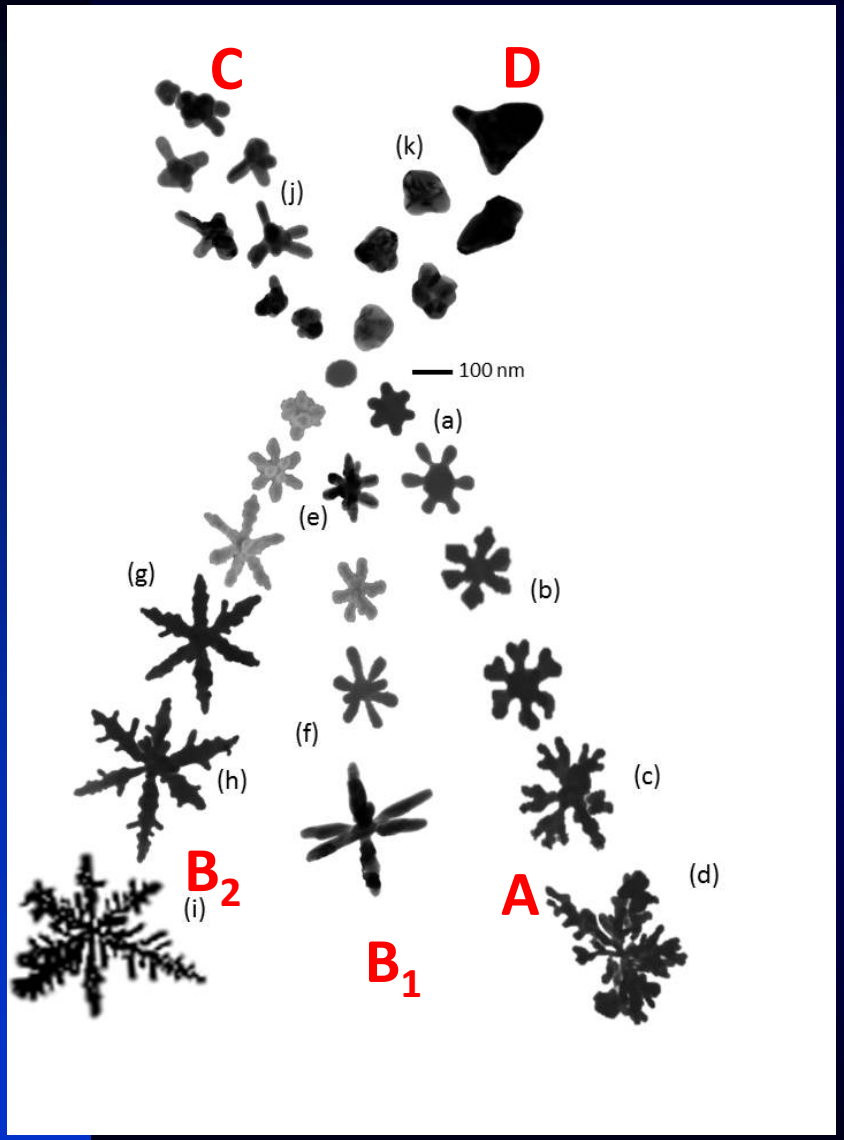




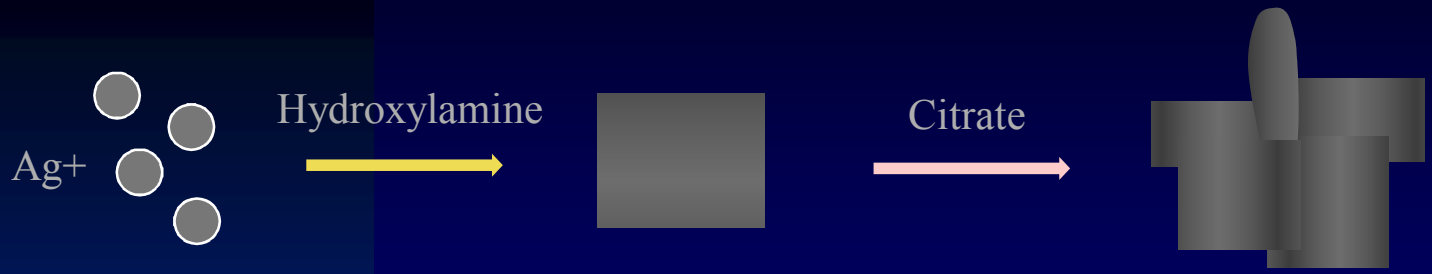
Izquierdo-Lorenzo et al ***Langmuir*** 28, 8891 **(2012)**

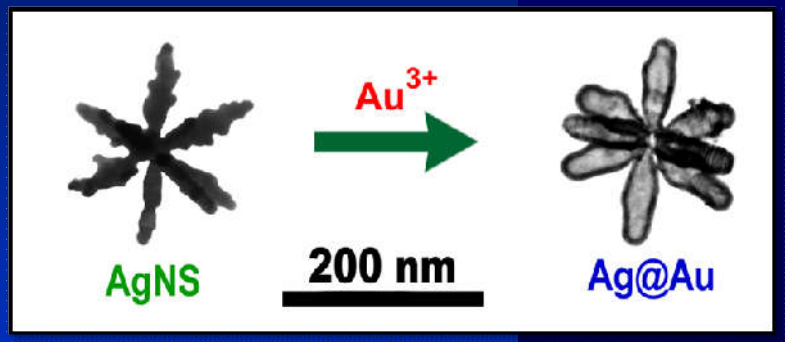
Garcia-Leis et al. ***J. Phys. Chem.*** **C 117**, 7791 **(2013)**

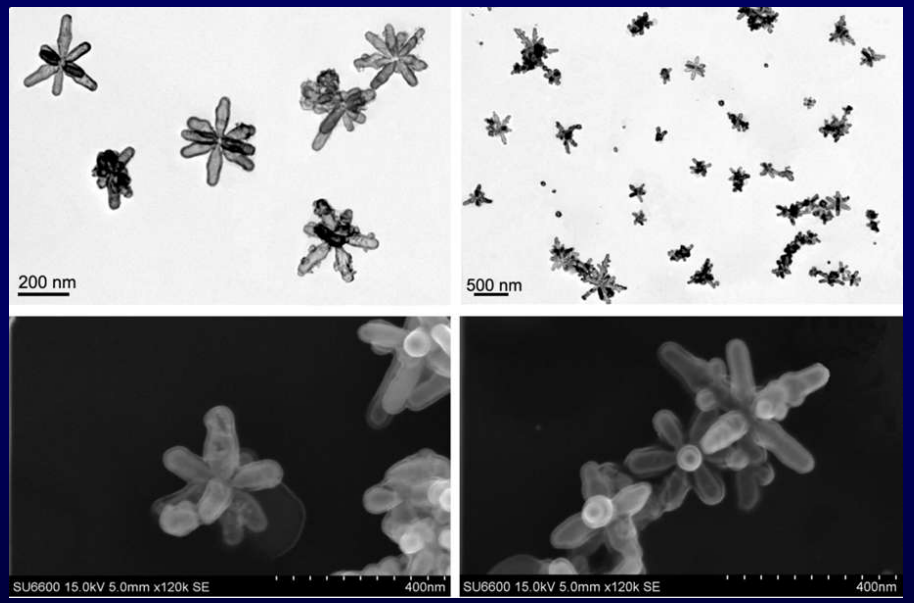
Growth Paths



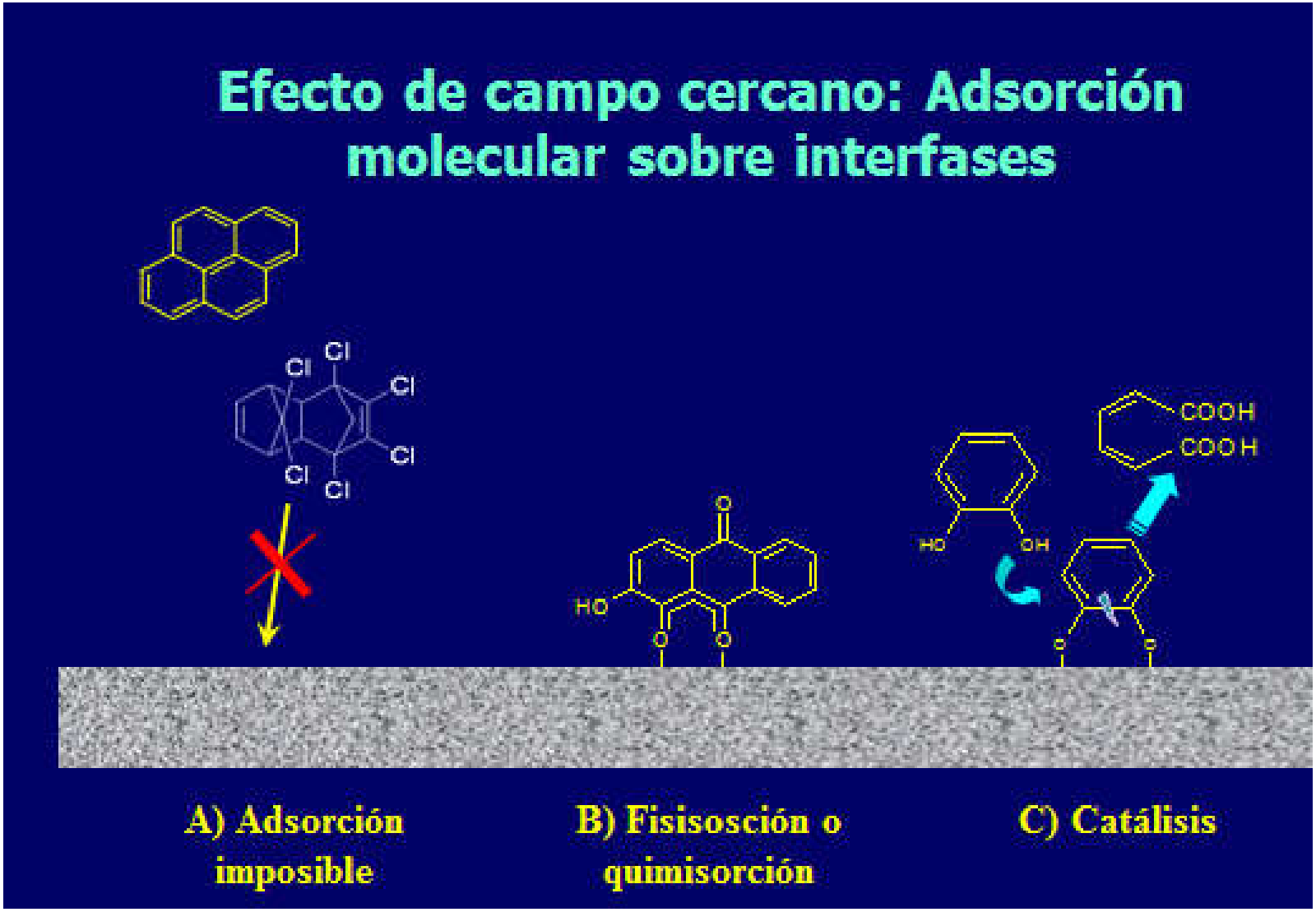
Core@Shell Nanostars







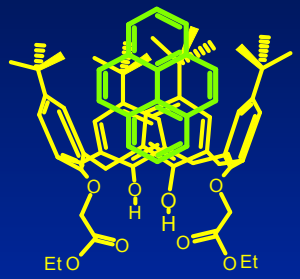
Funcionalización de nanopartículas plasmónicas



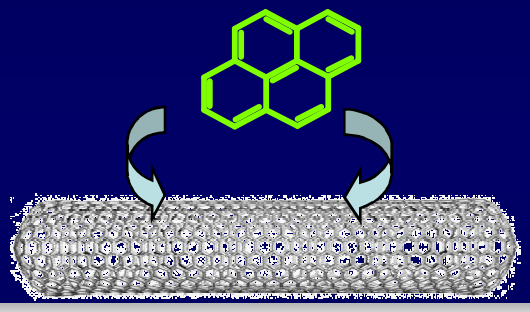
Funcionalización

Funcionalización

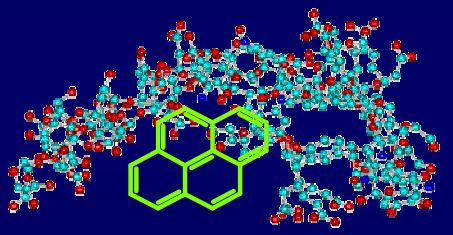
Inclusion



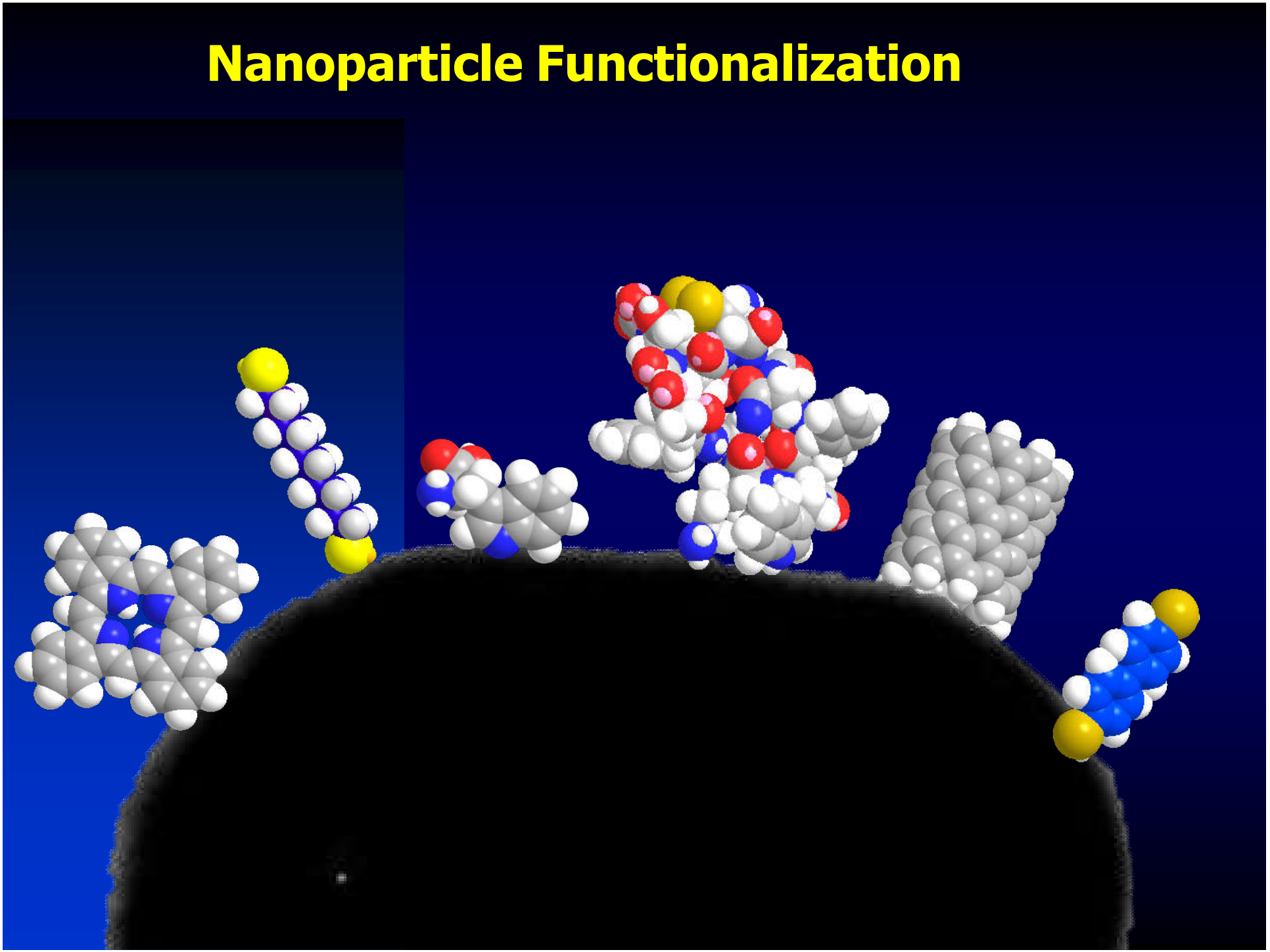
Contact



Occlusion

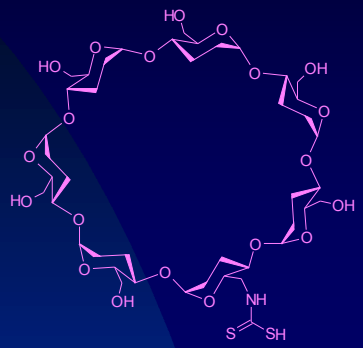


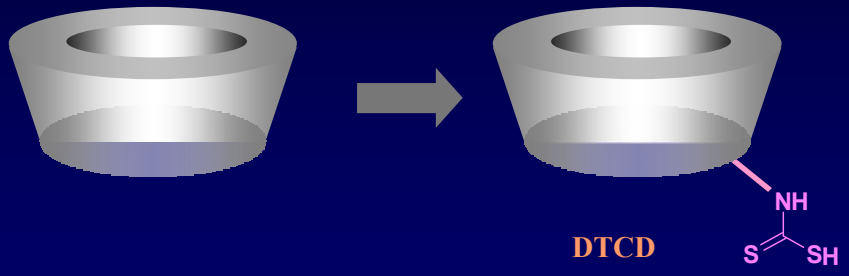
Nanoparticle Functionalization



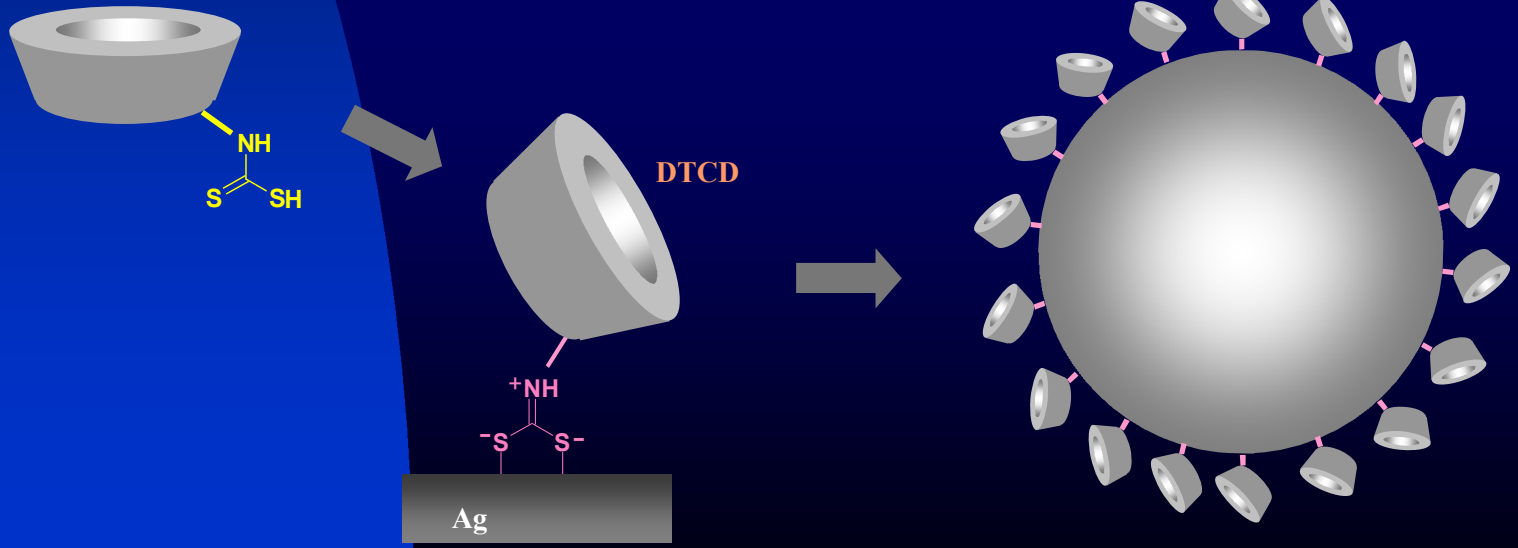
Surface Functionalization with Cyclodextrines

A) DTC derivatized Cyclodextrins



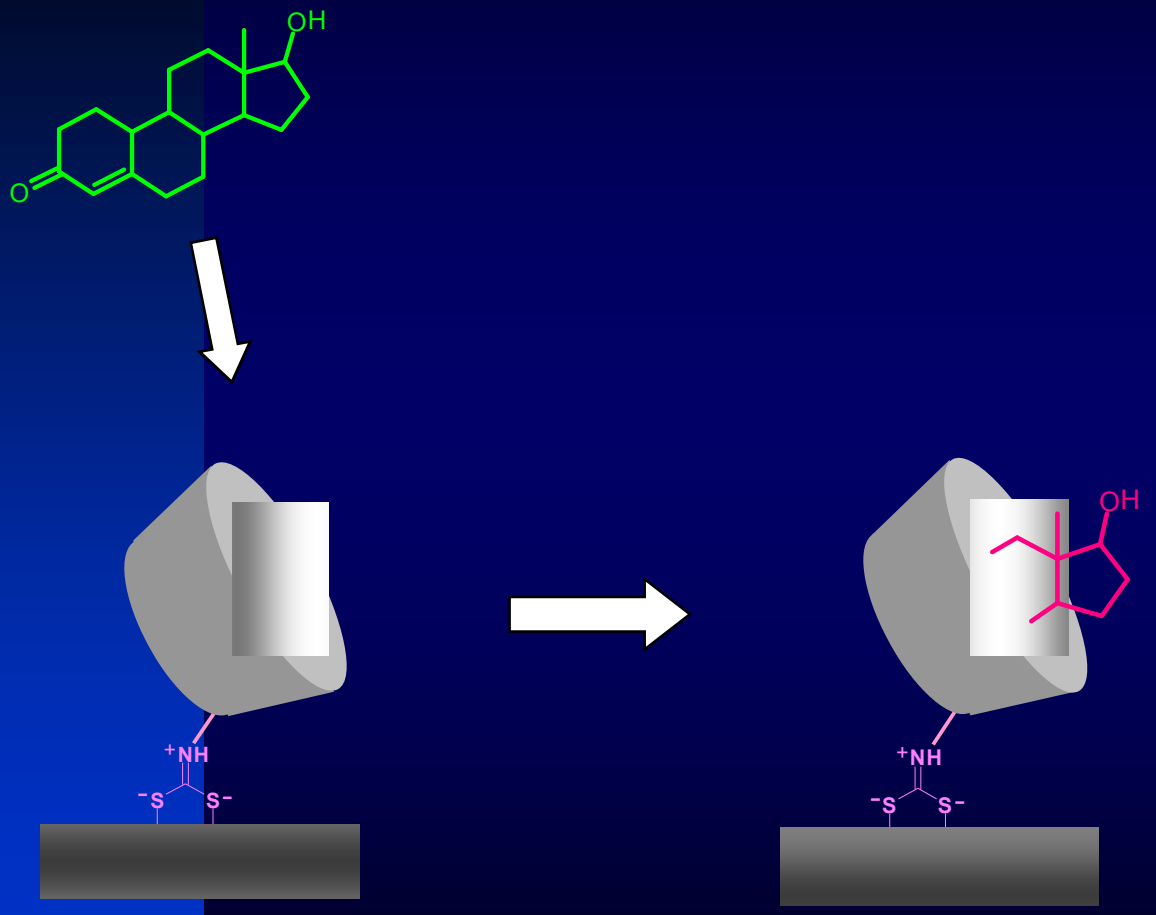


B) Functionalization of Ag NPs with DTCD

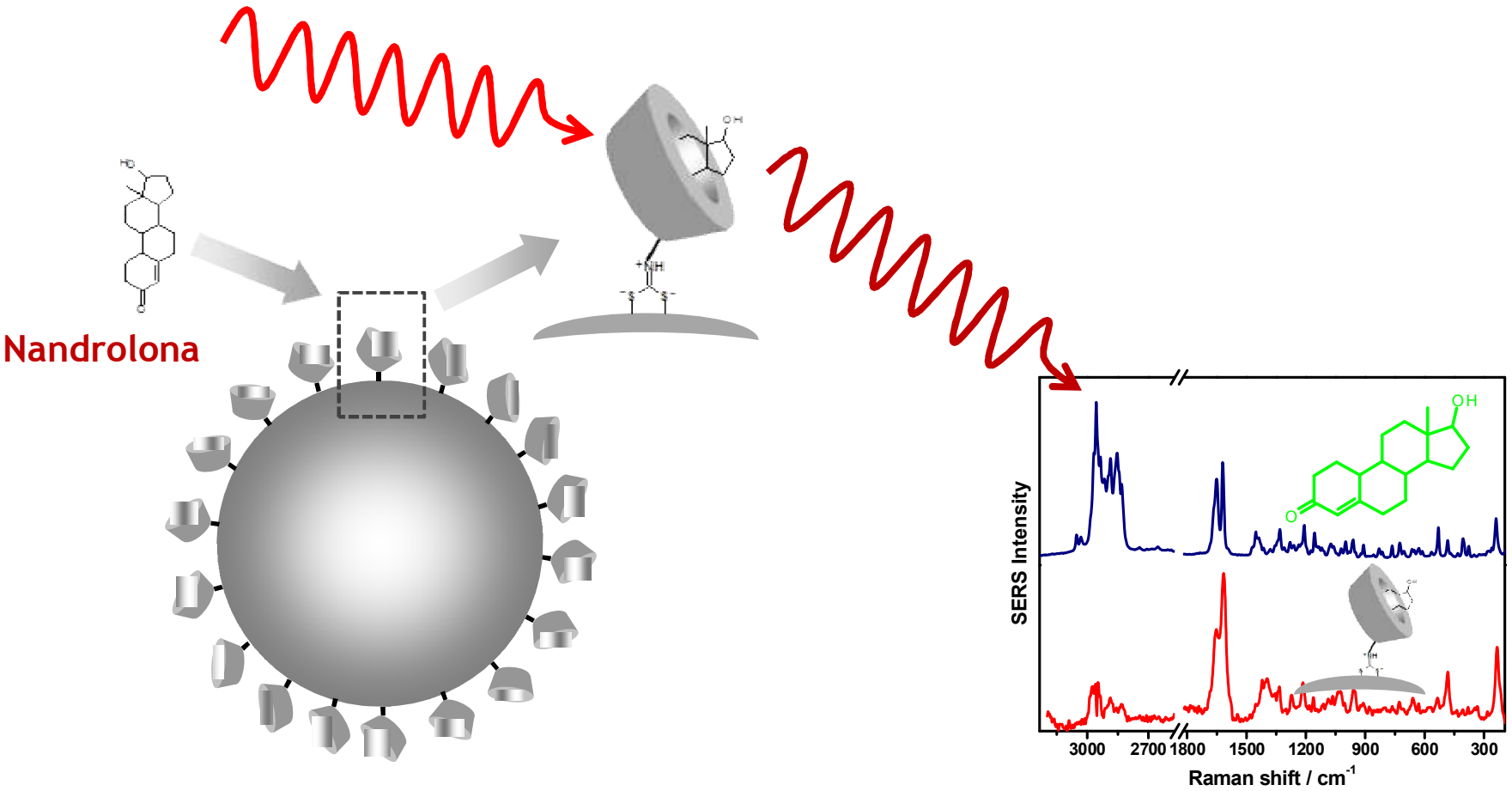


Encapsulation with DTCD

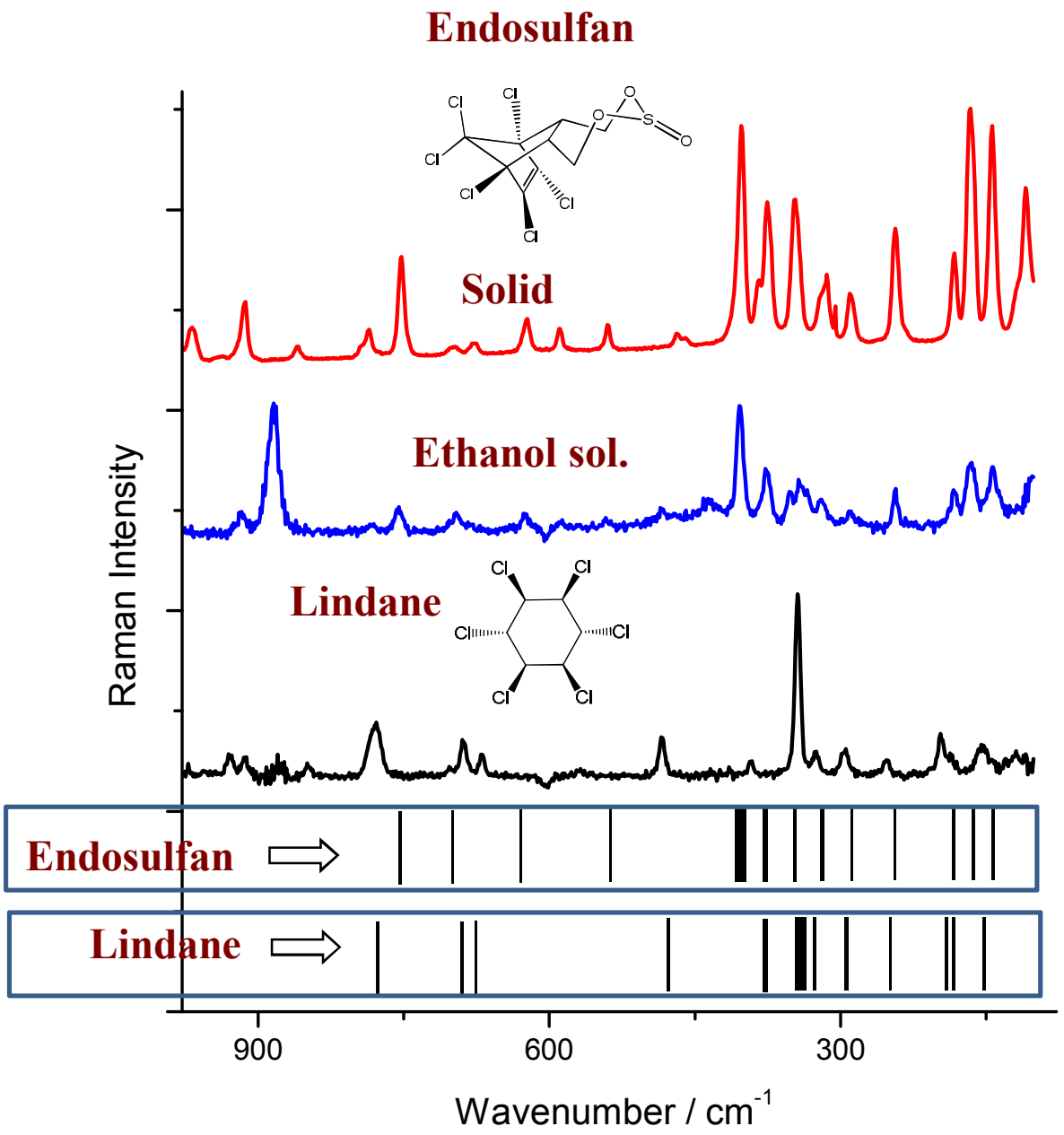
Encapsulation of Nandrolone



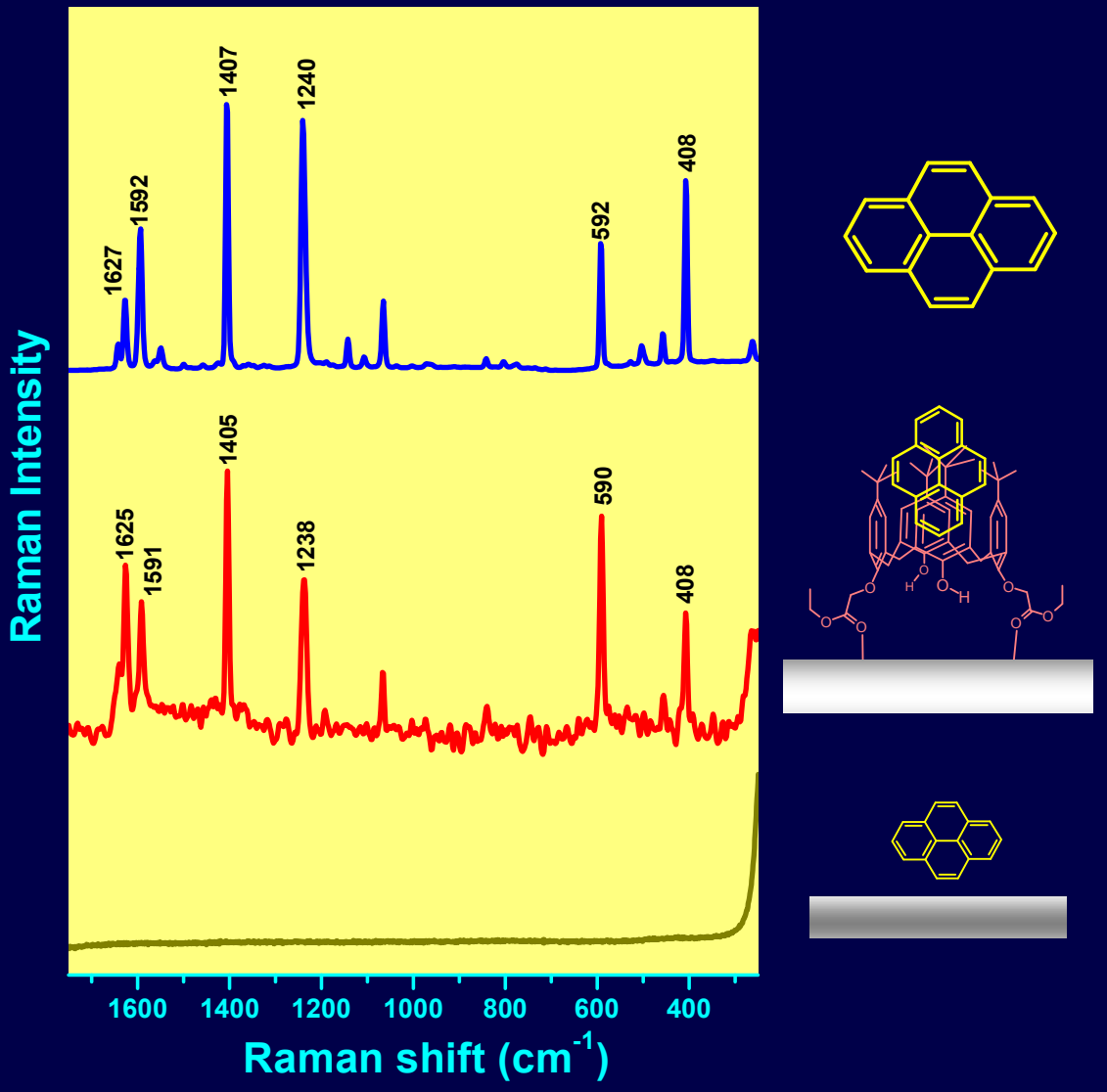
NANOPARTÍCULAS DE PLATA FUNCIONALIZADAS CON DITIOCARBAMATO DE CICLODEXTRINA, Y SU USO EN LA DETECCIÓN ULTRASENSIBLE DE NANDROLONA



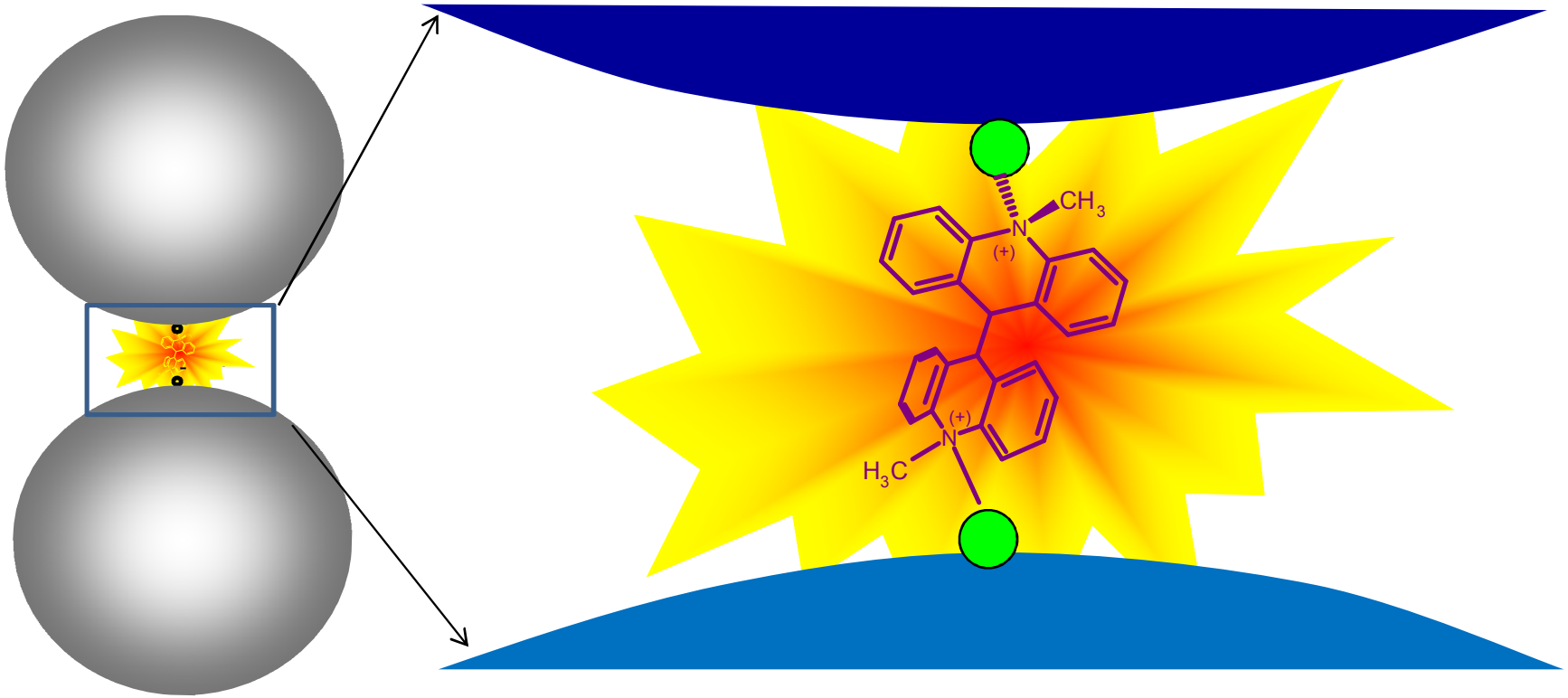
Selective detection of pollutants by Raman



Detección de contaminantes con calixarenos

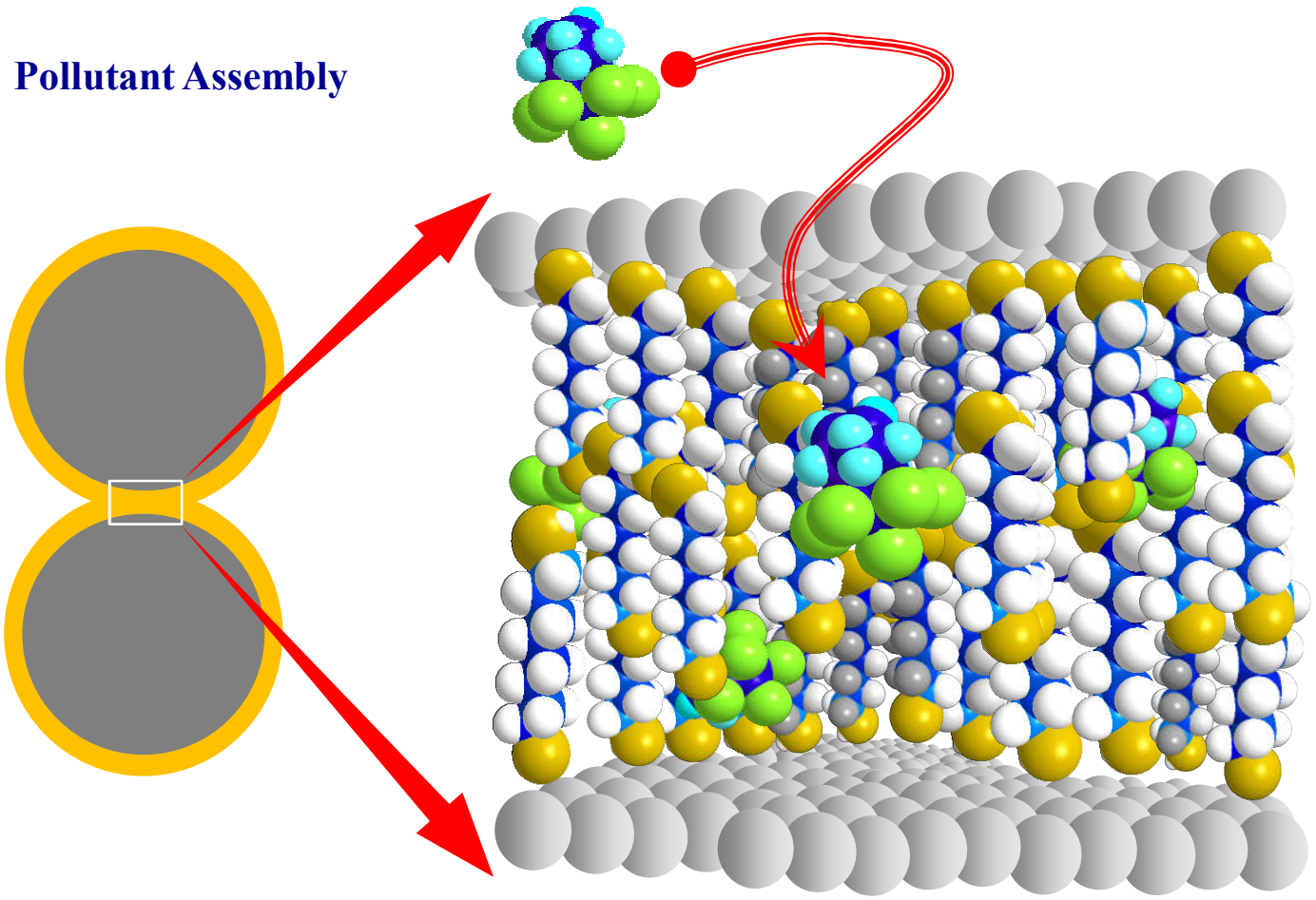


Construcción de espacios interpartícula o *gaps* mediante ensambladores moleculares bifuncionales

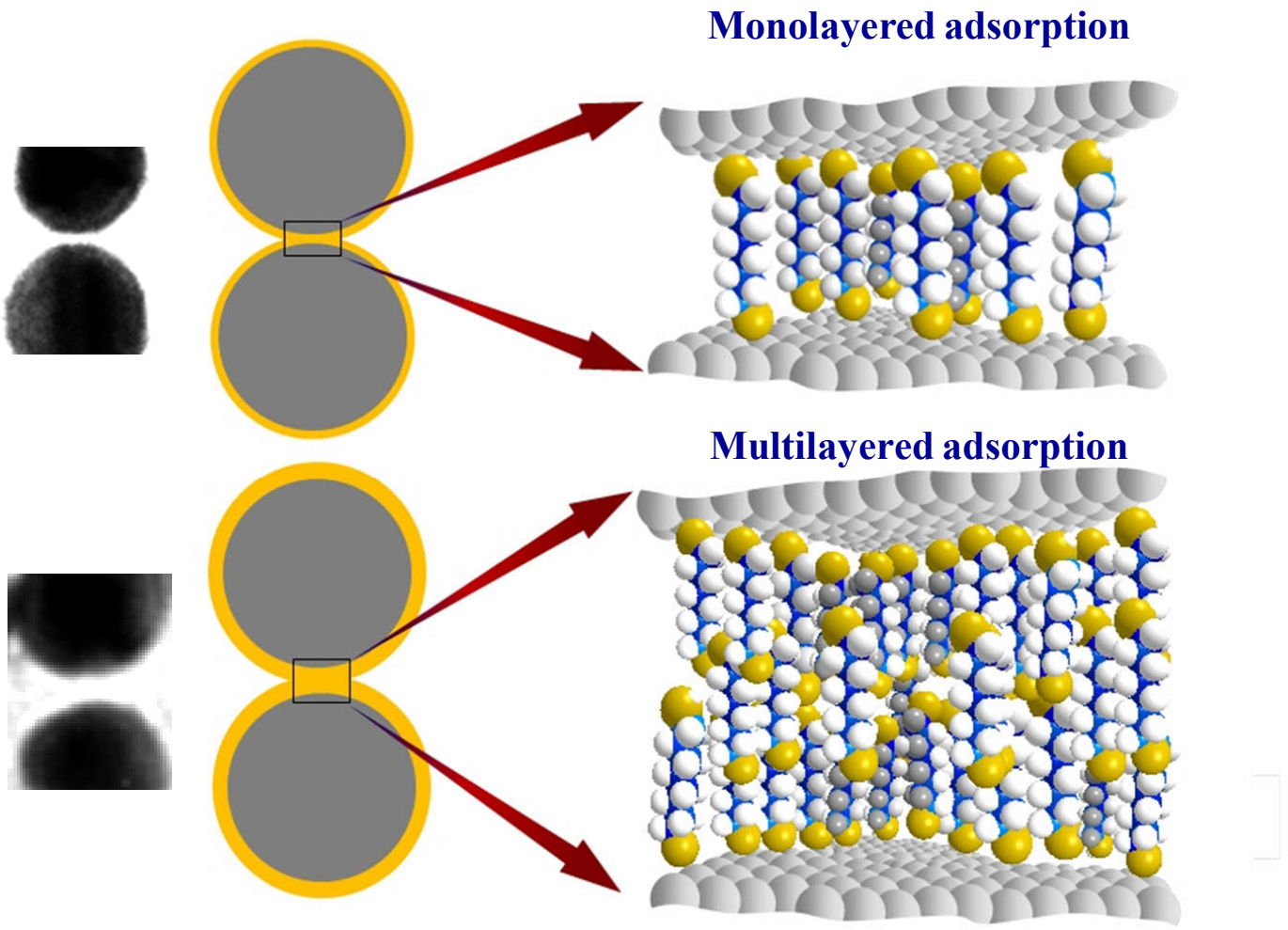


Guerrini et al *Anal. Chem.* 81, 1418 (2009)

Dithiol-Functionalized Interparticle Spaces: Hot Spots + Pollutant Binding Sites

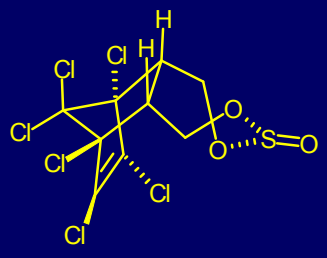


Interparticle Spaces:
Hot Spots + Pollutant Binding Sites

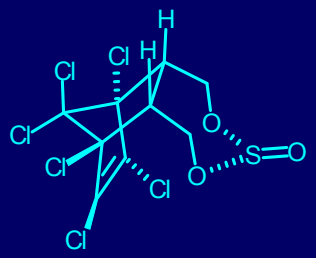


Aliphatic Linear Linkers: Molecular Detection

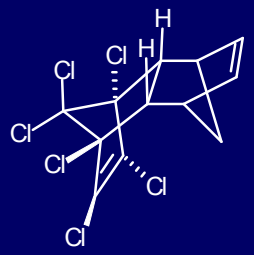
Chlorinated Pesticides Detected in this Work



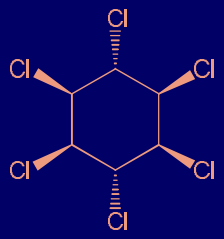
α-Endosulfan



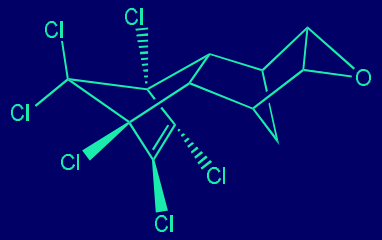
β-Endosulfan



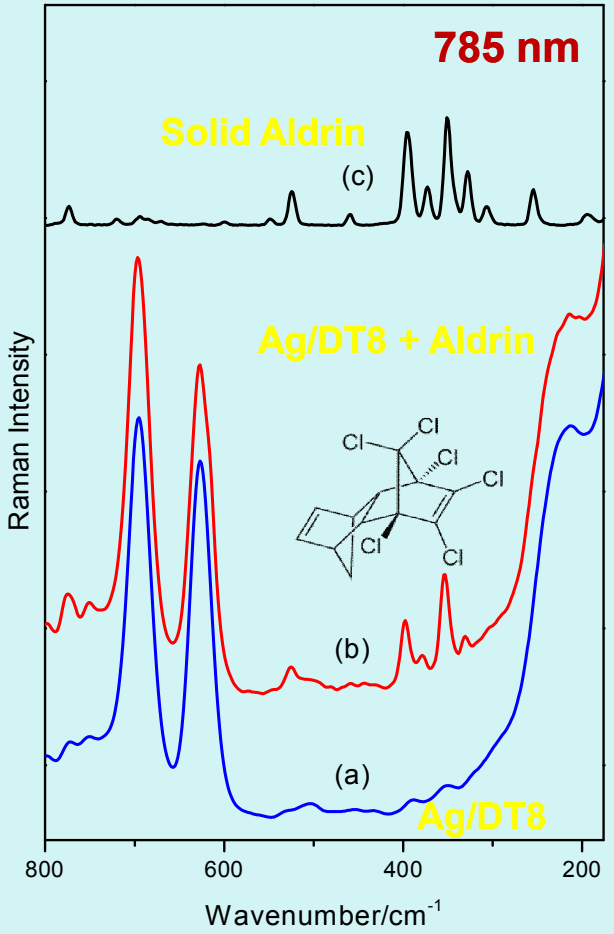
Aldrin



Lindane

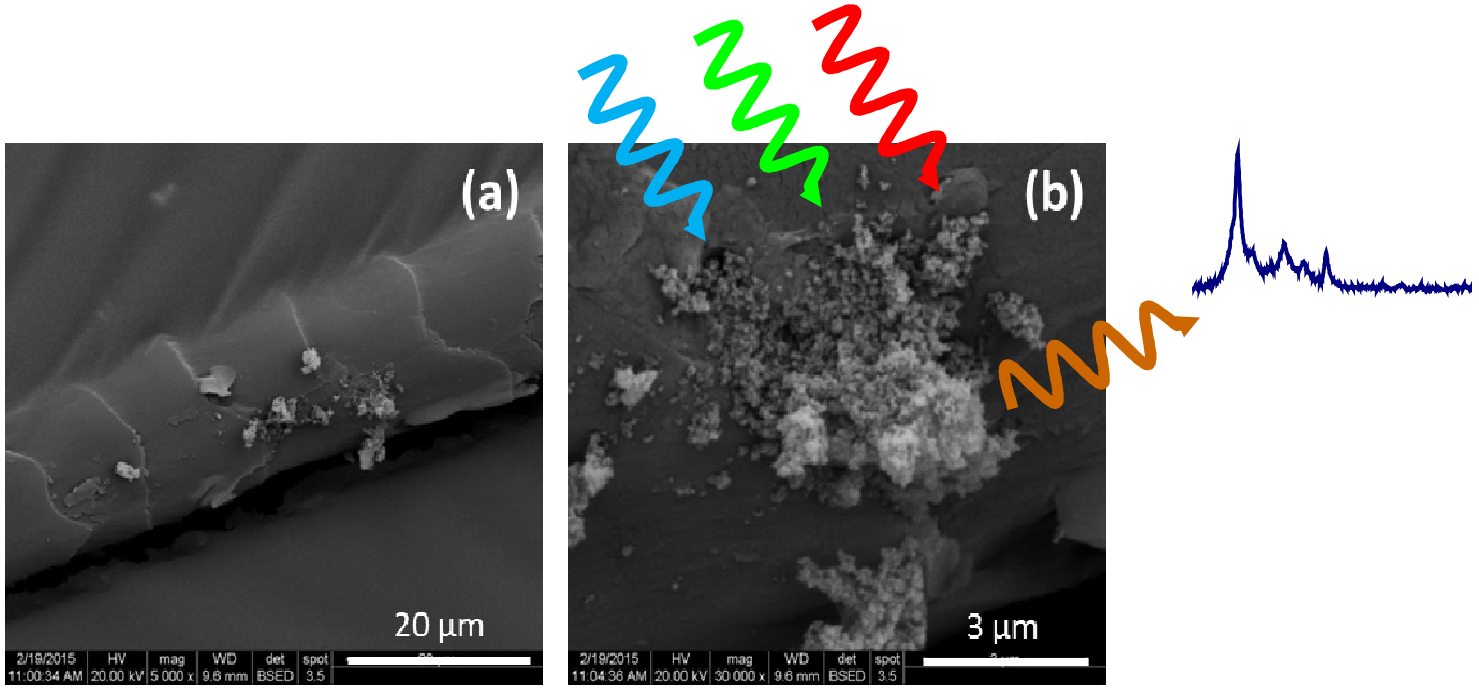


Dieldrin



[Aldrin] = 50 μM [DT8]= 50 μ M

Nanopartículas de plata inducidas sobre fibras de tejidos

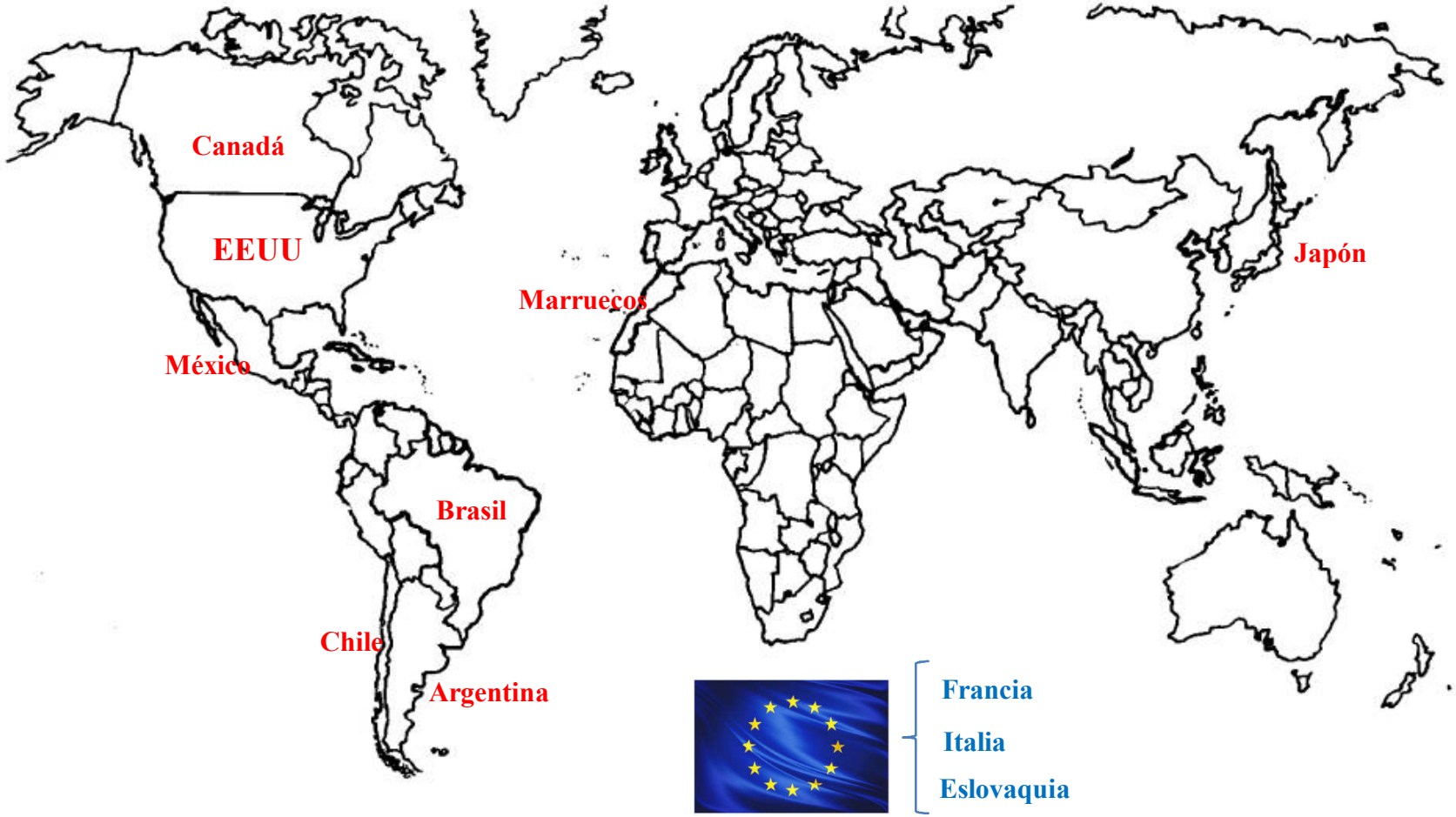


Posobilidades de Trabajo e Internacionalización

a) **Proyectos de colaboración e intercambio de investigadores (CSIC, Mineco, MAE)**

b) **Proyectos ligados a la Transferencia de Tecnología (UE): Desarrollo de Nanosensores**

c) **Proyecto Marie Sklodowska Curie (MSC) European Training Network in Interdisciplinary Biosciences**



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GRACIAS POR SU ATENCIÓN

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