Universidad Nacional de Ingeniería
NATIONAL UNIVERSITY OF ENGINEERING, FACULTY OF SCIENCES, LIMA, PERU
XIX Meeting of Physics
24th-26th September 2020

Au-SiO_2 Nanoshells Operating at the First Biological Window

"El saber de mis hijos hará mi grandeza"

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UNIVERSIDAD DE SONORA
(Hermosillo, Sonora, México)

BIONANOMED & MEDICAL PHYSICS GROUP

Universidad de Sonora

Research interest:

B I O N A N O M E D I C I N E

1. Synthesis and characterization of nanomaterials for biomedical applications.
   - Magnetic, Metallic nanoparticles and Nanocomposites.
2. *In situ* plasmonic or magnetically-induced hyperthermia for tumor annihilation.
3. Surface Enhanced Raman Spectroscopy (SERS) for environmental and biological analysis.
4. Theranostics: Nanoparticles-based diagnosis and treatment combined.

M E D I C A L P H Y S I C S

1. Synthesis and Characterization of nanomaterials for ionizing radiation detection: personal dosimetry.
2. Radiobiology: Biological effects of ionizing radiation on biological tissues.

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OUTLINE

Introduction

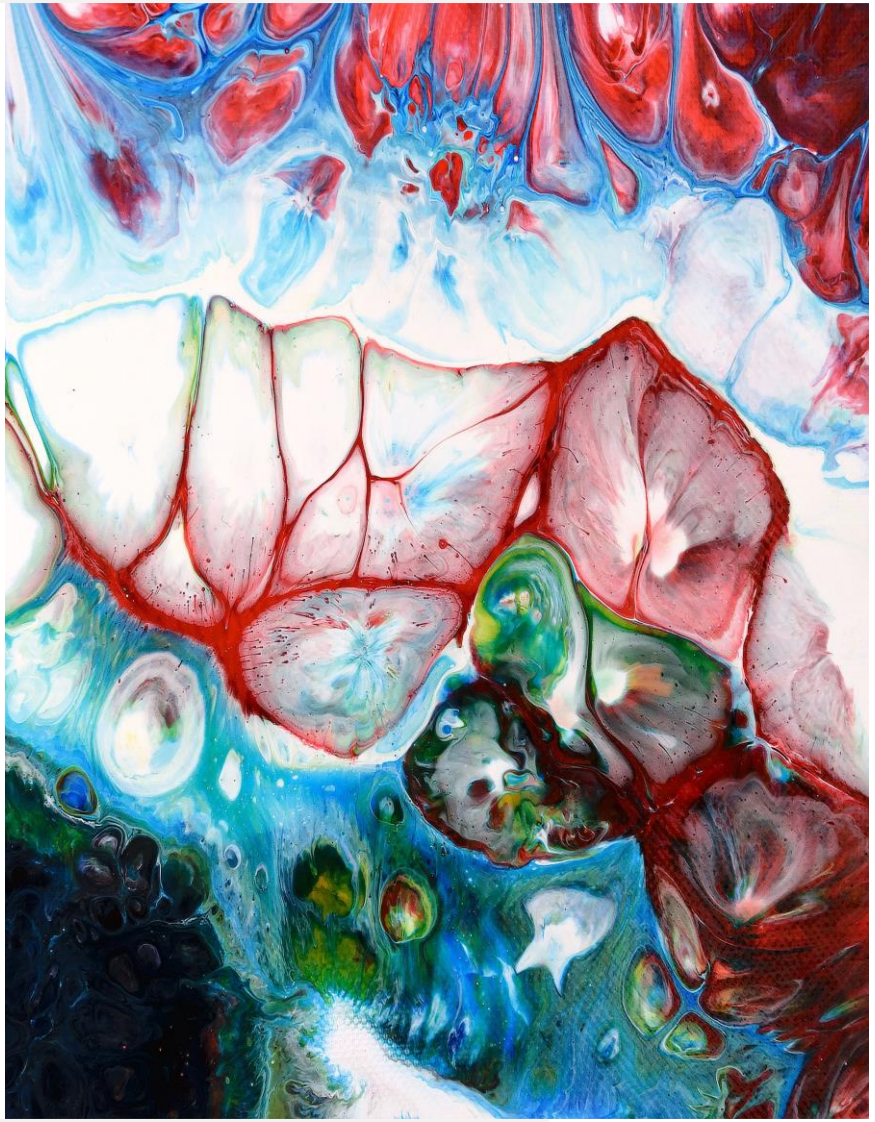
- Metallic NPs Bioaplications
- Surface Plasmon Resonance
- Biological Window

Methodology

- Synthesis:
- SiO2 Janus based Nanoparticles
- Colloidal gold seed
- Au:SiO_2

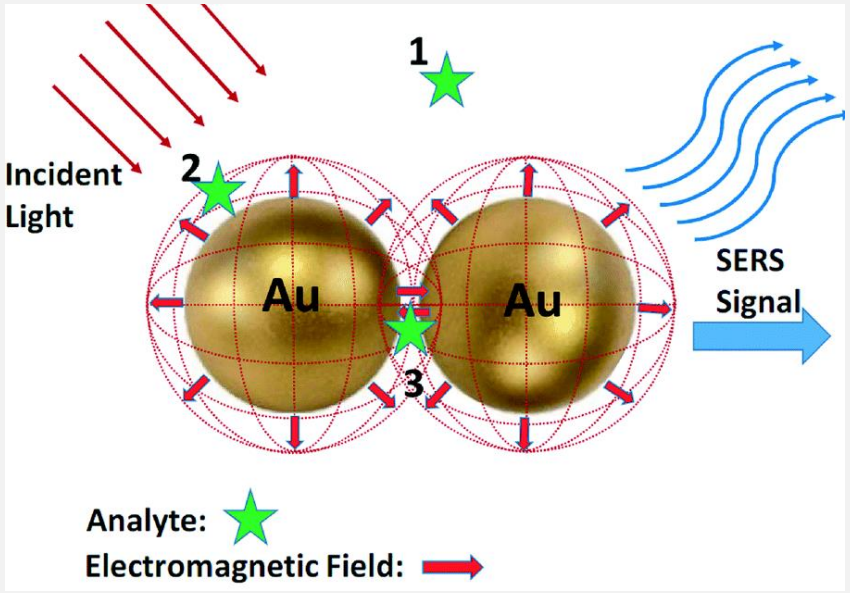
Results

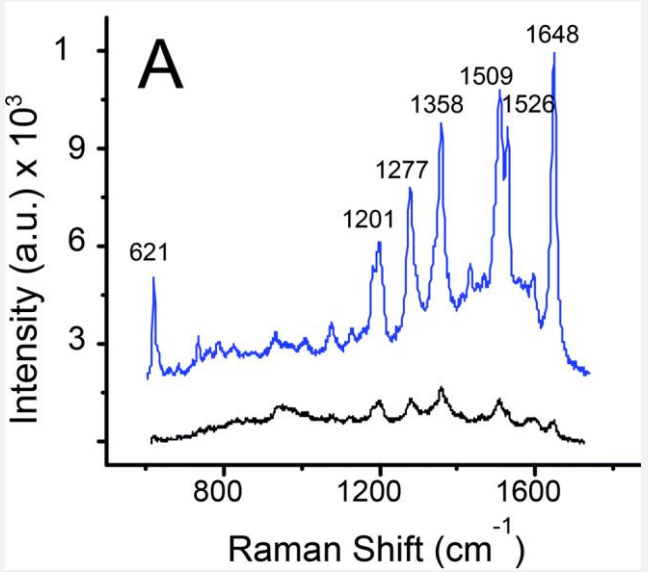
Conclusions



METALLIC NANOPARTICLES (MNPS) BIO-APPLICATIONS

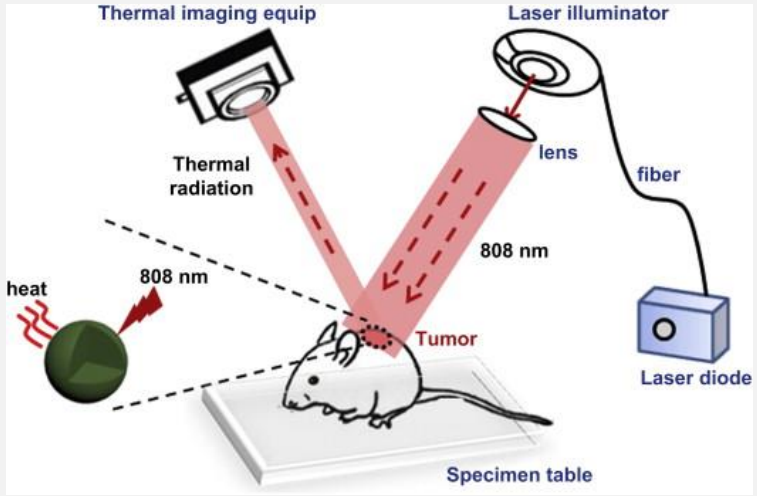
1. SERS
(Surface enhancement Raman Scattering)

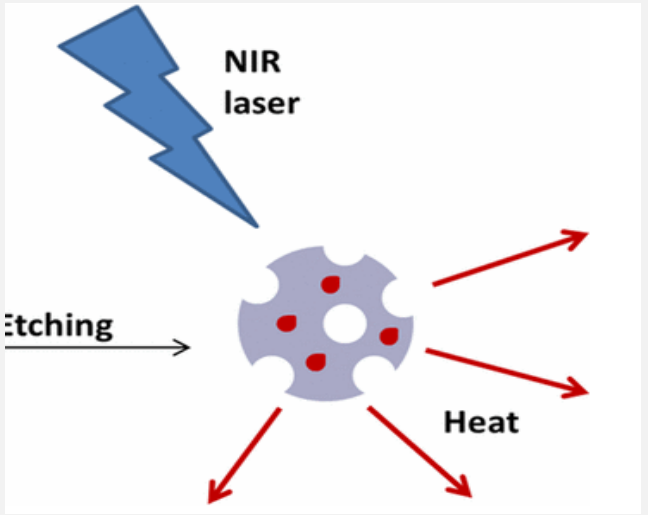




K. Mo, **Santacruz-Gomez K**, A. H., Landon, P. B., ., Kang, H. et al. (2016). **Magnetically-responsive silica–gold nanobowls for targeted delivery and SERS-based sensing**. *Nanoscale*, *8*(23), 11840-11850.

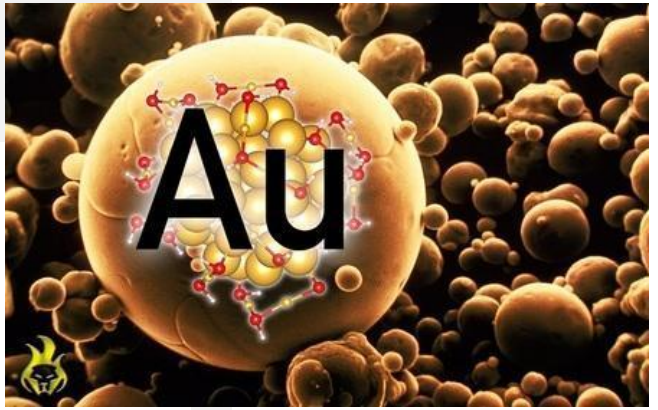
2. PPTT
(Plasmonic Photothermal Therapy)

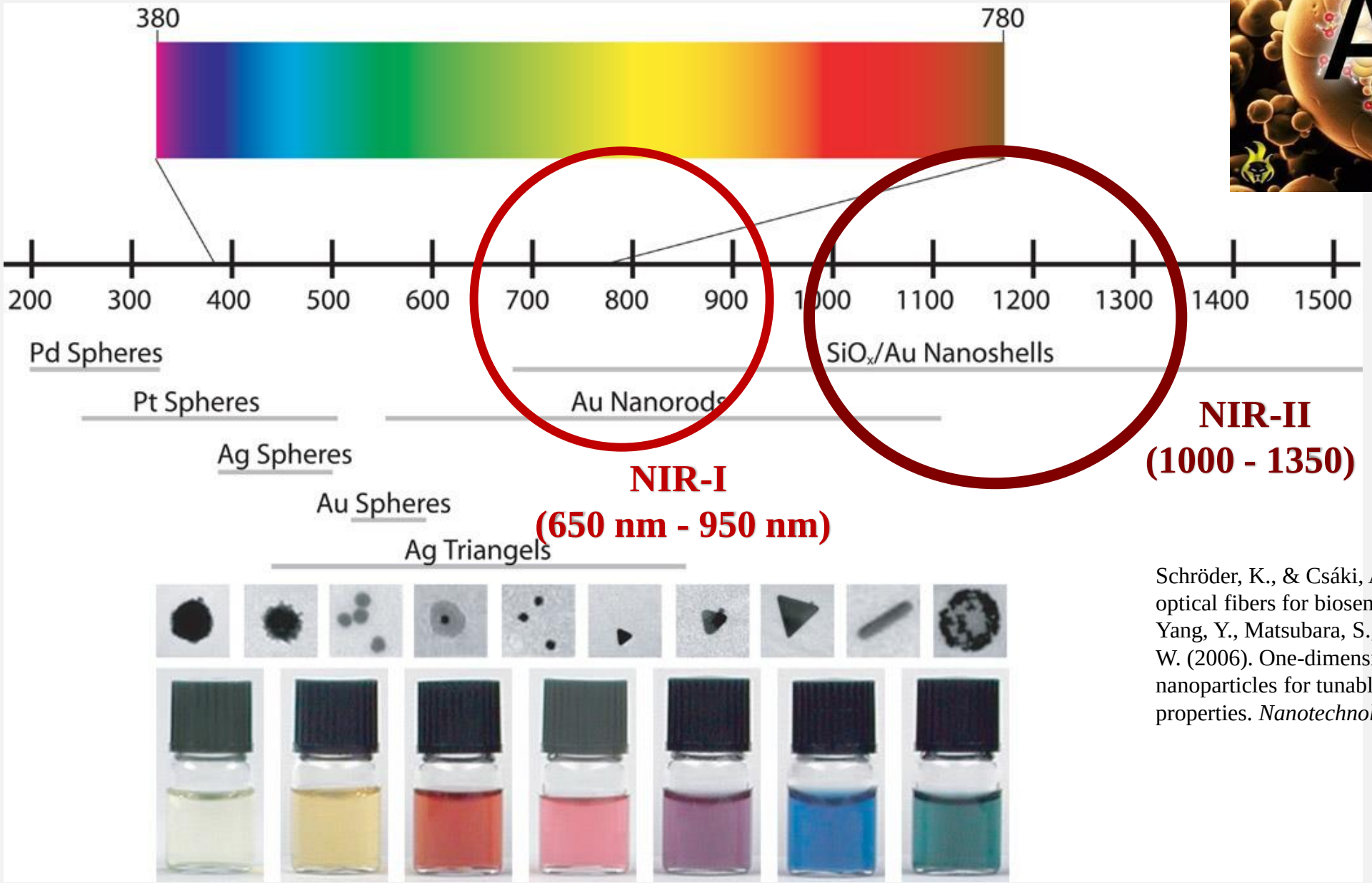




Janetanakit, W., **Santacruz-Gomez, K.**, R. Lal et al,. (2017). **Gold embedded hollow silica nano golf balls for imaging and photothermal therapy**. *ACS Applied Materials & Interfaces*.

MNPs-Plasmonic Resonance





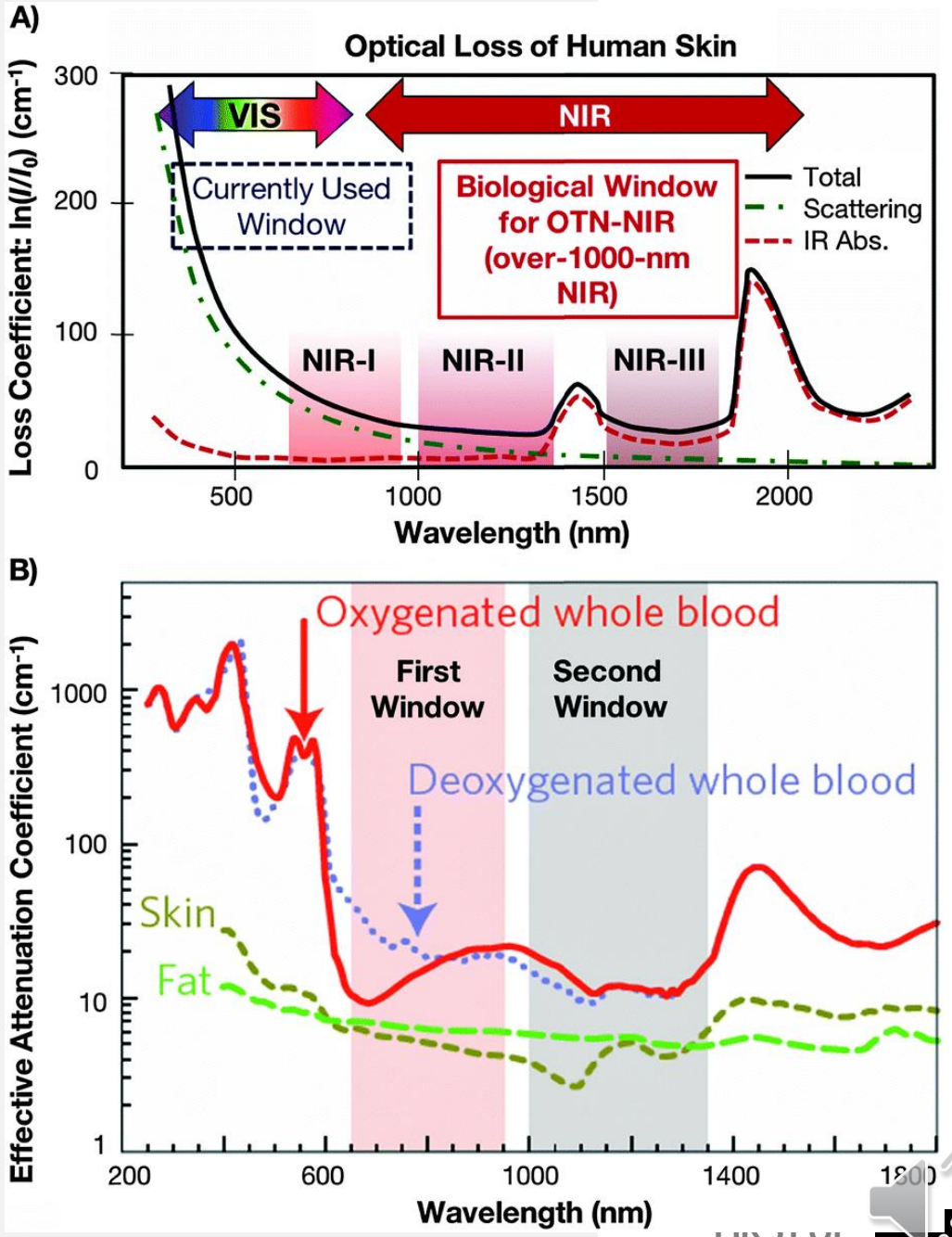
Schröder, K., & Csáki, A. (2011). Plasmonic tuning of optical fibers for biosensing,‖. *SPIE Newsroom*, 2-4.

Yang, Y., Matsubara, S., Nogami, M., Shi, J., & Huang, W. (2006). One-dimensional self-assembly of gold nanoparticles for tunable surface plasmon resonance properties. *Nanotechnology*, *17*(11), 2821.

NIR WINDOW IN BIOLOGICAL TISSUE

- First biological window : from 700 nm to 950 nm (NIR-I),
- Second biological window : from 1000 to 1350 (NIR-II).
- Third biological window: from 1550 to 1870 (NIR-III)

- Each window providing increased transparency toward biological matter.



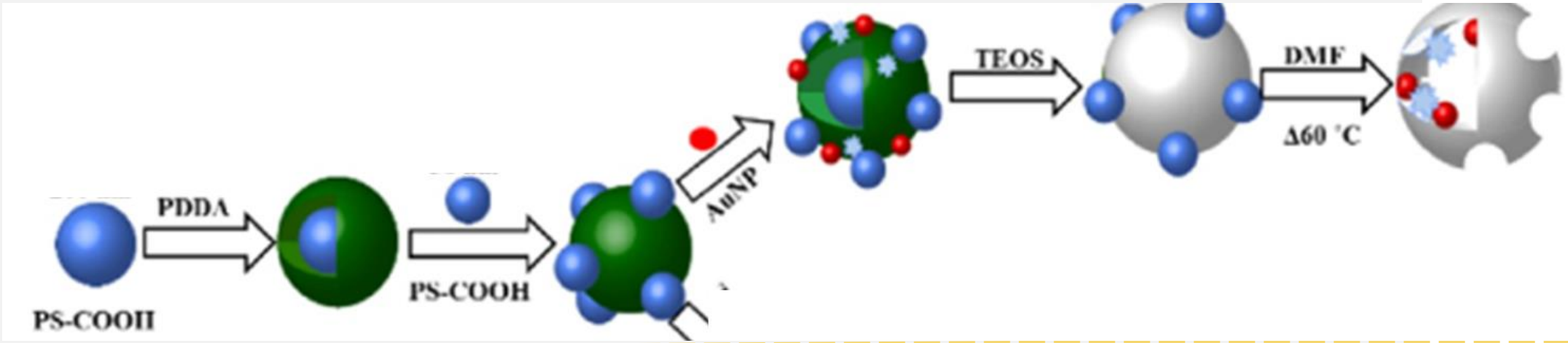
Macmillan Publishers Ltd: Nature Nanotechnol., 2009, 4, 710–711

The Aim of this Work Was…

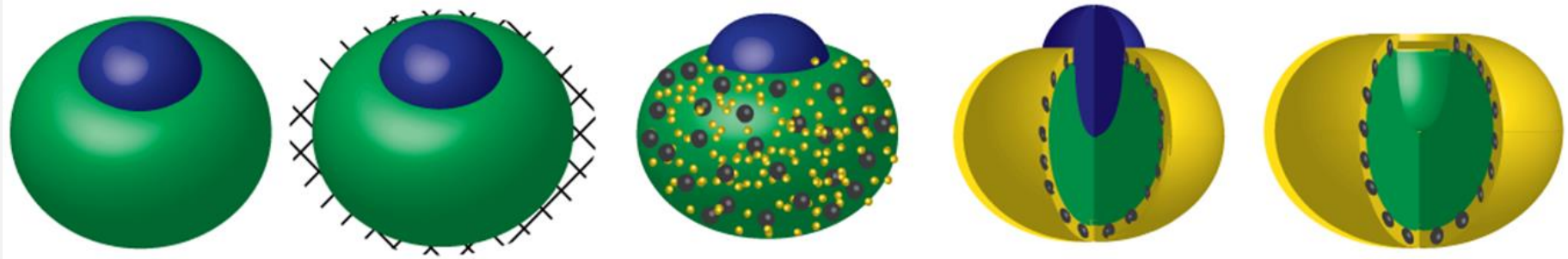
To synthethize Silica-gold nanoshells ($Au:SiO_2$)in two ways (Au embedded and Au core-shell) optimized to absorbed in the first biological spectral window were synthetized in two different ways to add the gold nanoparticles.

SYNTHESIS

Au:SiO2 (Au embedded)

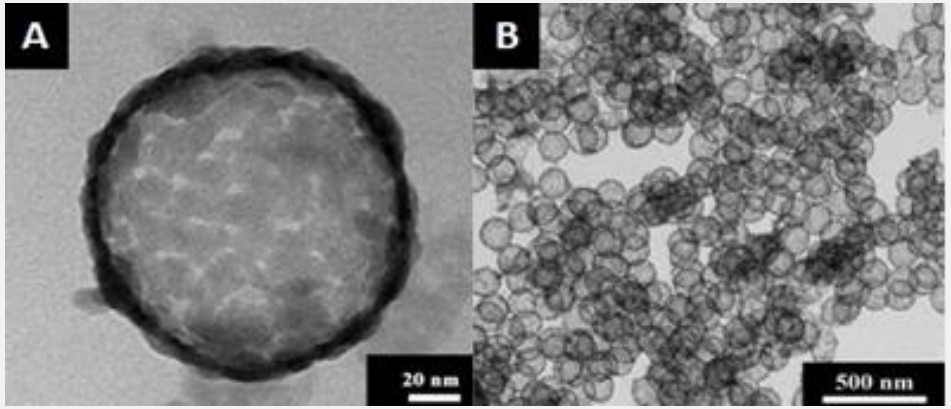


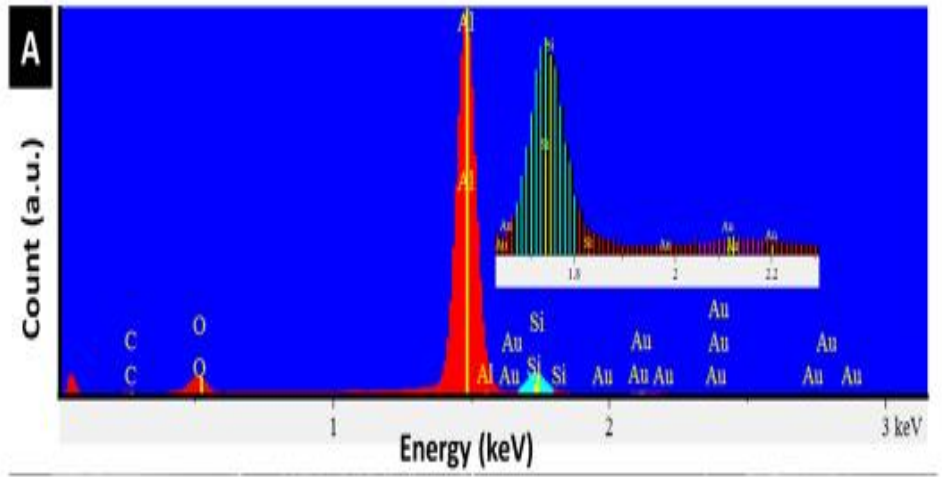
Au:SiO2 (Au core-shell)



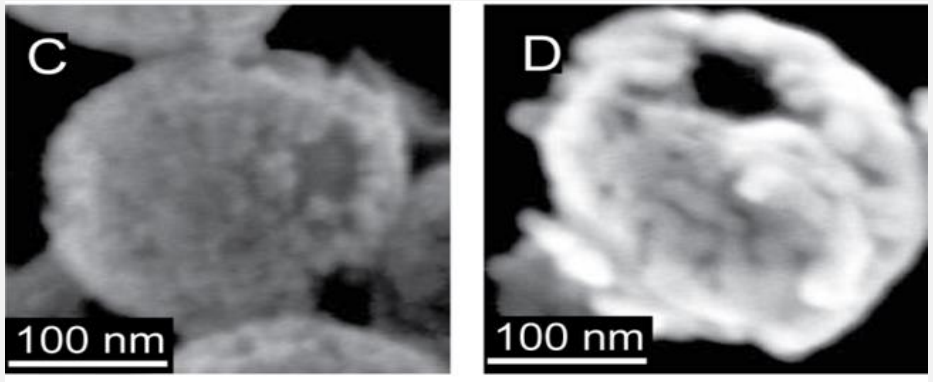
TEM Image Of Au:SiO_2 Nanoshells

Au:SiO2 (Au embedded)





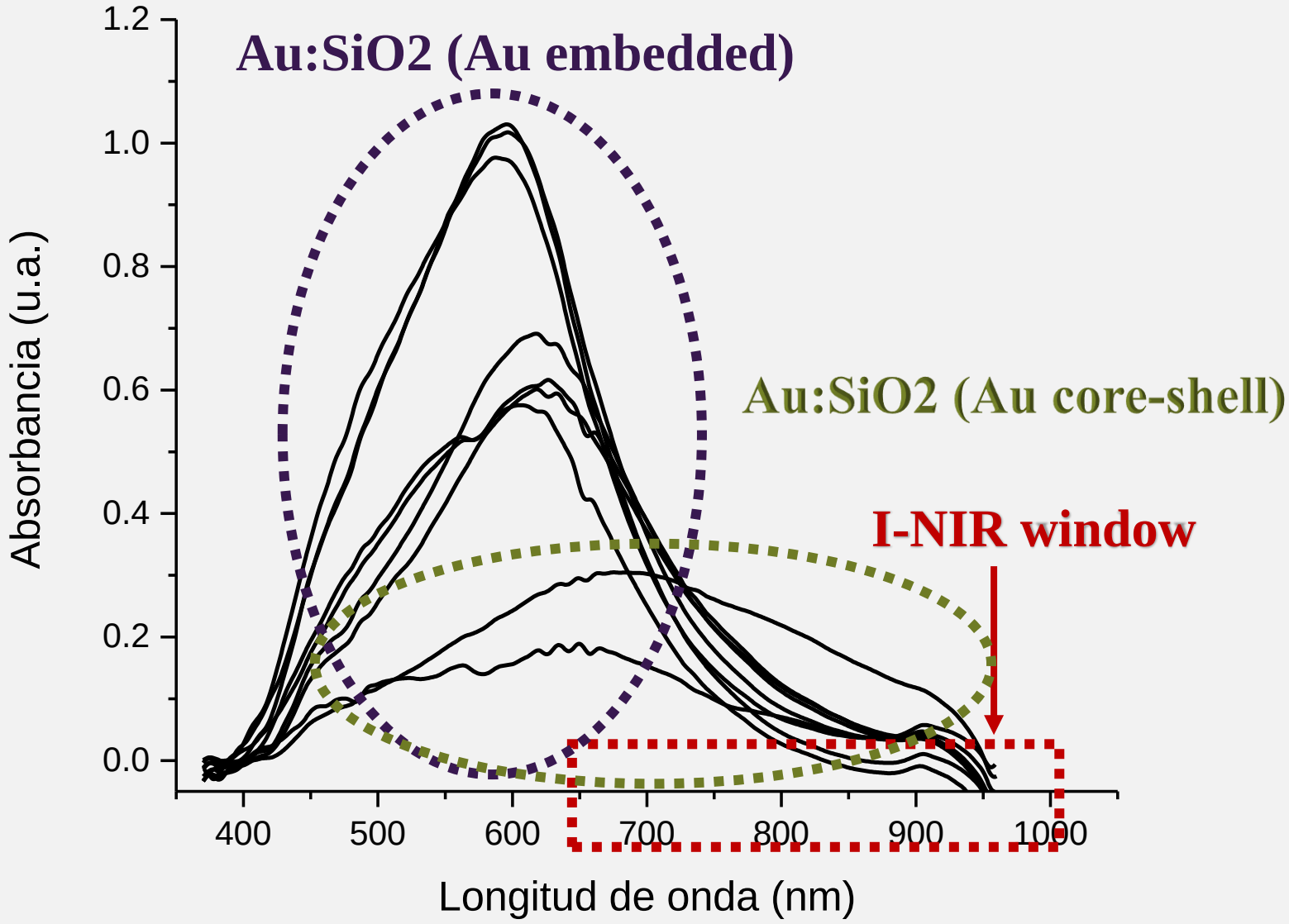
Au:SiO2 (Au core-shell)



- Au:SiO_2 (Au embedded): 150 nm

- Au:SiO_2 (Au core-shell) 240 nm

SURFACE PLASMON RESONANCE



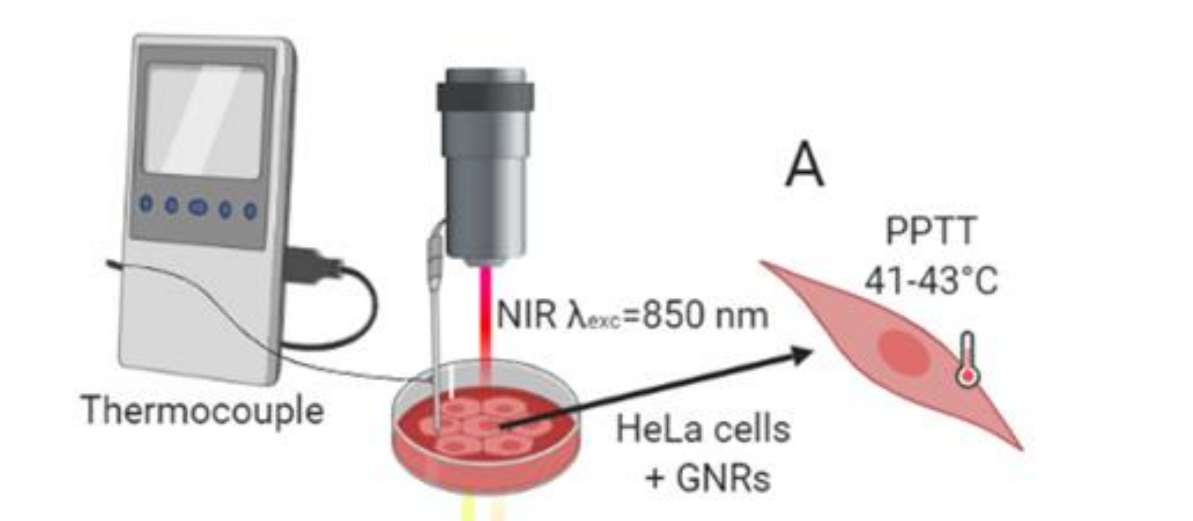
- $Au:SiO_2$

(Au embedded): absorbed from 400 to 800 nm. λ_{max}=600nm

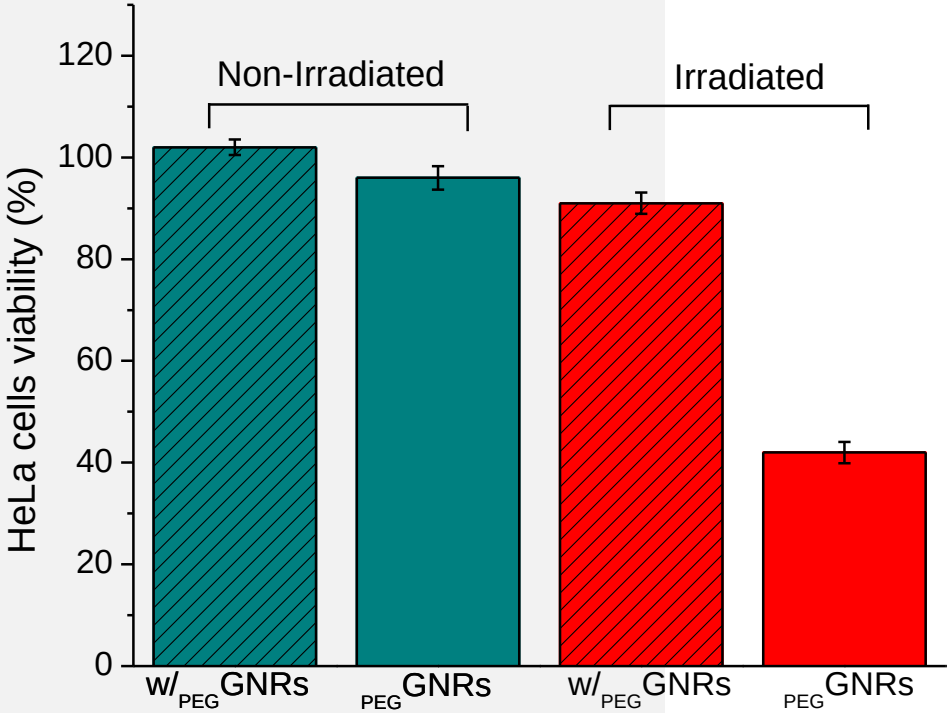
- $Au:SiO_2$

(Au core-shell) absorbed from 400 to 950 nm. λ_{max}=700nm

PHOTOCHEMICAL EFFECT



The microscope includes an optical fibre, an 850 nm laser was coupled to this fibre and the IR light was delivered directly into the microscope objective to the sample.



PPTT killed 60.5% of the HeLa cells, whereas 97.3% of cells remained viable in samples irradiated in the absence of $_{PEG}$GNRs; in comparison, both non-irradiated samples (with and without $_{PEG}$GNRs) shown a non-significant effect on viability

CONCLUSIONS

- Two types of Au:SiO_2 nanostructures absorbing at the first biological window were synthetized: (Au core-Shell and Au embedded).

Au:SiO_2	**Au core-Shell**	**Au embedded**
Size (nm)	240	150
Optical absorption (nm)	400 - 950	400 - 800
LSPR máximum(nm)	700nm	600nm
LSPR max intensity (a.u.)	0.3	0.8

- After 5 and 10 minutes of (850 nm) laser exposure of HeLa Cells incubated with Au:SiO2 PEGylated nanoshells, no significative photochemical damage was observed

FIRST UP
CONSULTANTS

THANKS