X Conferencia Anual Plataformas Tecnológicas de Investigación Biomédica

Universidad de Alcalá

Plataforma de Mercados Biotecnológicos

NANOMED SPAIN

MEDICAMENTOS INNOVADORES Plataforma Tecnológica Española

PLATAFORMA ESPAÑOLA INNOVACIÓN TECNOLOGÍA SANITARIA

Micromotors for clinical diagnosis

Alberto Escarpa

Professor of Analytical Chemistry

Universidad de Alcalá

Madrid. Spain

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Downsizing Analytical Diagnostics

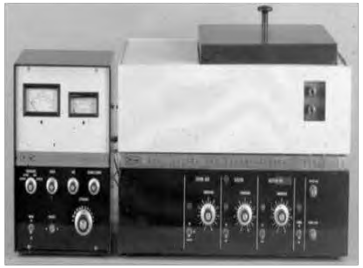
MILLISYSTEMS

MICROSYSTEMS

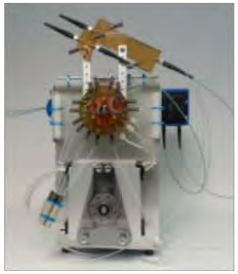
CONVENTIONAL ANALYTICAL SYSTEMS

m mm µm nm

NANOSYSTEMS

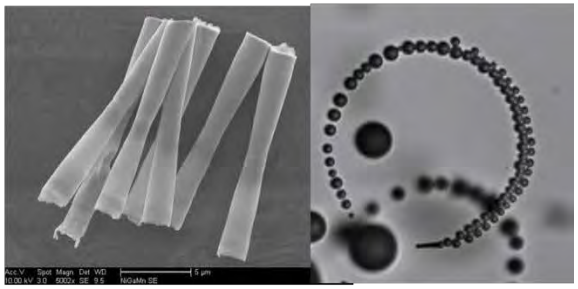


Old gas chromatograph



Miniaturized FIA

MEMS
µTAS



Self-propelled nanomotors

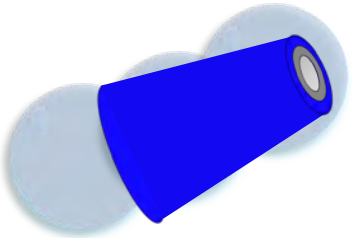
What and Why micromotors?

- Microdevice that converts energy into mechanical work
- Propulsion based in asymmetry
- Chemistry "*on the fly*"

- Autonomous work
- Fast diagnosis times
- Diagnosis"*on the fly*"
- Low clinical sample volumes

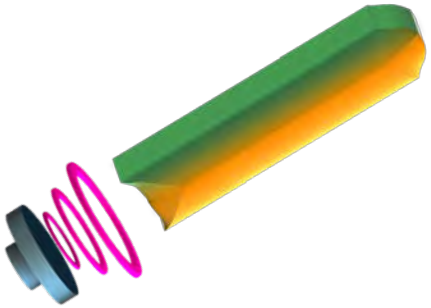
Chemical reaction

Chemically powered micromotors

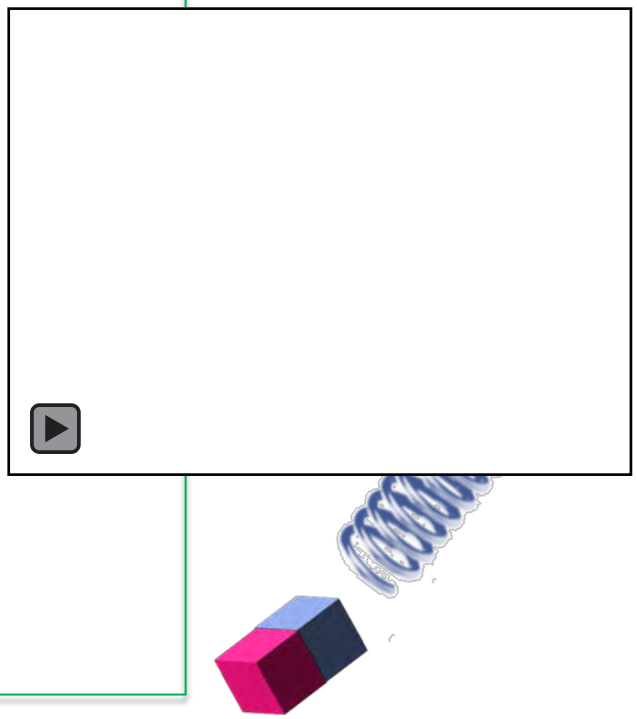


Acoustic energy

Ultrasound powered micromotors



Others



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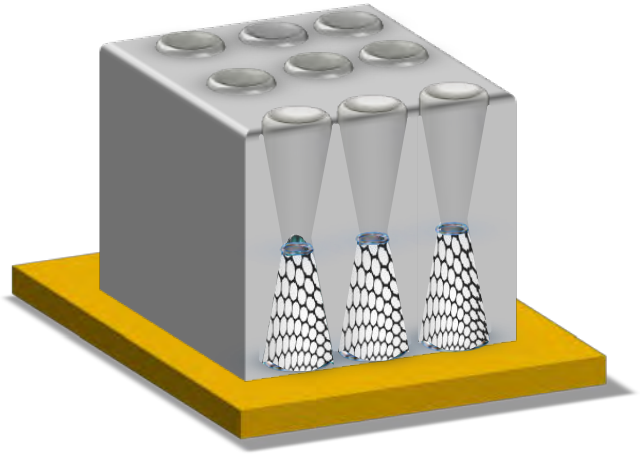
Fabrication of graphene-based micromotors



Synthesized micromotors

Graphene/Pt
Graphene/Au

Control (polyaniline, PANI)
PANI/Pt
PANI/ Au

Membrane as template

Gold sputter

Electrochemical cell
WE- membrane
RE- Ag/AgCl
CE- Pt wire

Graphene oxide
CV (-1.5 V, 5 cycles)

Platinum
(-2 mA 500s)

or Gold/catalase
(-0.9 V, 1 C)

Electrochemical deposition

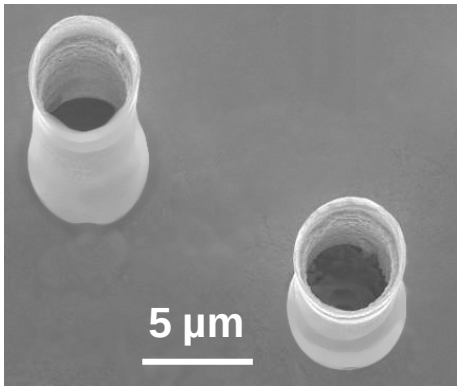
Removal of sputtered layer

Removal of membrane

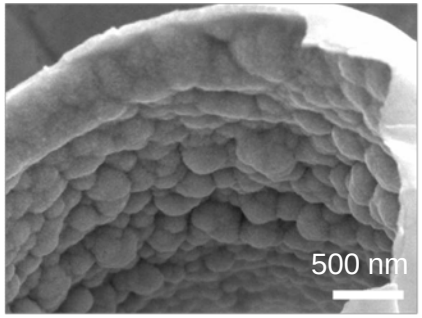
Micromotors release

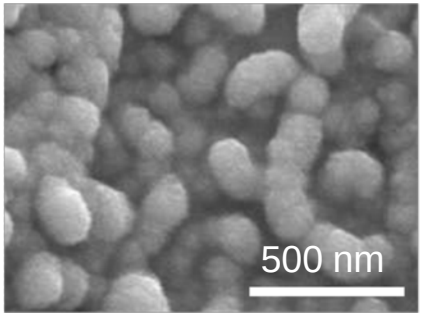
A. Martín, B. Jurado, **A. Escarpa**, J. Wang, *Small,* **2015**, 11, 3568

Characterization of graphene-based micromotors by SEM

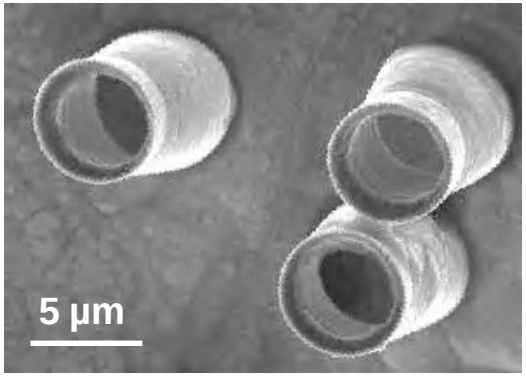


Graphene/Pt

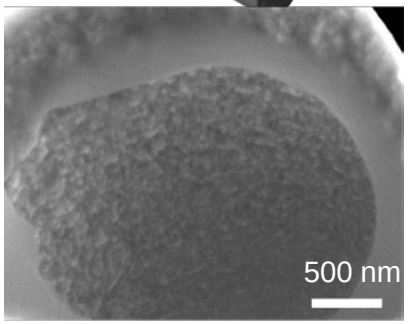


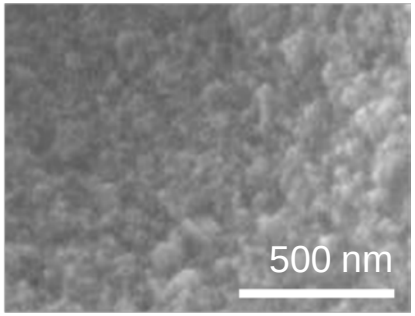


Pt Nanoparticles



Graphene/Au





Au Nanoparticles

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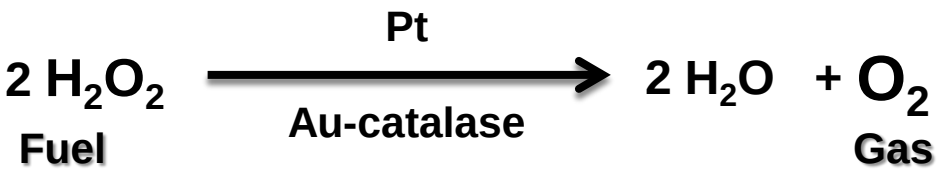
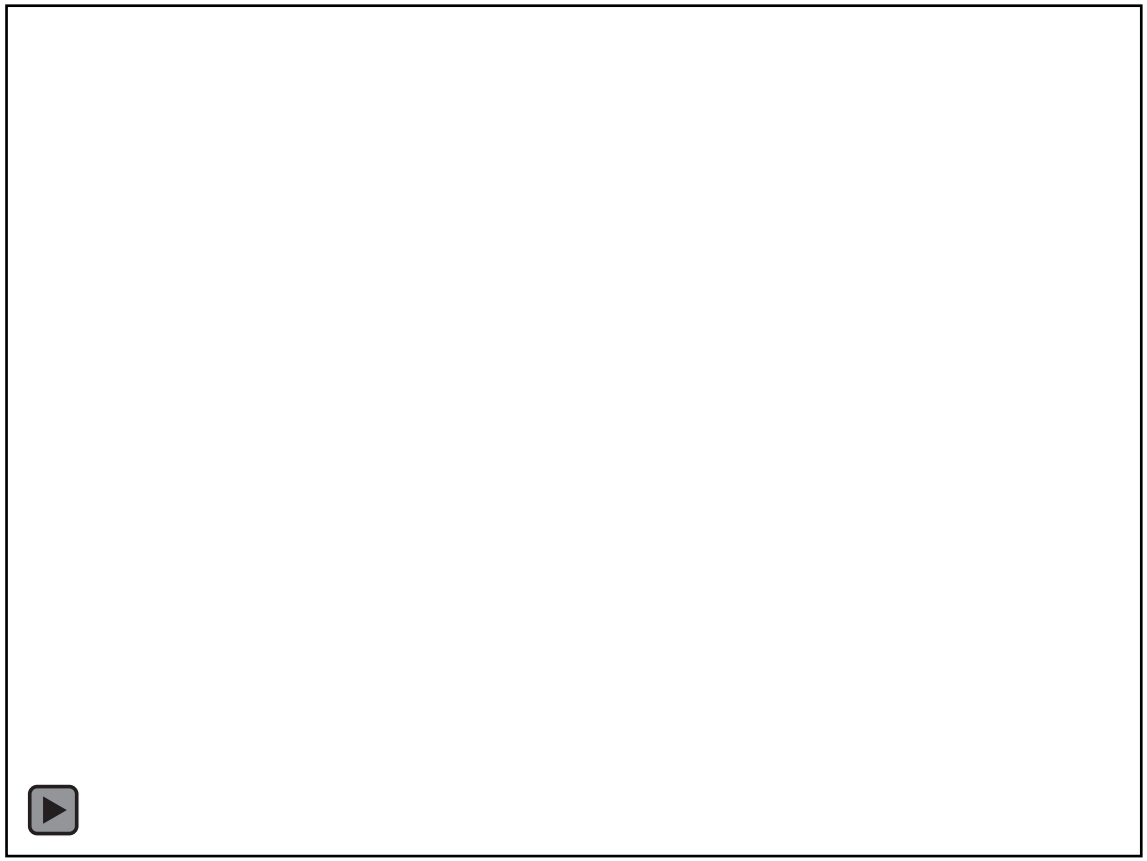
Chemically powered graphene micromotors



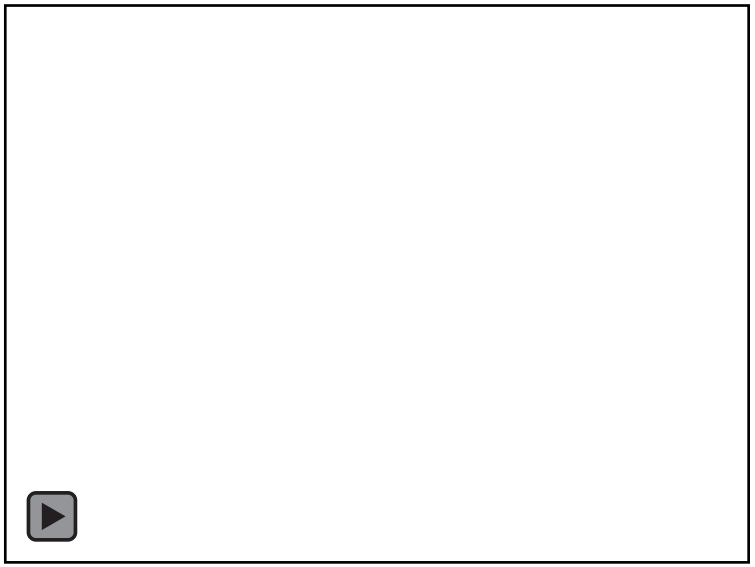
Bubble propulsion



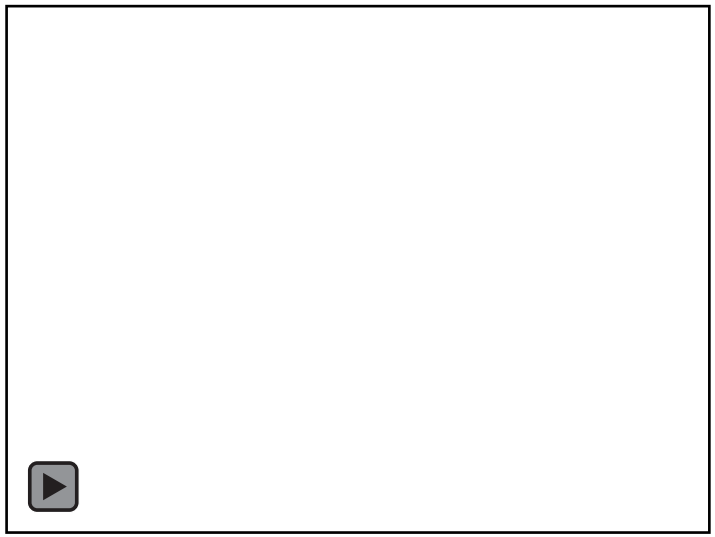
Graphene/Pt microengines in 2 % H_2O_2 with 1.5% sodium cholate.

Speed of chemically powered graphene micromotors

Pt (μm s^{-1})					
Graphene	**37**	81	170	390	1700
PANI	**0**	30	96	220	660
H_2O_2 (%)	**0.1**	0.2	0.5	1.0	3.0



Au/catalase (μm s^{-1})	
Graphene	**321**
PANI	**156**
H_2O_2 (%)	**1.0**



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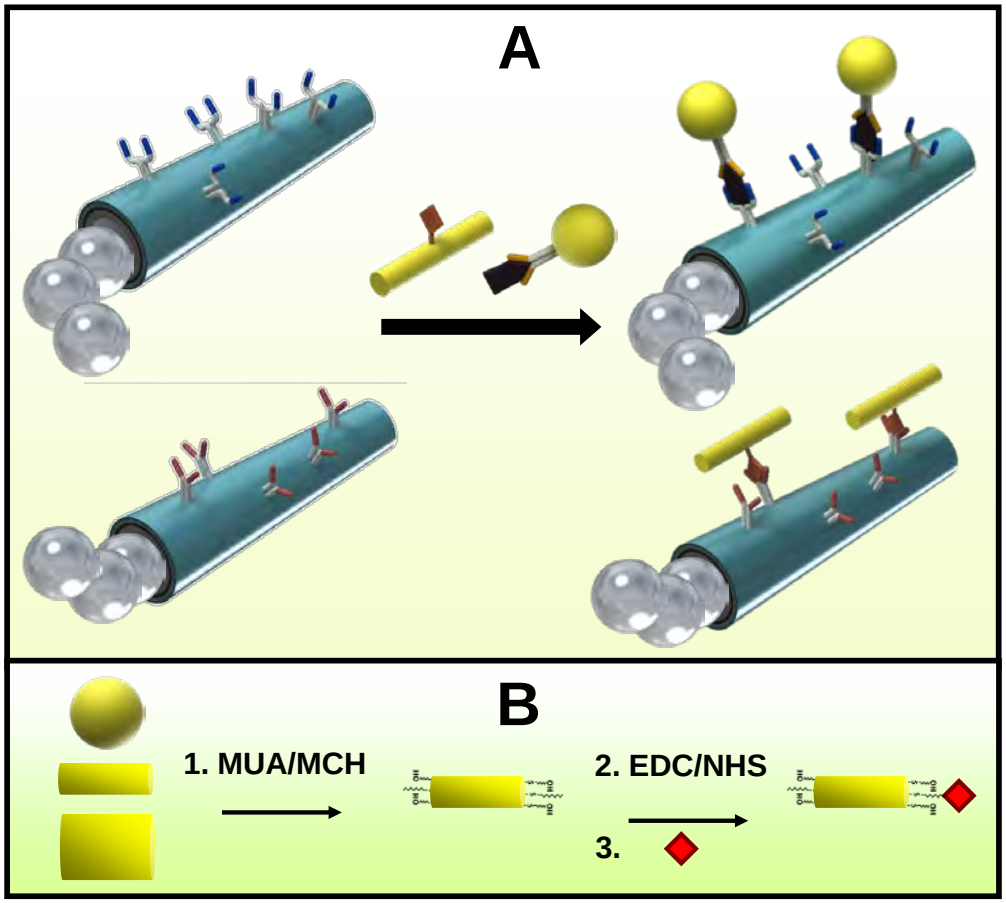
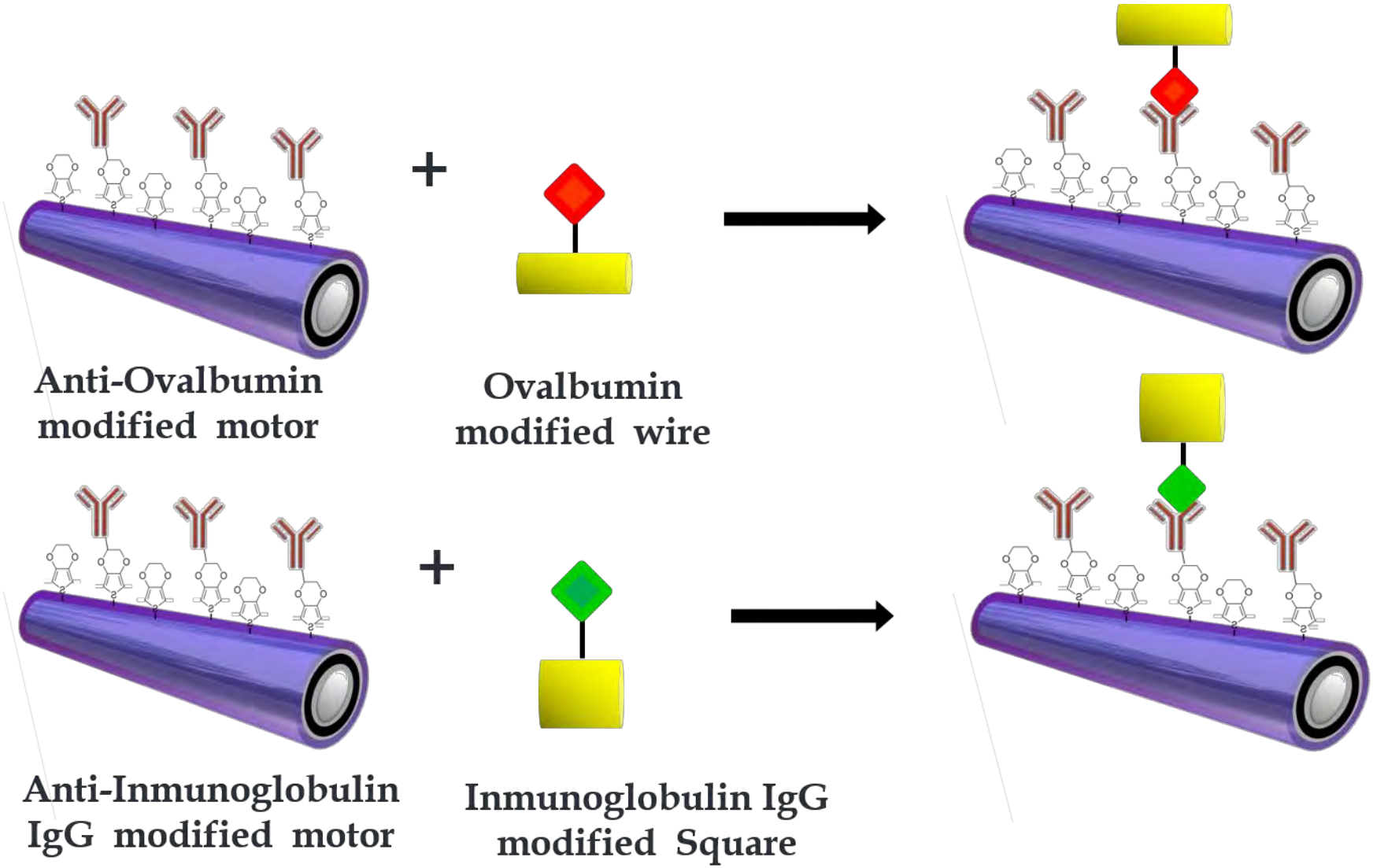
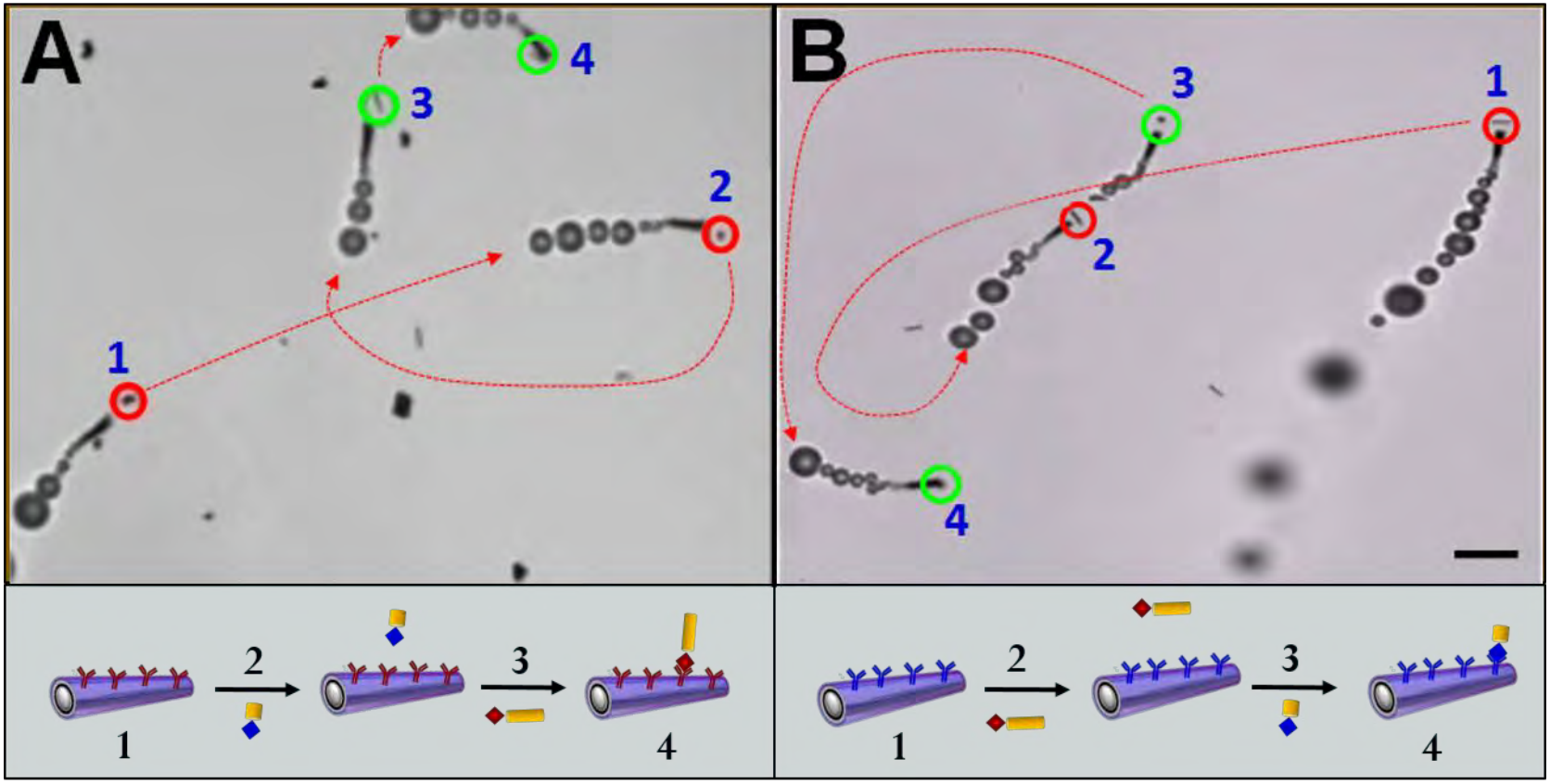
Protein detection with particles of different shapes and sizes



Protein detection with particles of different shapes and sizes



Multiplexed detection of proteins



A. An anti-ovalbumin-functionalized micromotor capturing a 4 µm wire-tagged ovalbumin proteins after bypassing a 2 µm square-tagged IgG proteins as negative control

B. Anti-IgG functionalized micromotor capturing a 2 µm square-tagged IgG proteins after bypassing a 4 µm wire-tagged ovalbumin proteins.

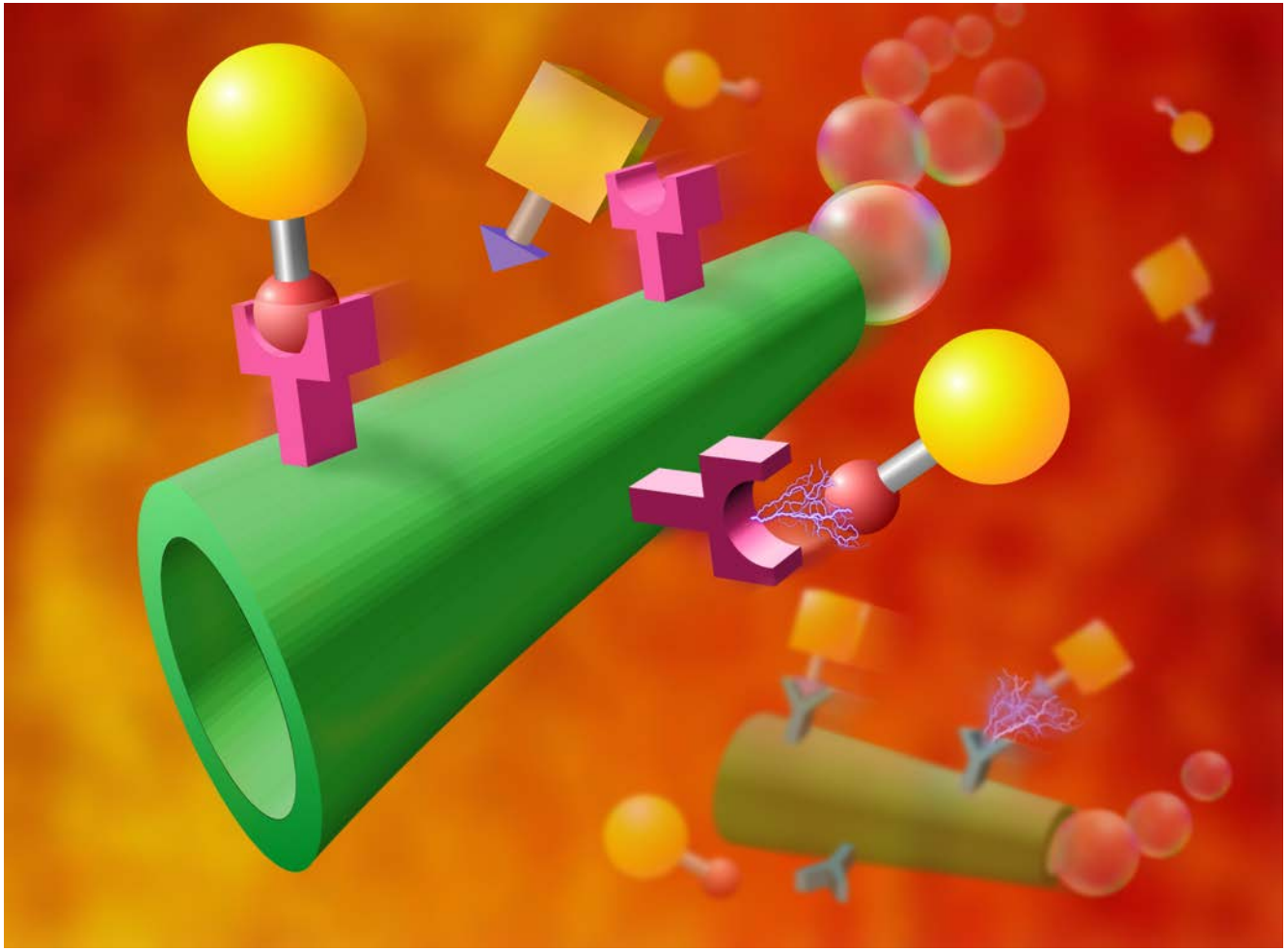
Selective capture of Ovalbumin

2 μm squares-tagged IgG (N.C.)

Selective capture of IgG

4 µm wires-tagged Ovalbumin (NC)

Micromotors for multiplexed immunoassays



D. Vilela, J. Orozco, G. Cheng, J. Wang and **A. Escarpa**, Lab Chip 14 (2014) 3505 – 3509

Featured as Hot Paper & Front Cover Issue

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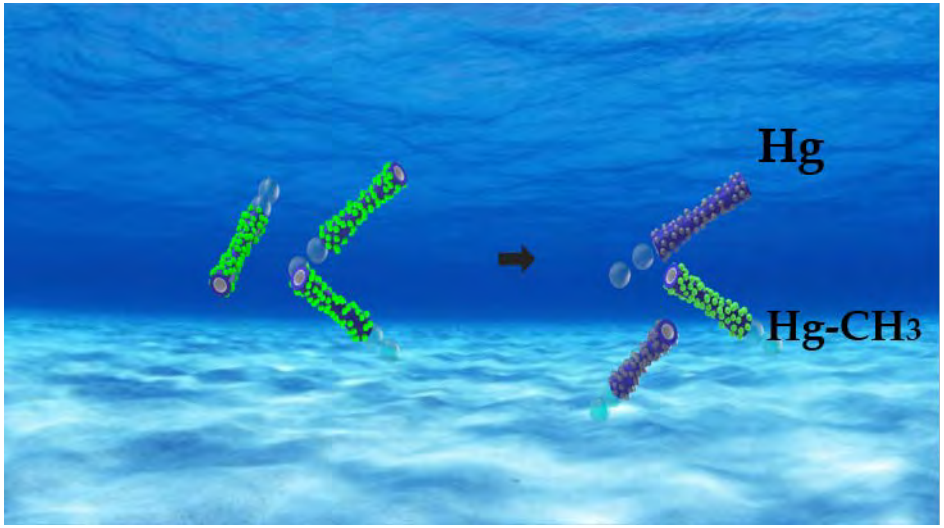
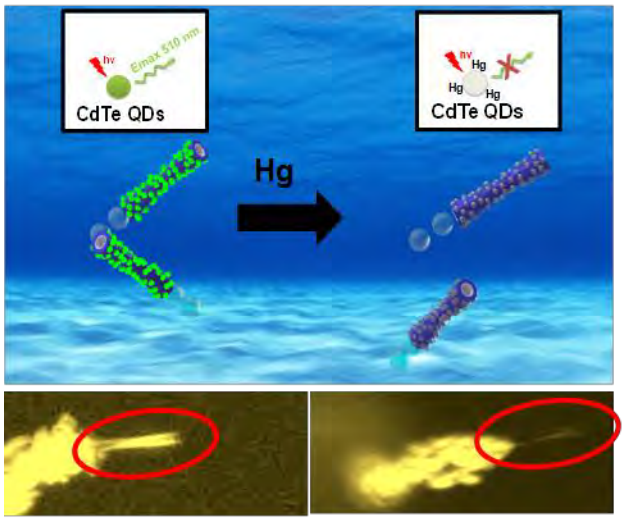
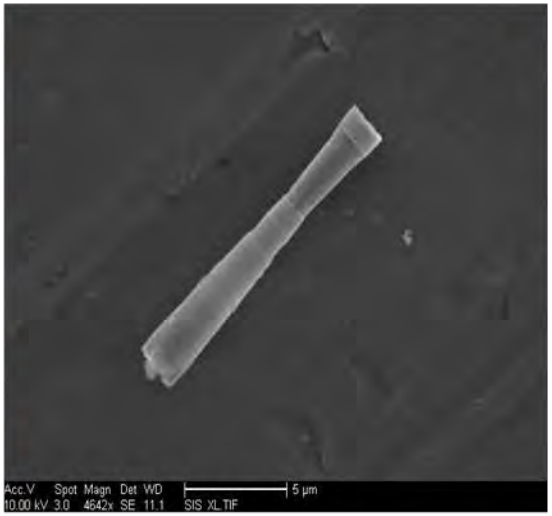
Quantum Dots-based micromotors for smart chemical sensing

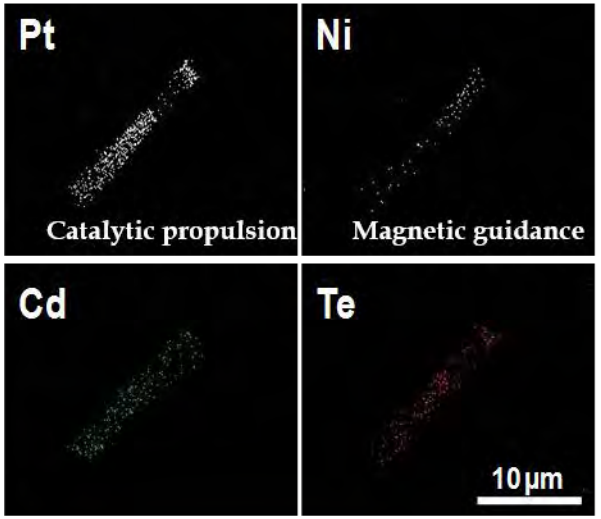


B. Jurado, **A. Escarpa**, J. Wang Chem. Commun., 51, 2015, 14088

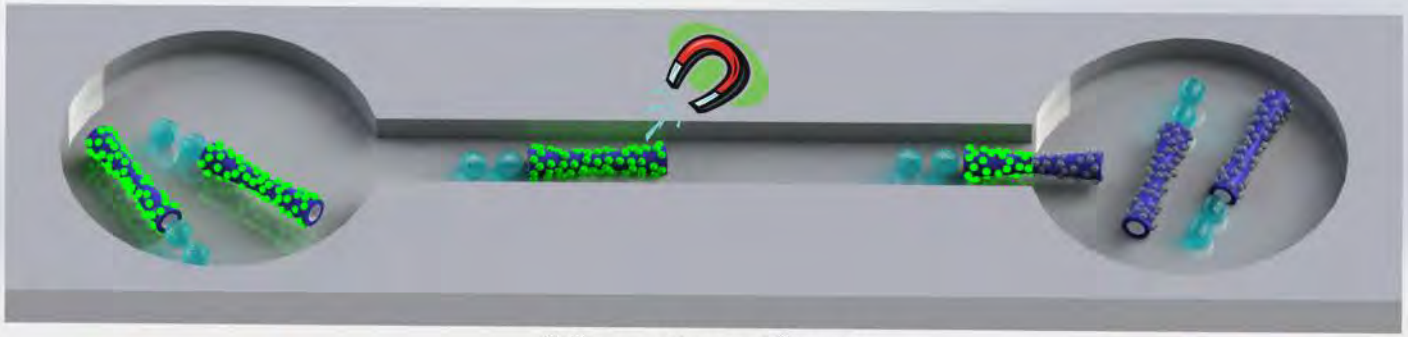
Quantum Dots-based micromotors for LOC chemical sensing





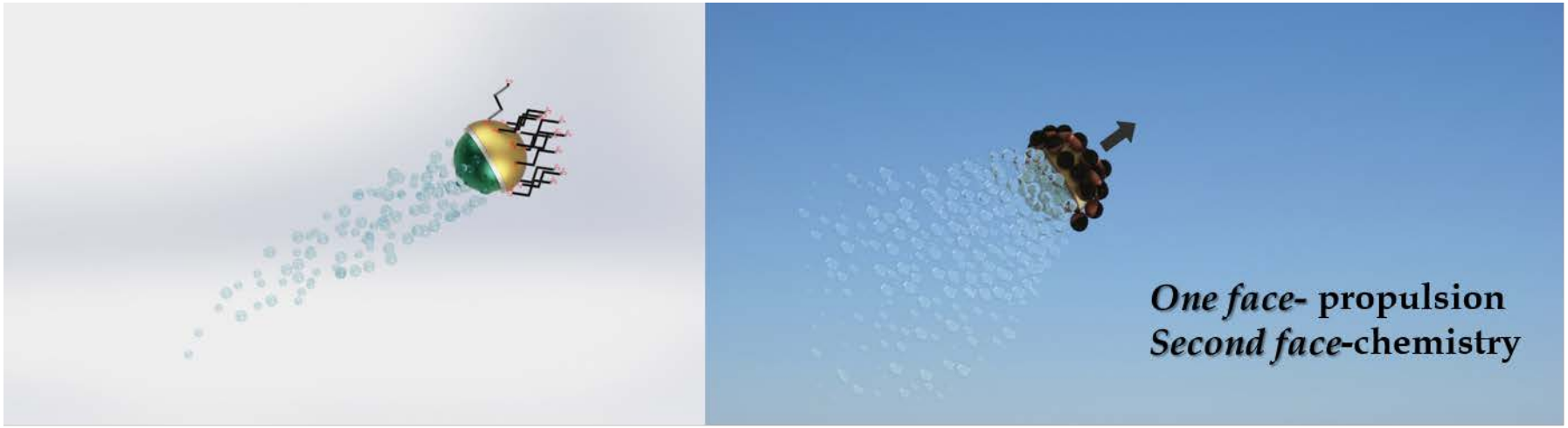


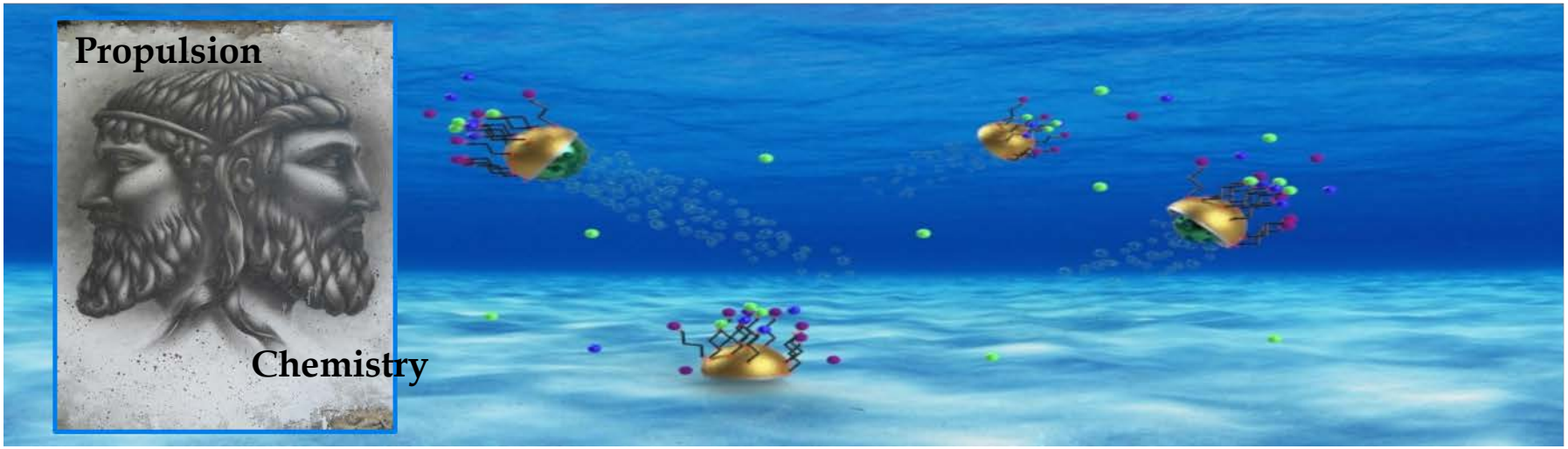
Future perspectives



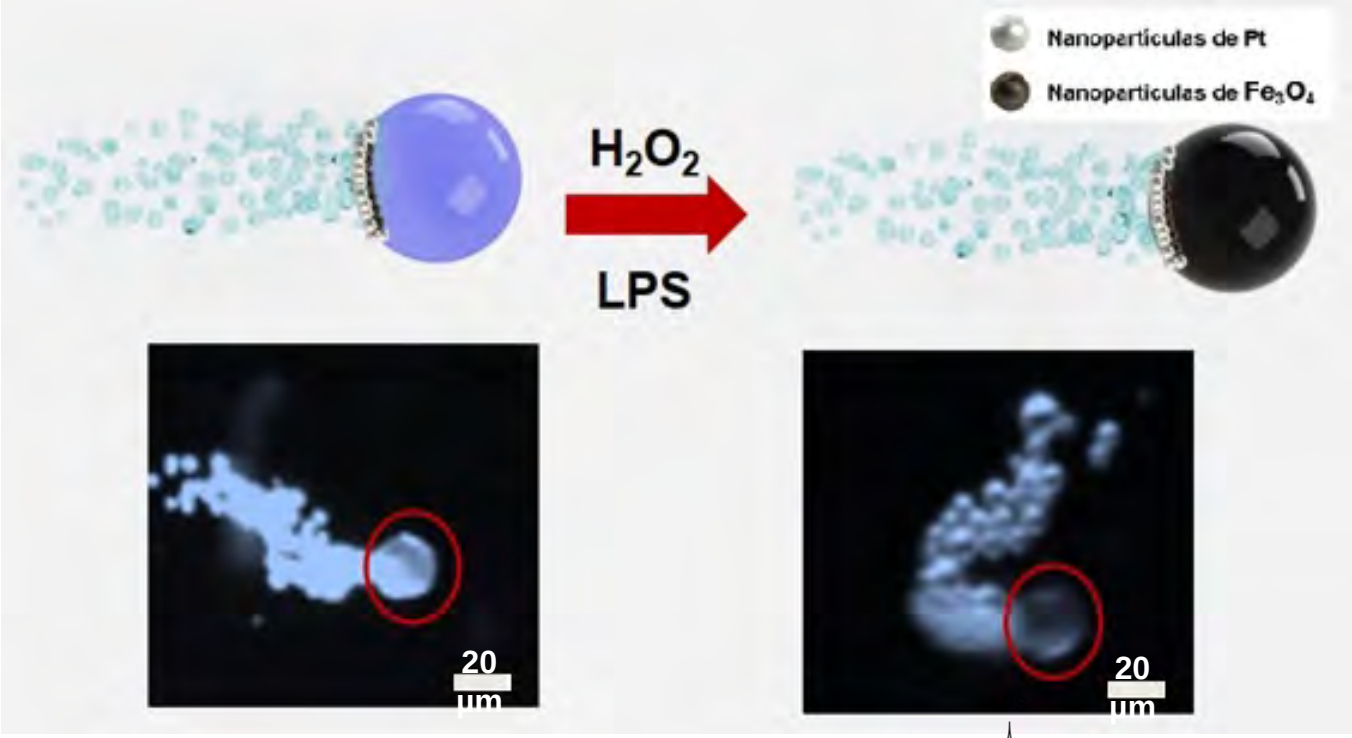
B. Jurado, **A. Escarpa**, J. Wang, Chem. Commun., 51, 2015, 14088

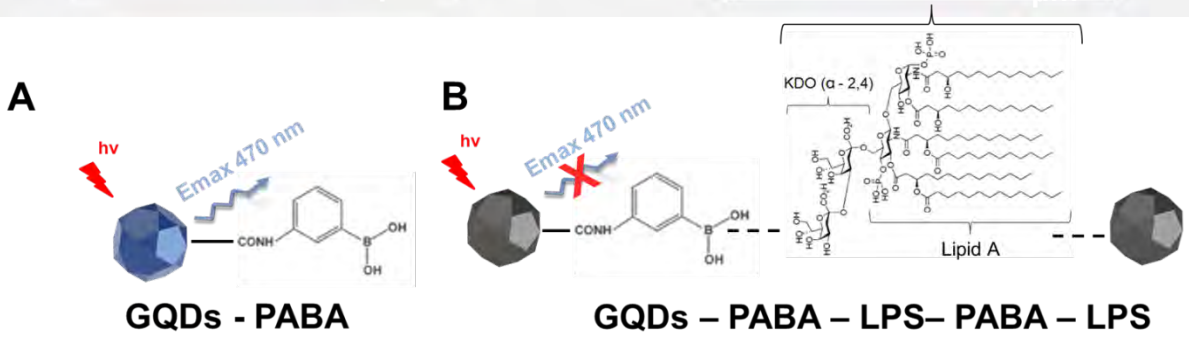
What is a Janus particle? Two faces, two components





Graphene Quantum Dots-based Janus micromotors for endotoxin detection: strategy





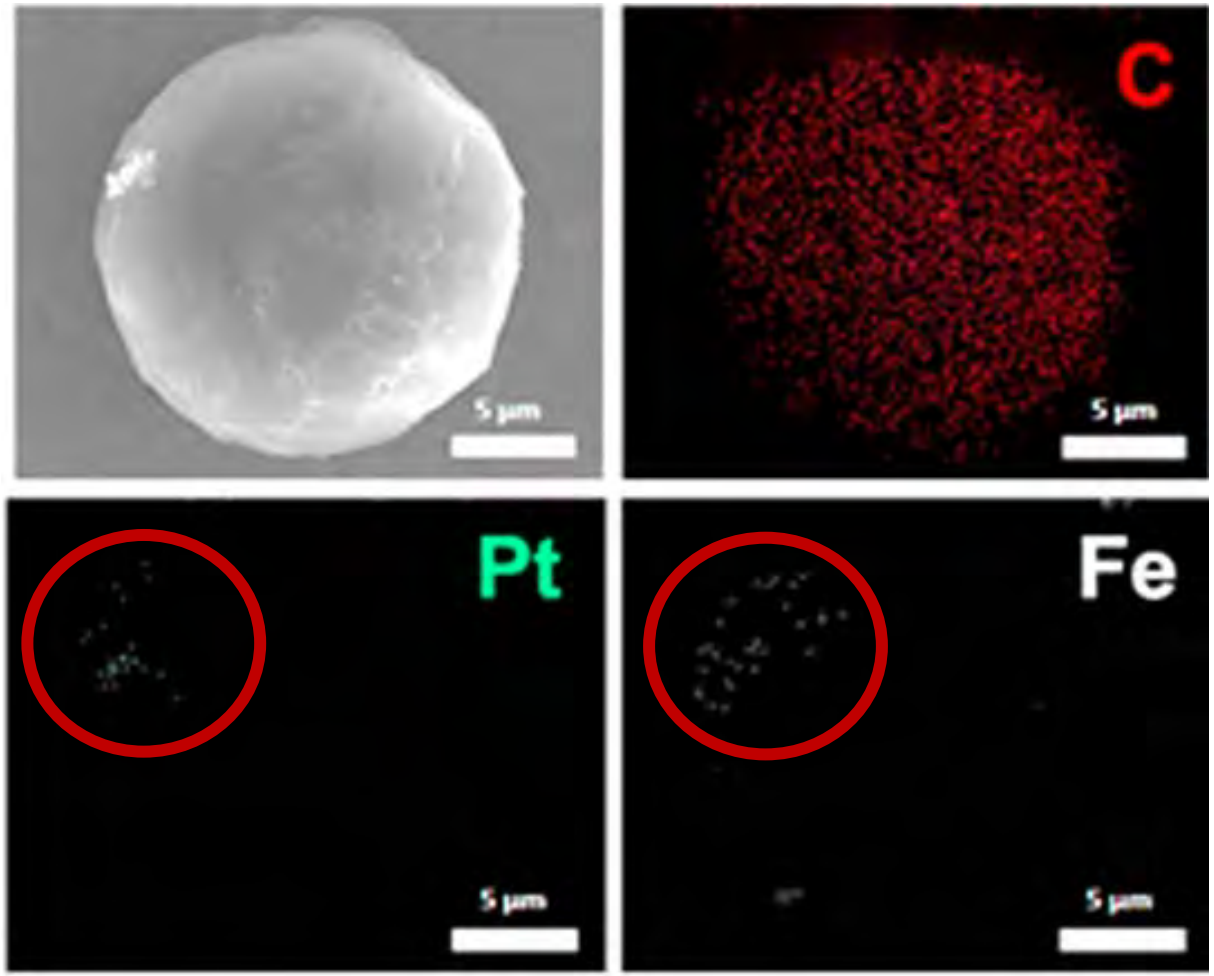
GQDs - PABA

GQDs – PABA – LPS– PABA – LPS

Lipopolysaccharides (LPS) from Escherichia Coli/3-Aminophenylboronic acid (PABA)

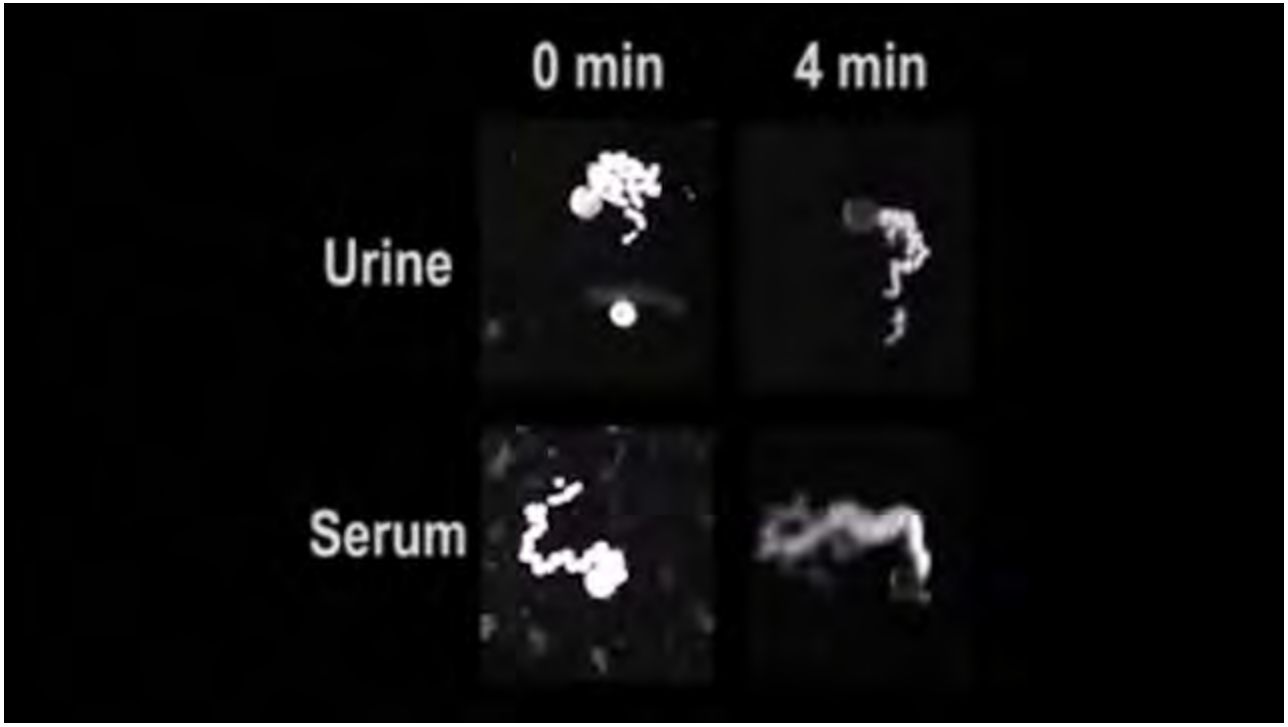
Graphene Quantum Dots-based Janus micromotors for endotoxin detection: characterization

SEM Y



Graphene Quantum Dots-based Janus micromotors for endotoxin detection

Graphene Quantum Dots-based Janus micromotors for endotoxin detection



Biological materials detection: extension of the concept

Recognition Labeling
Detection

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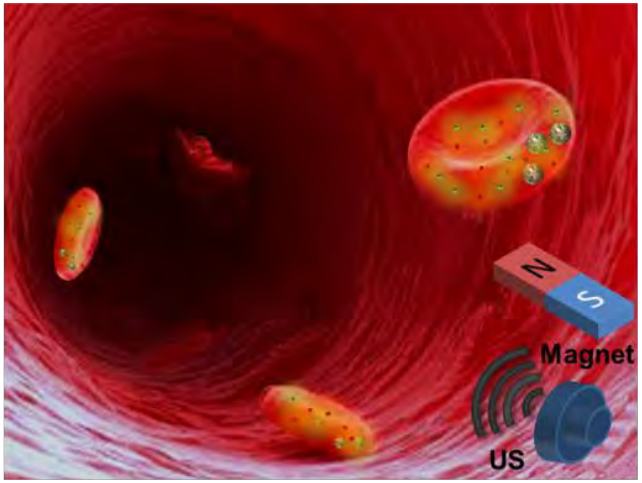
Red Blood Cell micromotors: biocompatible transporters



Mimeting blood vessels with microfluidic channels

Magnetic nanoparticles (MNPs)

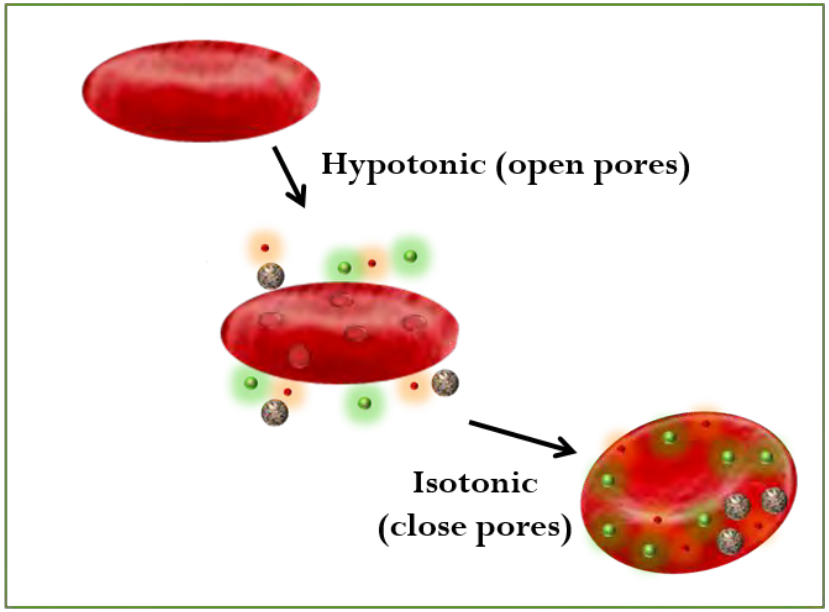
Magneto-switchable control
Ultrasound propulsion

Quantum Dots (QDs)

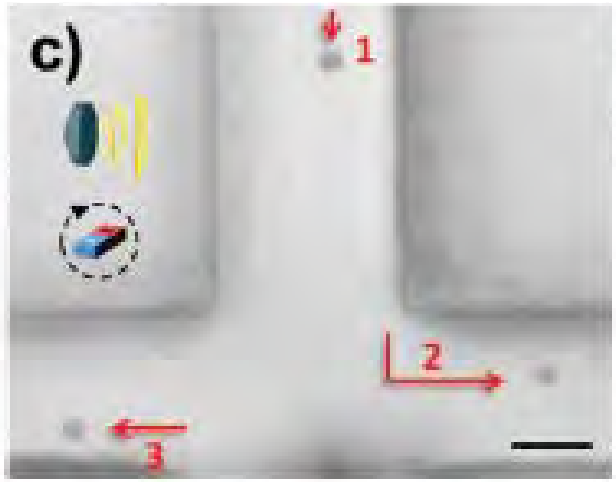
Fluorescence imaging

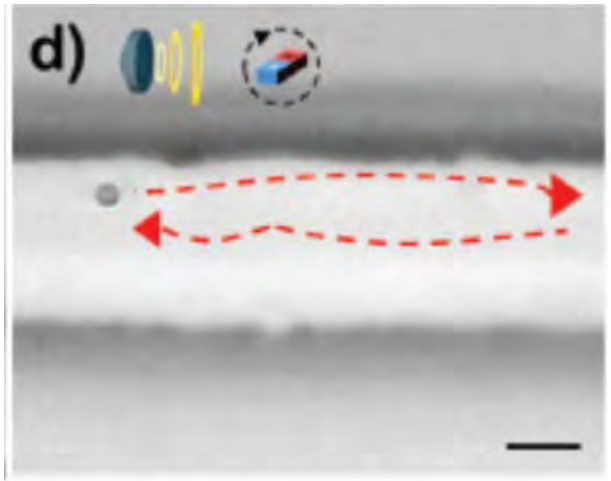
Doxorubicin (DOX)

Cargo towards theranostics



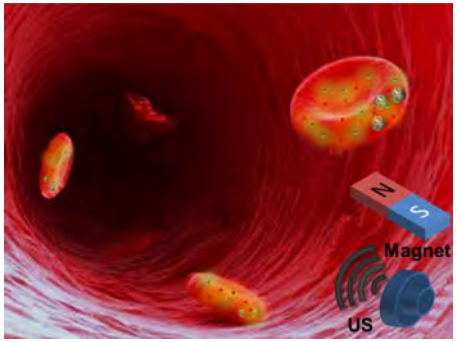
Red Blood Cell micromotors: biocompatible transporters





A. Martin, A. Escarpa, J. Wang et al. *Nanoscale*, **2015**, 7, 13680-13686

Red Blood Cells micromotors: biocompatible transporters



Magneto-switchable control

Ultrasound propulsion

PDMS microfluidic channel

Nanoscale, **2015**, 7, 13680-13686

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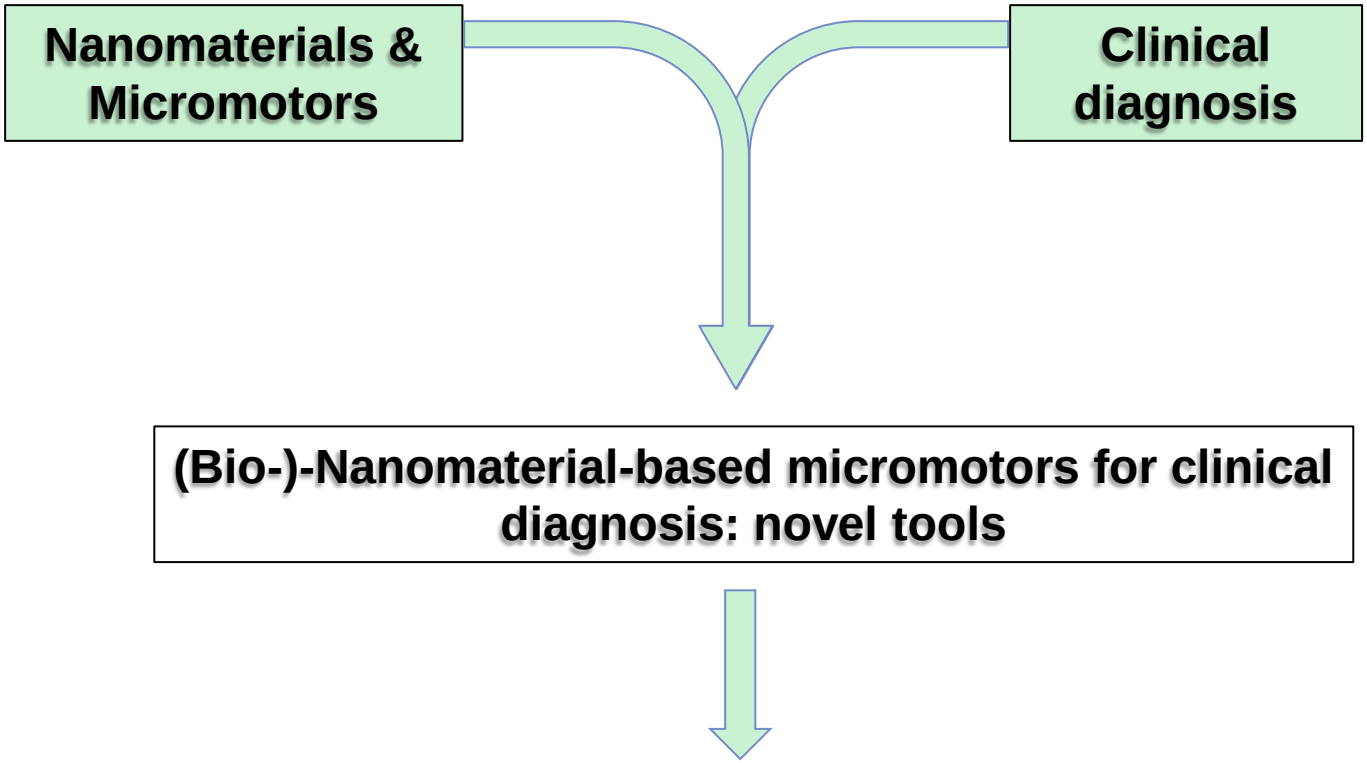
Conclusion & Perspective



Prof. Alberto Escarpa alberto.escarpa@uah.es

Collaborators in this presentation:

Dr. Joseph Wang (UCSD, EEUU)

Dra. Beatriz Jurado
Dra. Aída Martín
Dra. Diana Vilela

More team members

Prof. M. Cristina González
Prof. Miguel A. López

Dra. María Moreno
Dr. Agustín González
Dr. Flavio dela Pelle

PhD students

Ldo. Juan Adrián Jodra
Lda. Laura García
Lda. Águeda Molinero
Ldo. Roberto María
Ldo. Daniel Rojas
Lda. Tania Sánchez
Lda. Marta Pacheco

Alcalá Old Town and University World Heritage Places by UNESCO






Thank you!
¡Gracias!