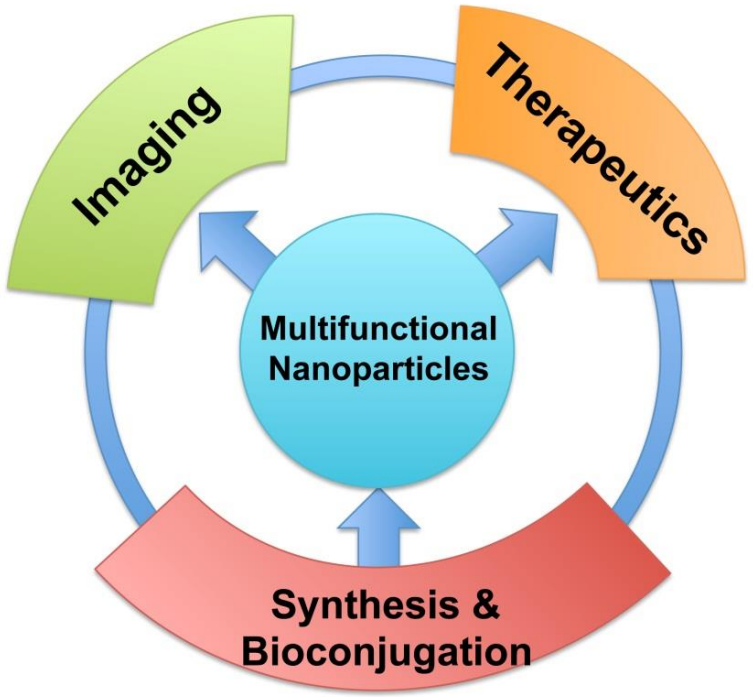
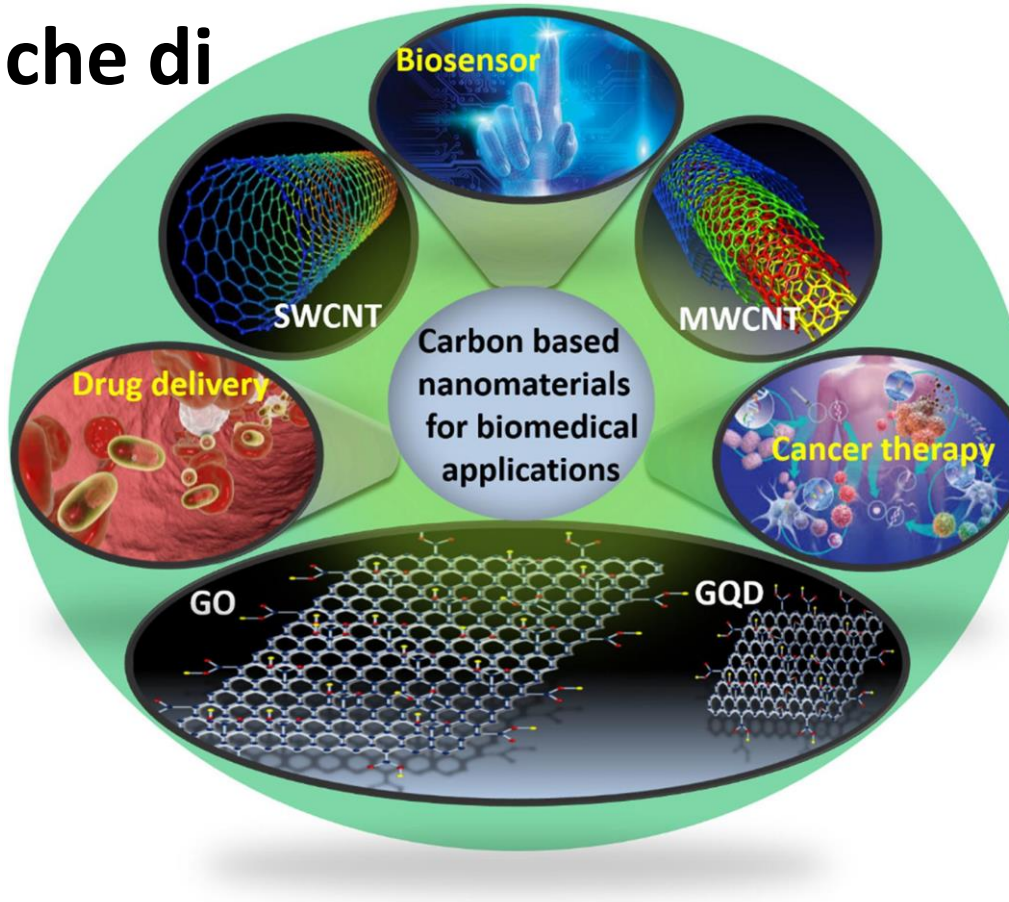
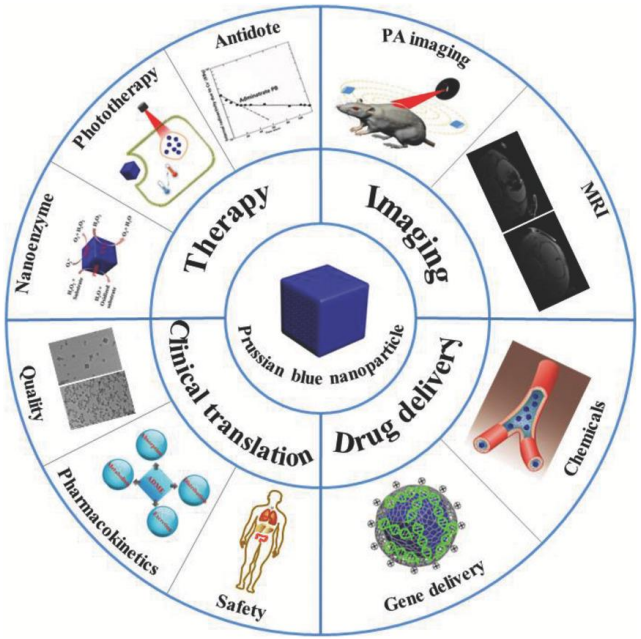
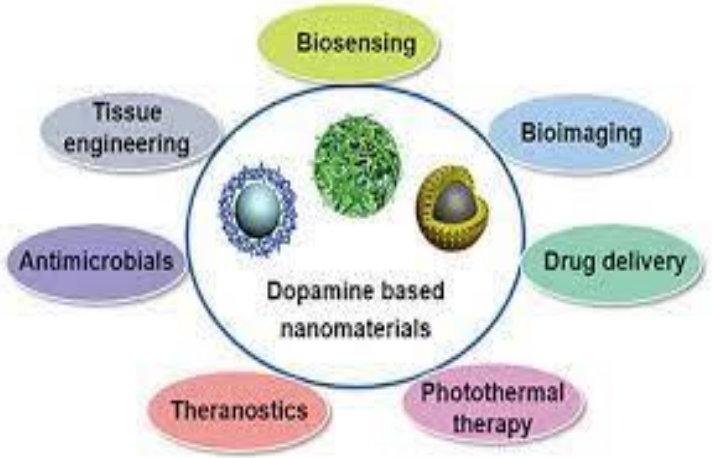
Applicazioni biomediche di nanomateriali

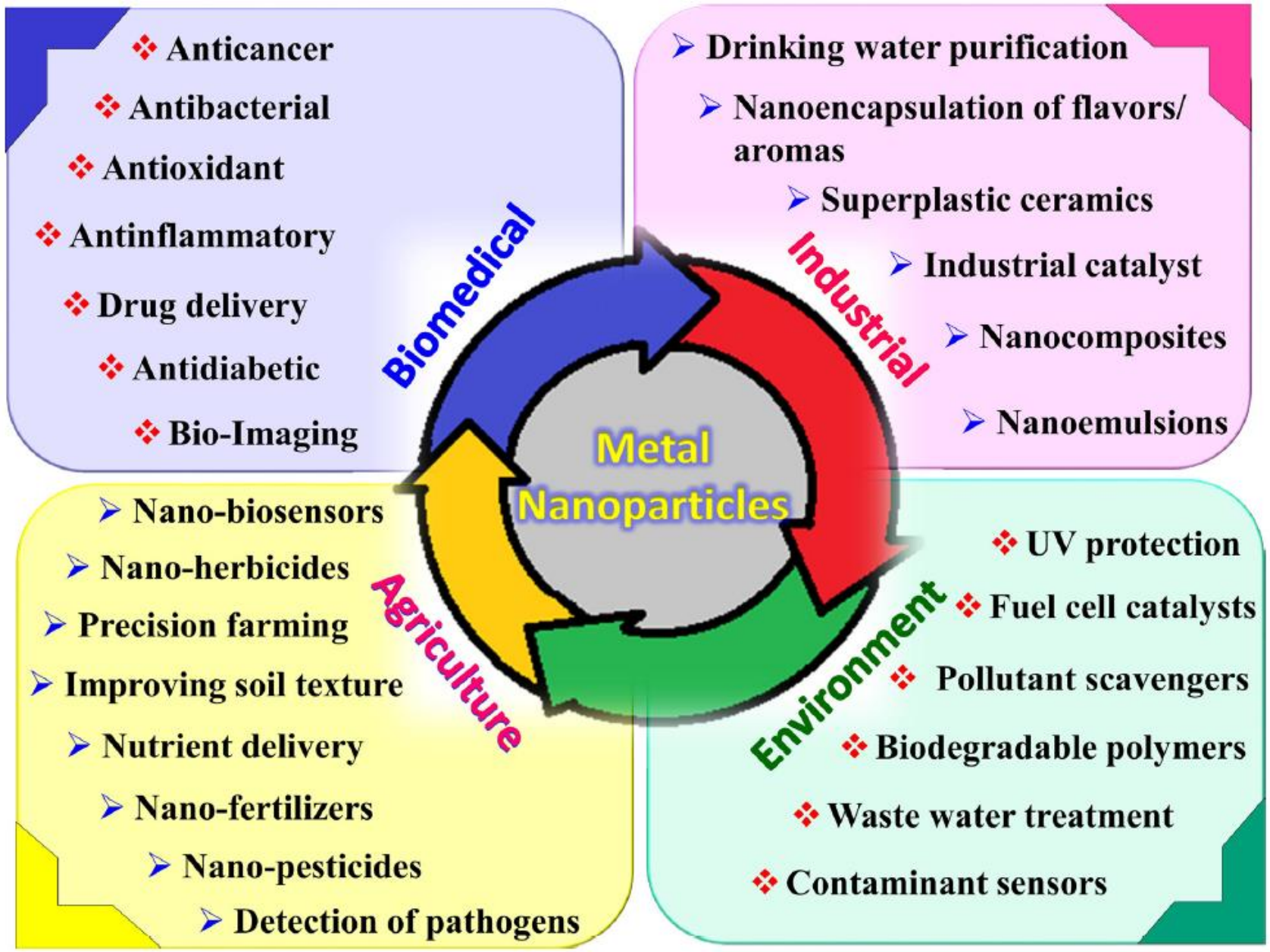




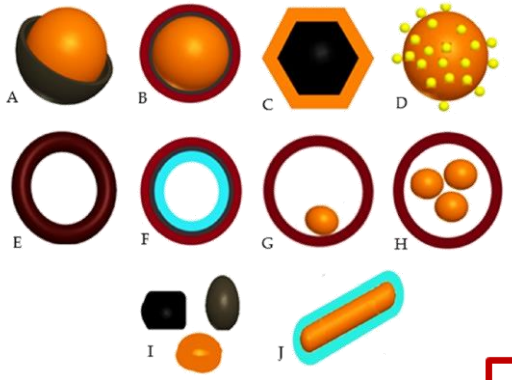


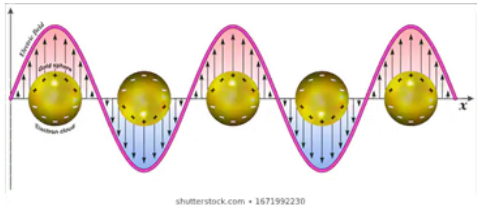


Metal Nanoparticles application fields



Advantages of metal nanoparticles for analytical purposes





Nano

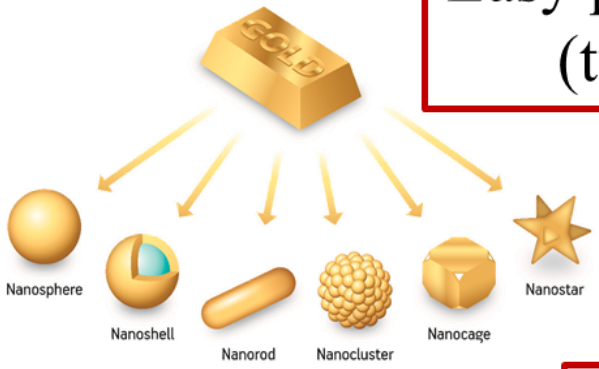
High conductivity

Easy preparation (tunable)

MNPs

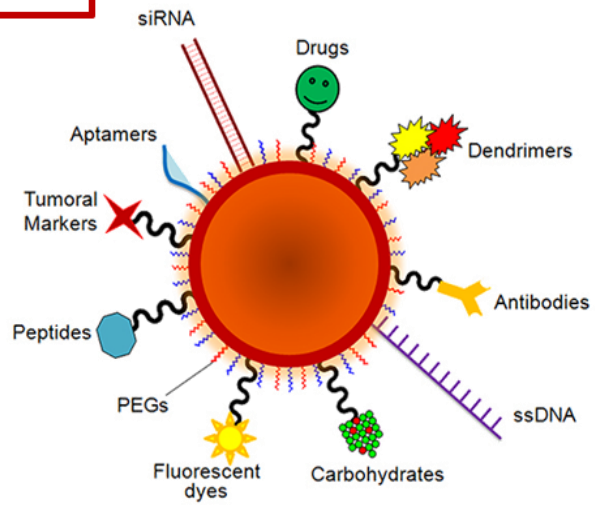
Robust / stable

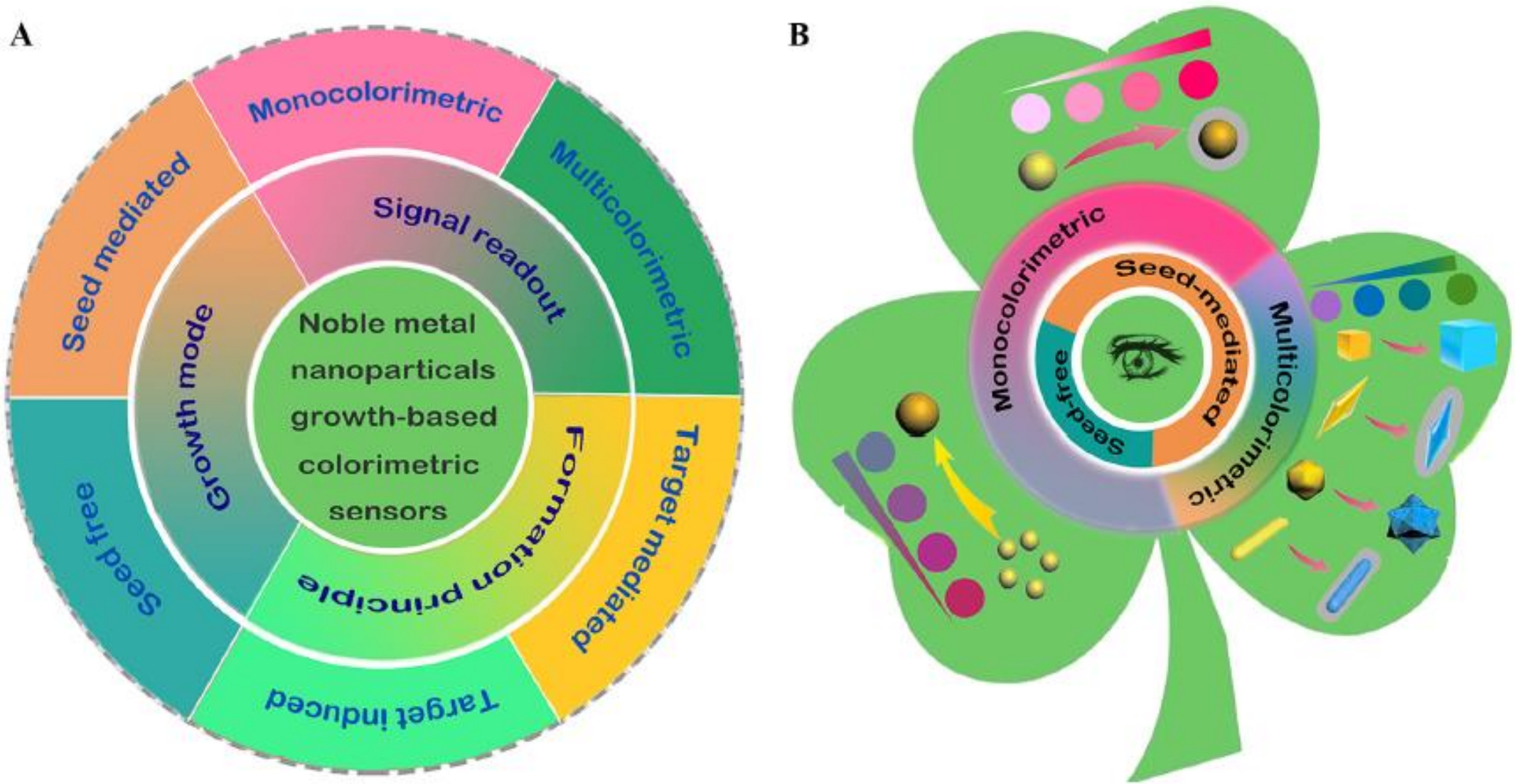
(Inhert)



Good biocompatibility

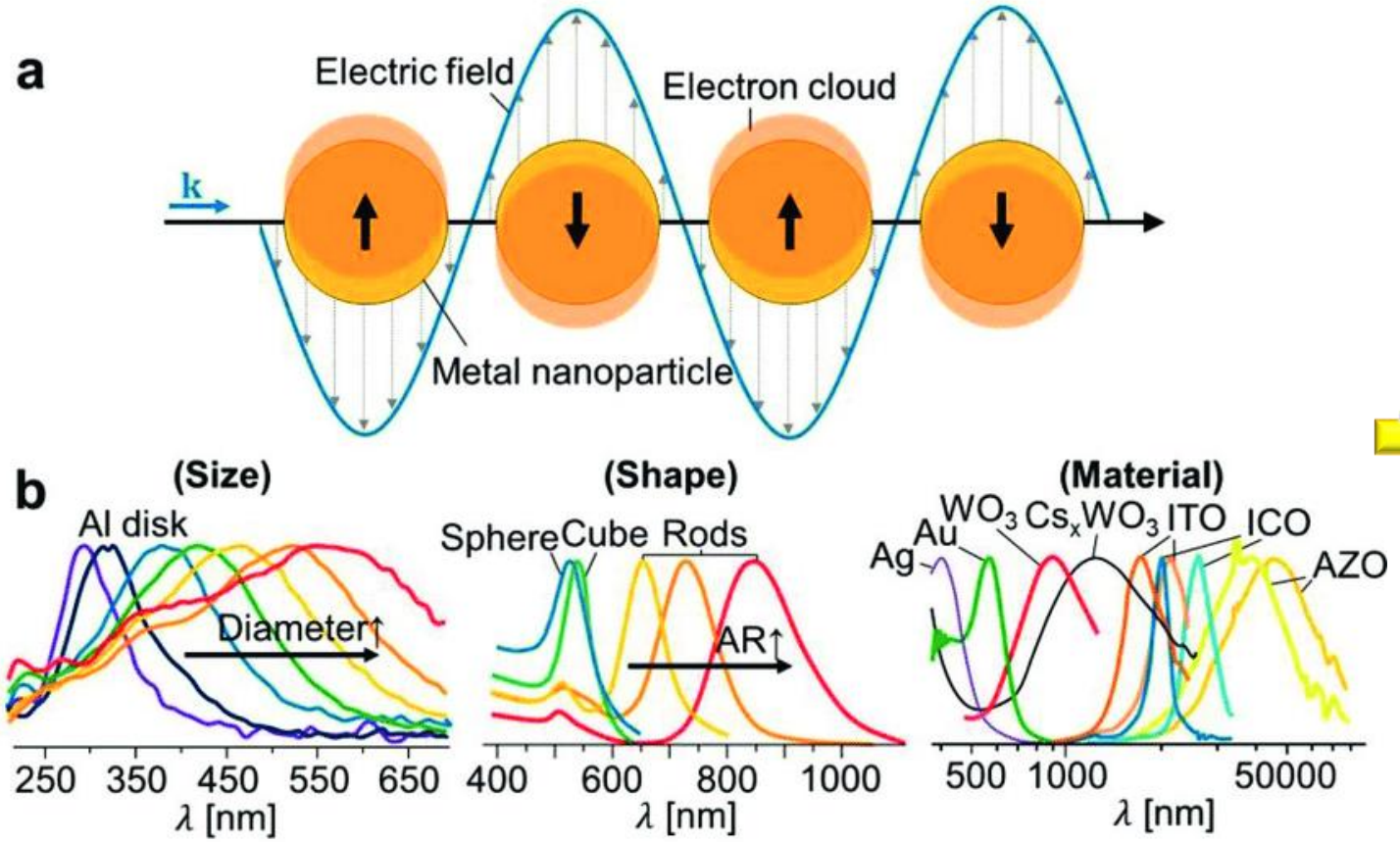
Surface (Bio)functionalization

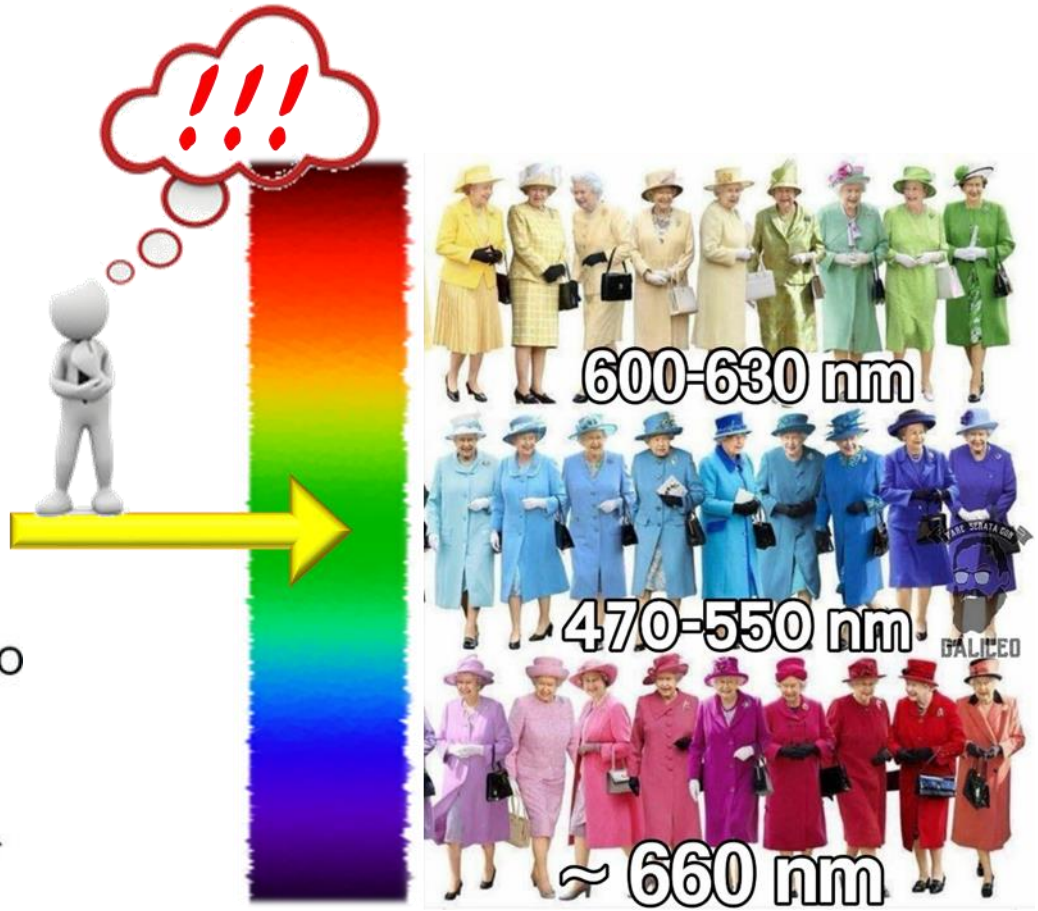



A
Monocolorimetric
Multicolorimetric
Seed mediated
Seed free
Target mediated
Target induced
Signal readout
Growth mode
Formation principle
Noble metal nanoparticals growth-based colorimetric sensors
B
Monocolorimetric
Seed-mediated
Multicolorimetric
Seed-free

Localized Surface Plasmon Resonance (LSPR)

Principle



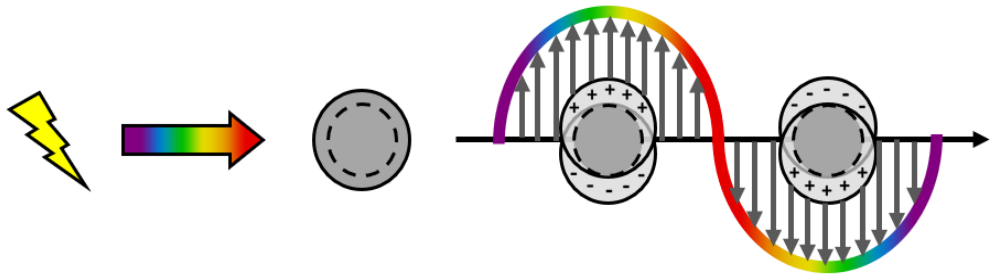


GÉRARD, Davy; GRAY, Stephen K. Aluminium plasmonics. *Journal of Physics D: Applied Physics*, 2014, 48.18: 184001.

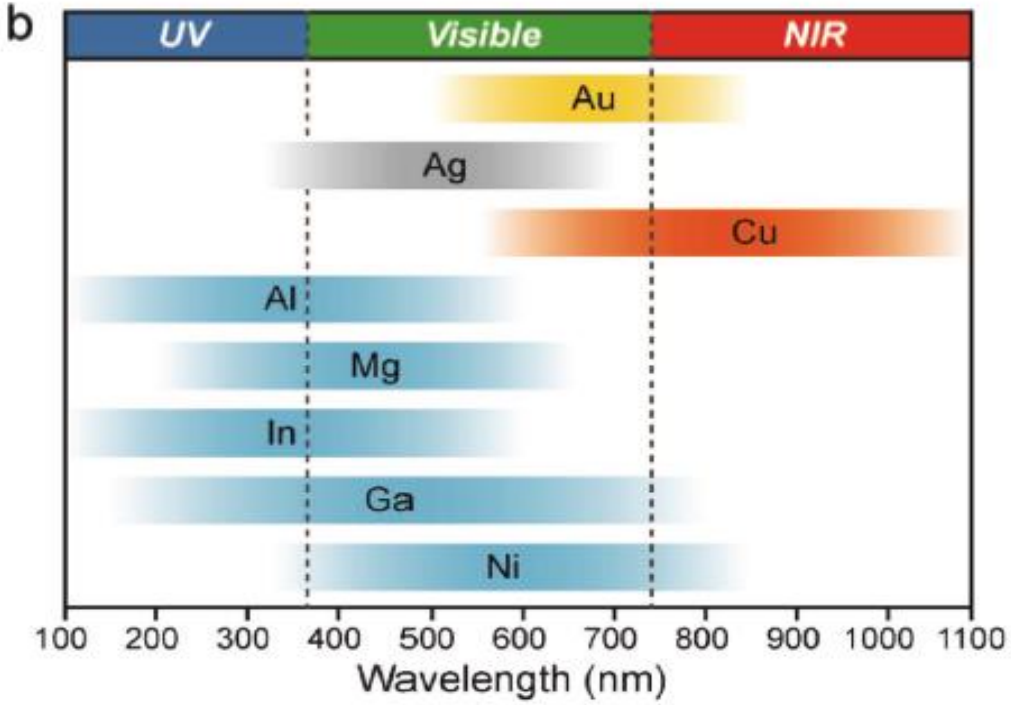
CHEN, Huanjun, et al. Shape-and size-dependent refractive index sensitivity of gold nanoparticles. *Langmuir*, 2008, 24.10: 5233-5237.

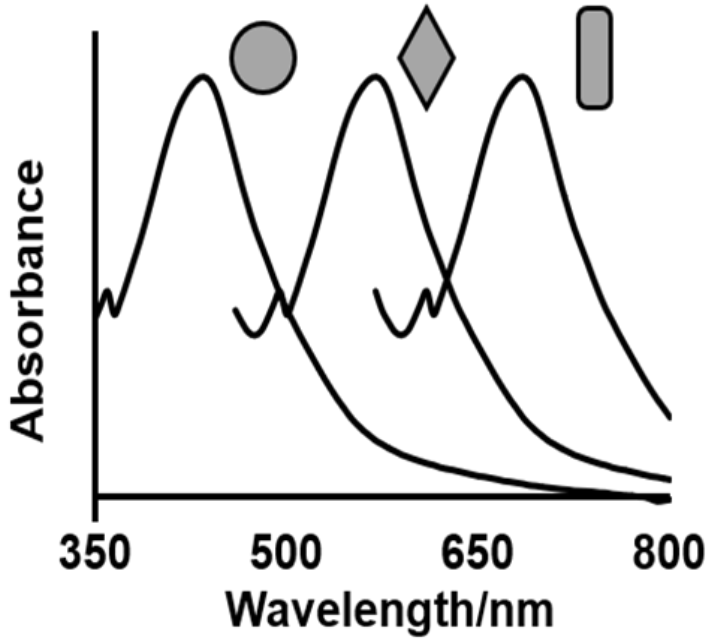
LOUNIS, Sebastien D., et al. Defect chemistry and plasmon physics of colloidal metal oxide nanocrystals. *The journal of physical chemistry letters*, 2014, 5.9: 1564-1574.

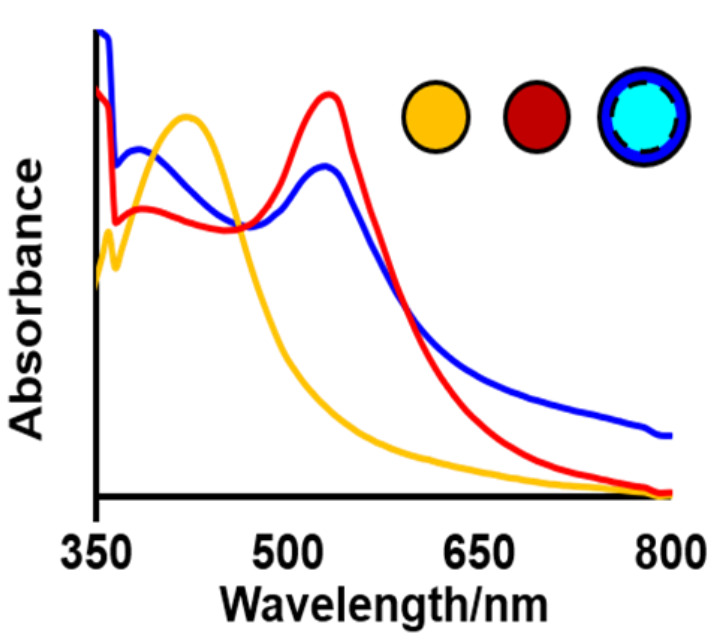
Metal nanoparticles optiocal key feature



Localized Surface Plasmon Resonance

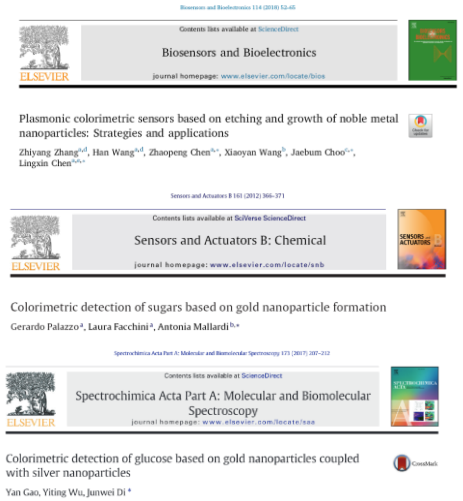


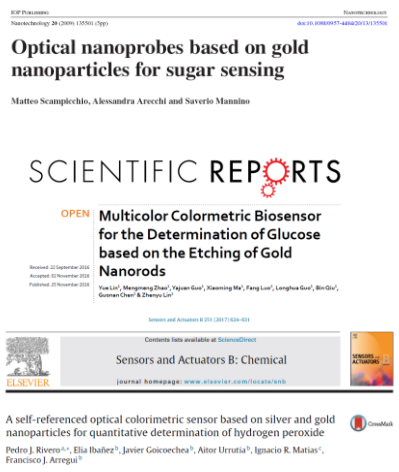




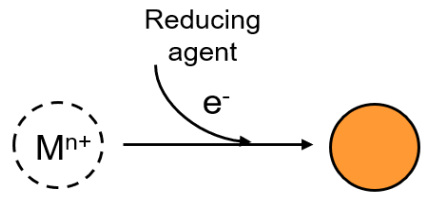
Plasmonic-active nanostructured materials for sensing and biosensing

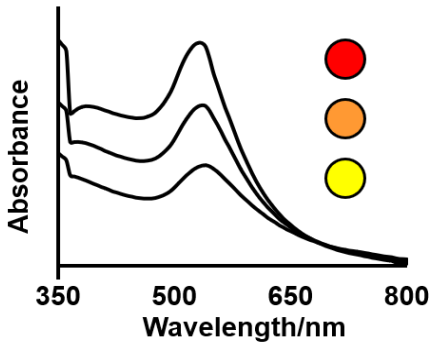
Colloidal metal nanoparticles based assays

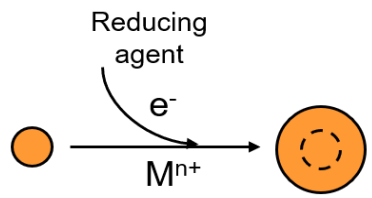


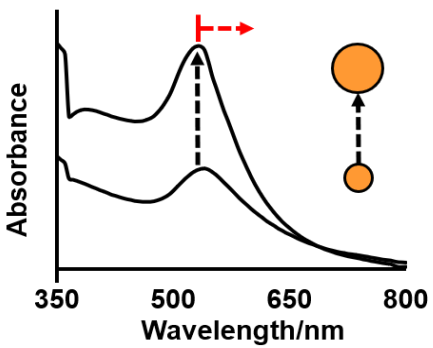


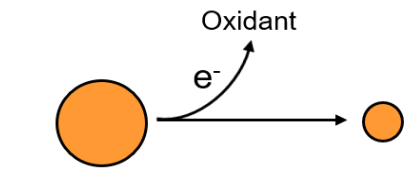
Localized Surface Plasmon Resonance

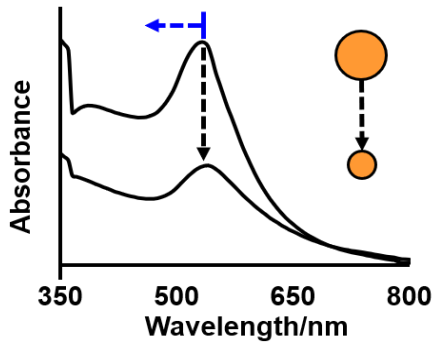


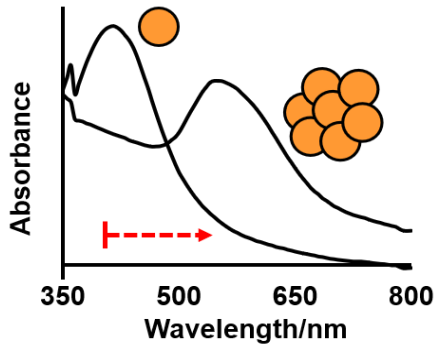




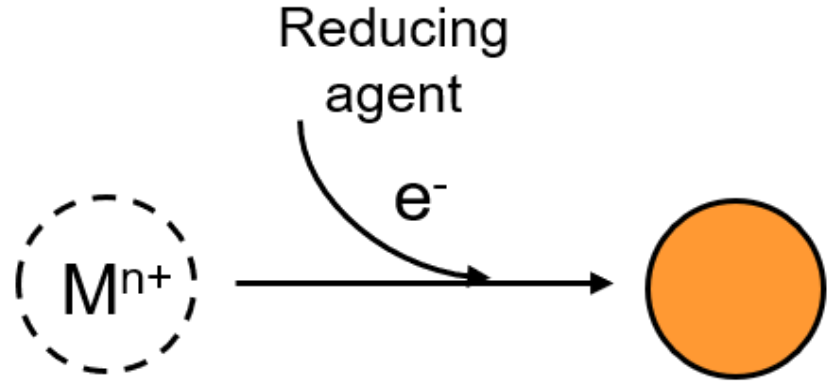


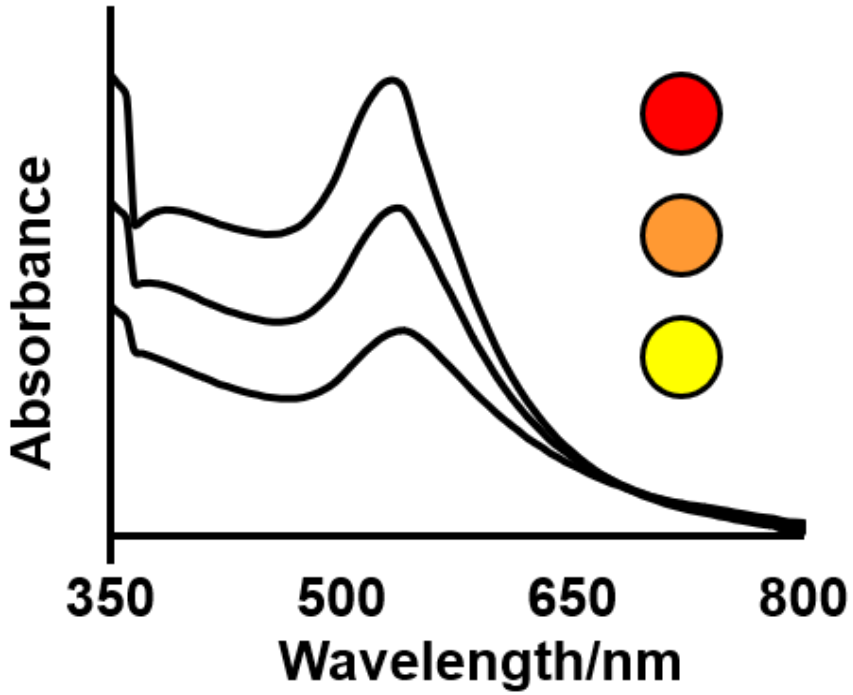






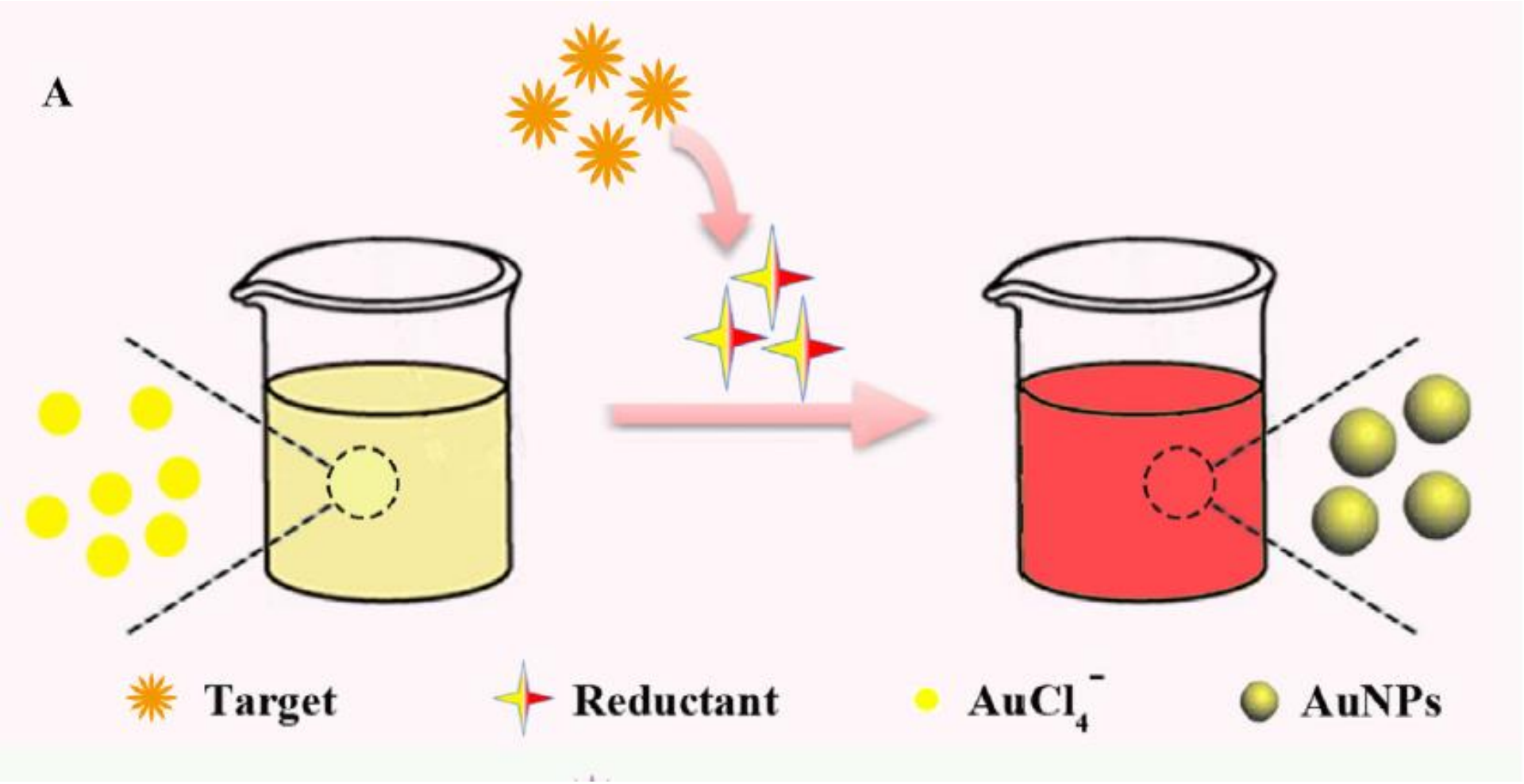
Metal nanoparticles formation





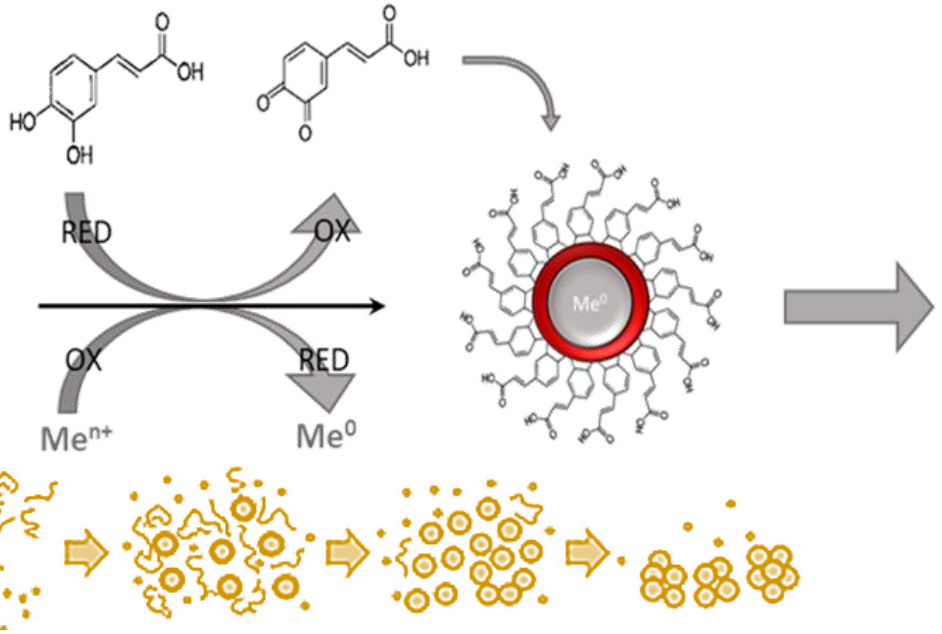
Metal nanoparticles formation.

Main strategy

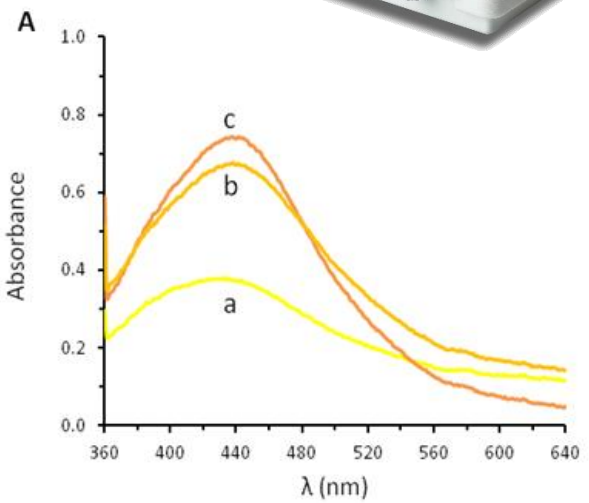


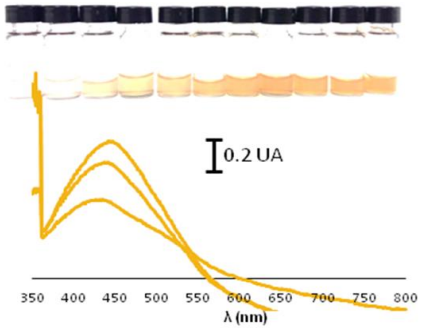
Metal nanoparticles formation

Reducing compounds evaluation trough AuNPs and AgNPs production (antioxidant capacity evaluation)

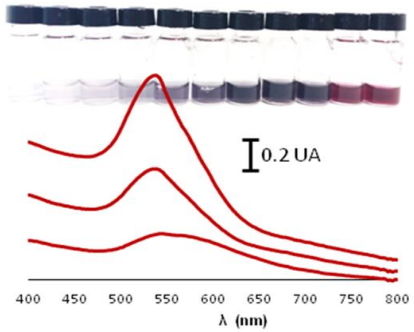


LSPR





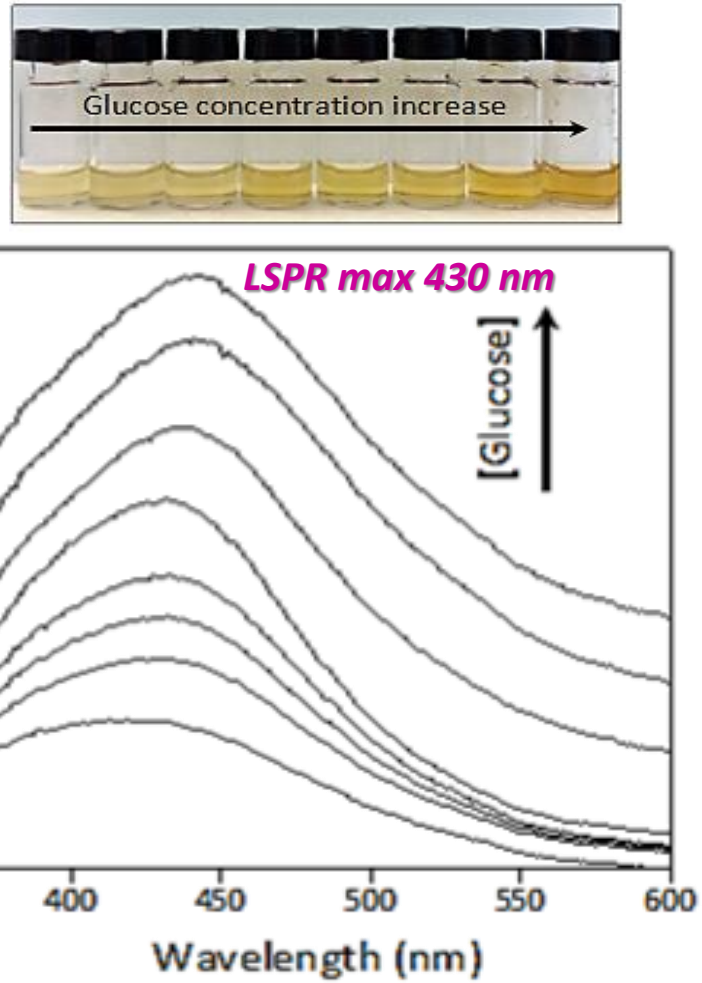
Epicatechin concentration:
2, 4 and 6 µM



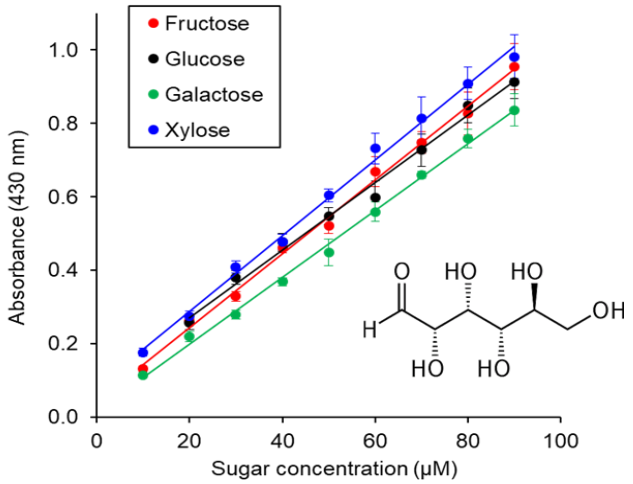
Epicatechin concentration:
70, 90, 110 µM

Metal nanoparticles formation

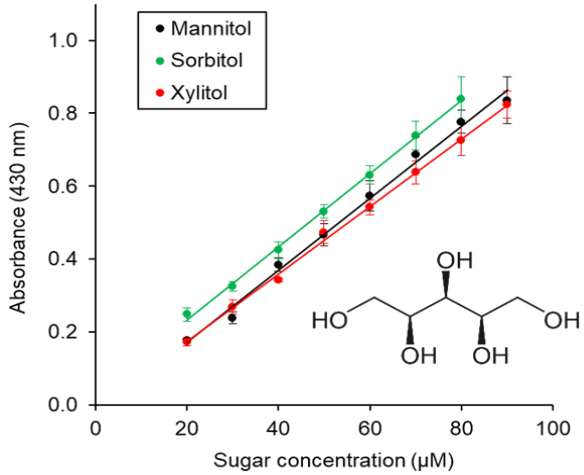
Sugars content evaluation trough AgNPs formation



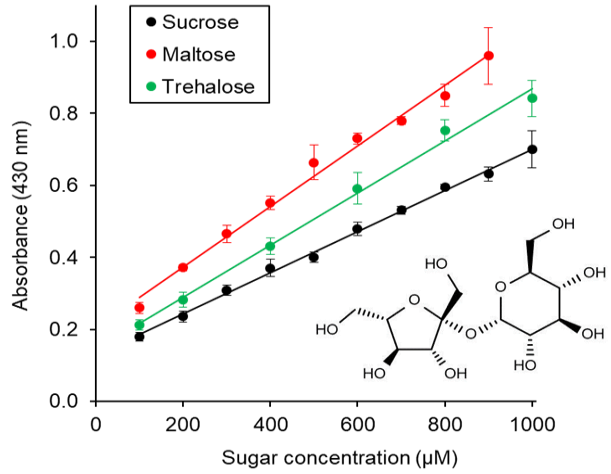
Monosaccharides



Polyols



Disaccharides



Metal nanoparticles formation

Determination of total sugars in real samples: AgNPs method vs. ion chromatography

Sample analysis

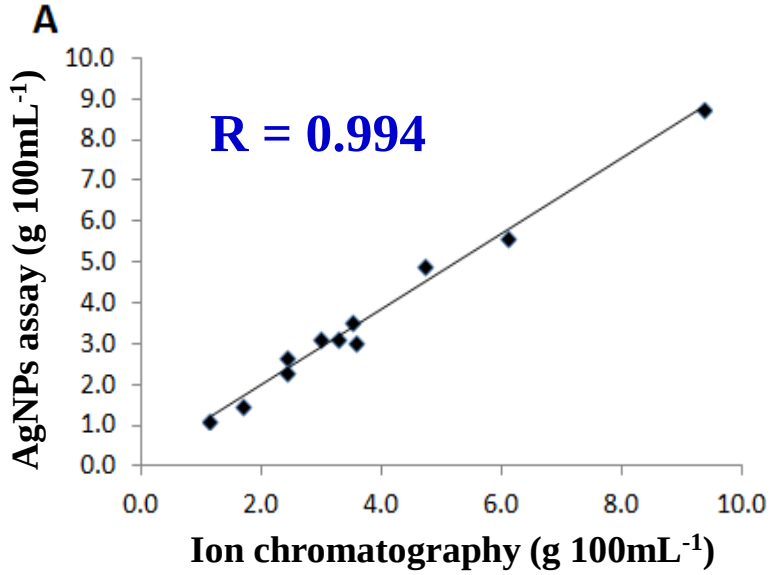
Samples challenged

- Soft drinks n° 6
- Apple extracts n° 6

Sample	AgNPs assay (g 100 mL^{-1}, Glu. Eq.)	RSD (%, n = 5)	Ion chromatography (g 100 mL^{-1}, Glu + Fru)	RSD (%, n = 3)	AgNPs assay relative error (%)
Peach tea	2.98 ± 0.14	4.74	3.13 ± 0.08	2.71	+ 5.0
Black tea	3.56 ± 0.23	6.51	3.05 ± 0.11	3.56	- 14.3
Coconut water	4.72 ± 0.13	2.84	4.93 ± 0.05	0.98	+ 4.4
Gaseous	3.50 ± 0.25	7.23	3.53 ± 0.04	1.21	+ 0.9
Cedrata	9.36 ± 0.27	2.85	8.74 ± 0.78	8.9	- 6.6
Tonic water	6.11 ± 0.07	1.15	5.62 ± 0.12	2.11	- 8.0
Apple 1	1.67 ± 0.02	1.12	1.50 ± 0.02	1.11	- 10.2
Apple 2	1.14 ± 0.04	3.41	1.14 ± 0.02	1.78	0.0
Apple 3	3.27 ± 0.04	1.30	3.12 ± 0.10	3.10	- 4.6
Apple 4	2.43 ± 0.23	9.42	2.67 ± 0.11	4.10	+ 9.9
Apple 5	2.43 ± 0.02	0.74	2.31 ± 0.9	3.80	- 5.0

* mean value n= 3

Rel. error between -14.9 and + 9.9 %



Recovery between 86 % and 118 %

Metal nanoparticles formation

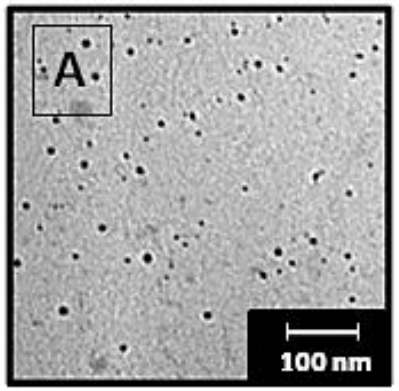
AgNPs Morphological study

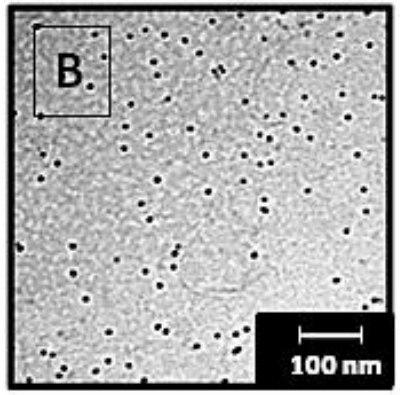
Glucose

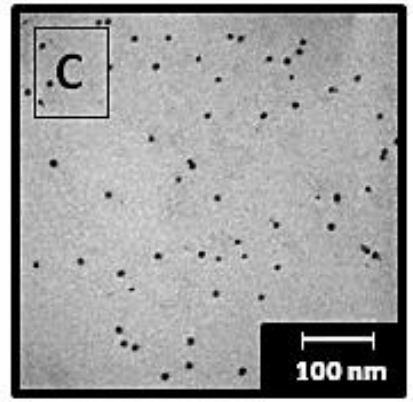
Sucrose

Xylitol

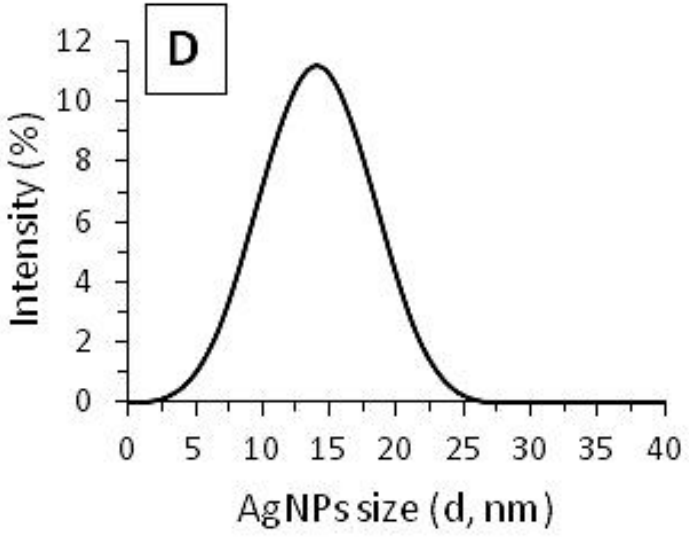
TEM

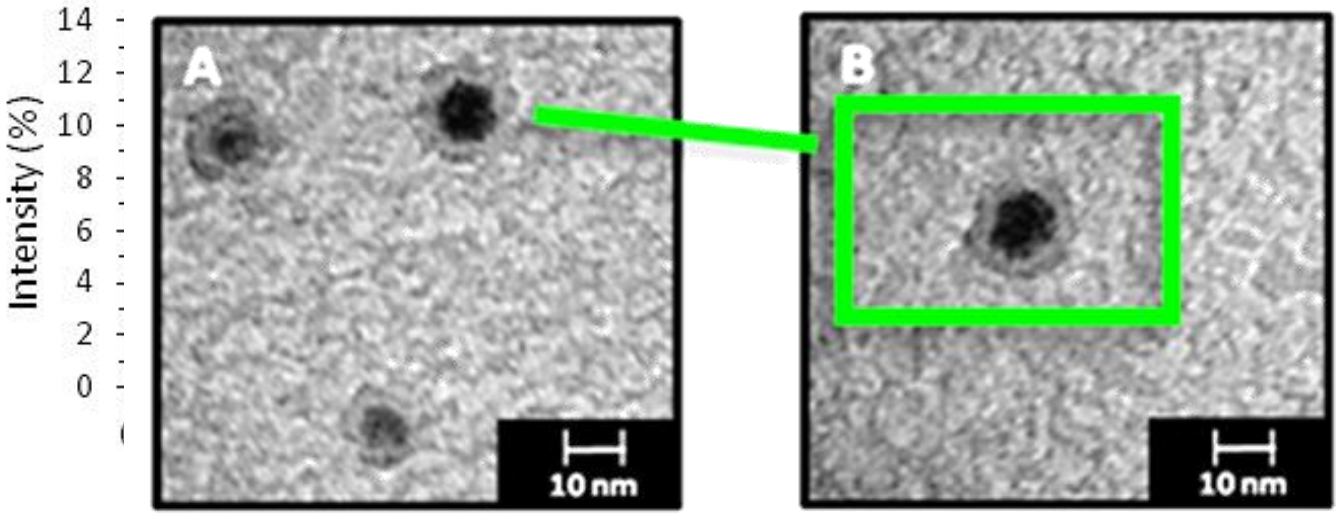


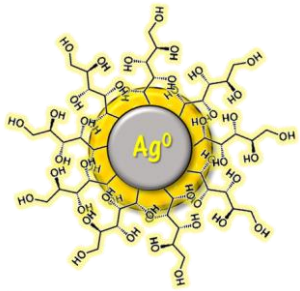




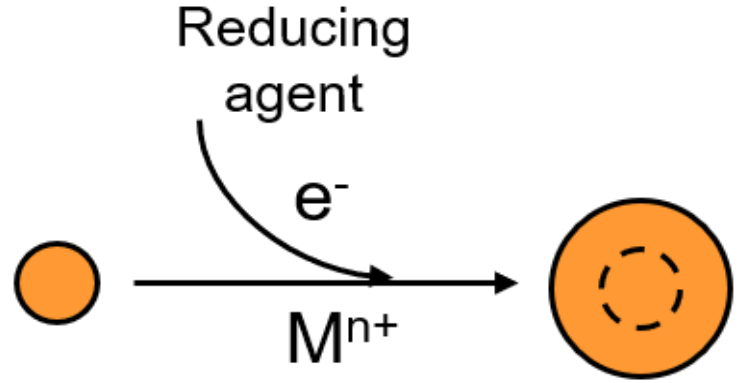
DLS

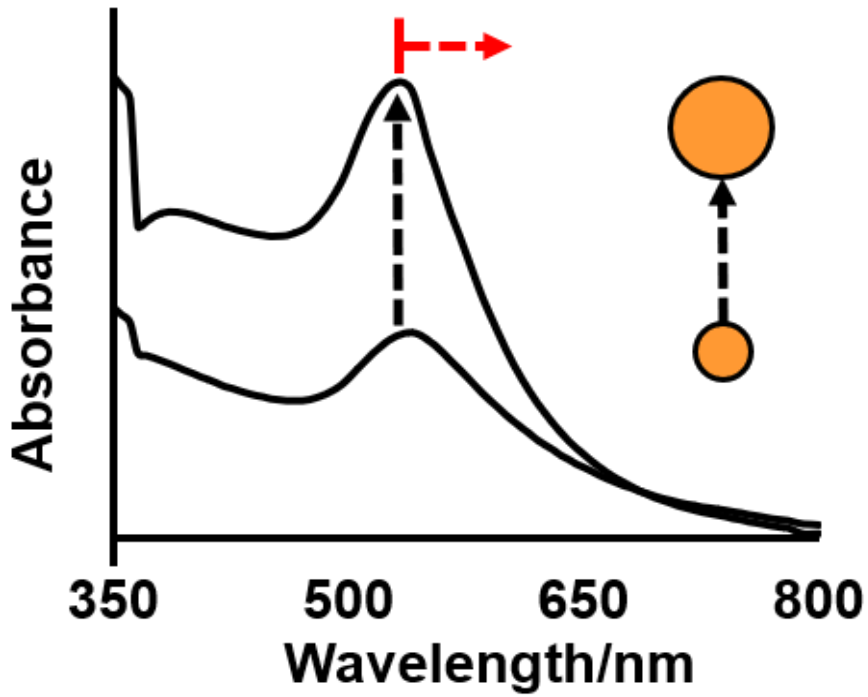






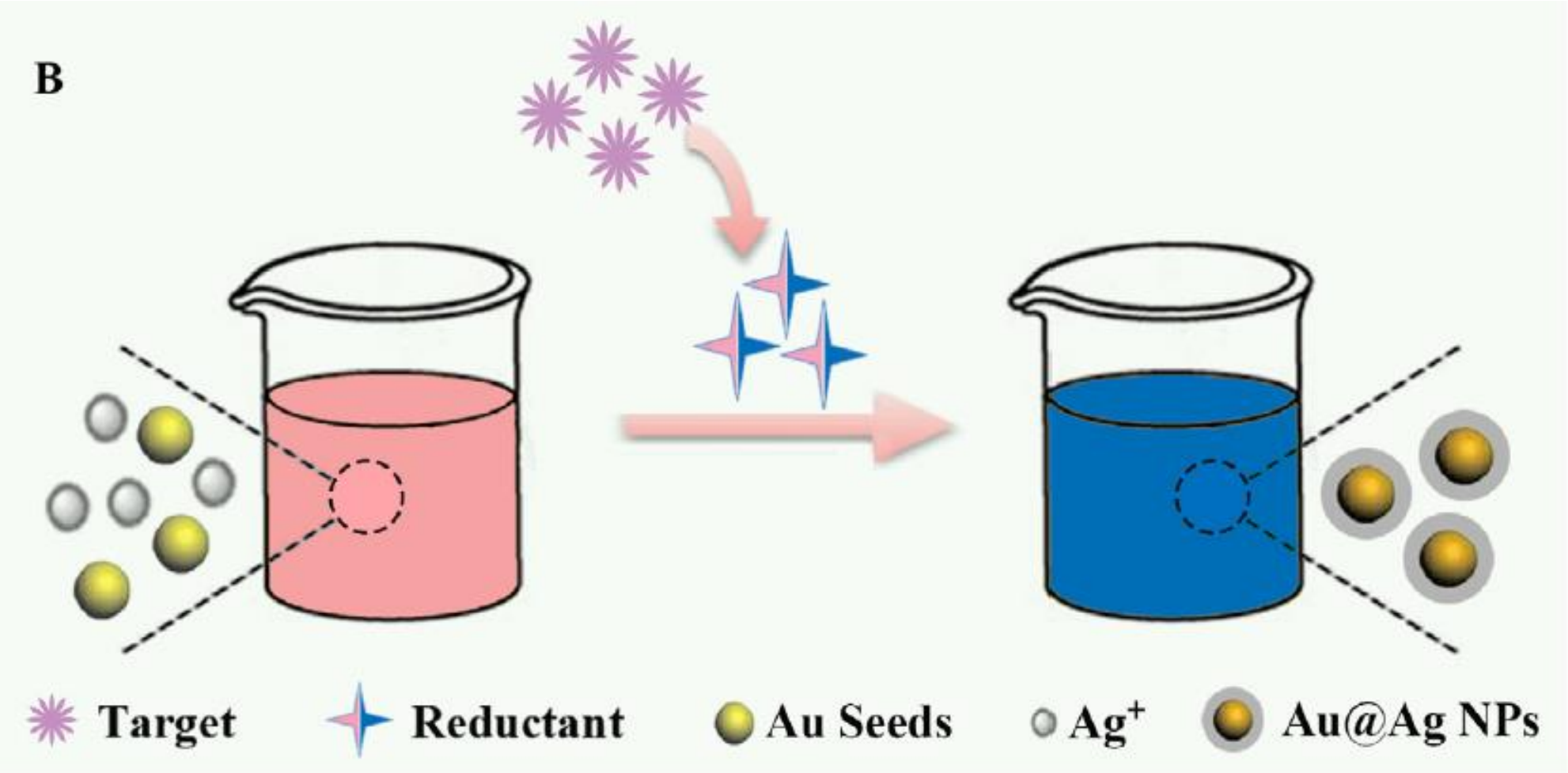
Metal nanoparticle-based seed-growth strategies





Metal nanoparticles growth

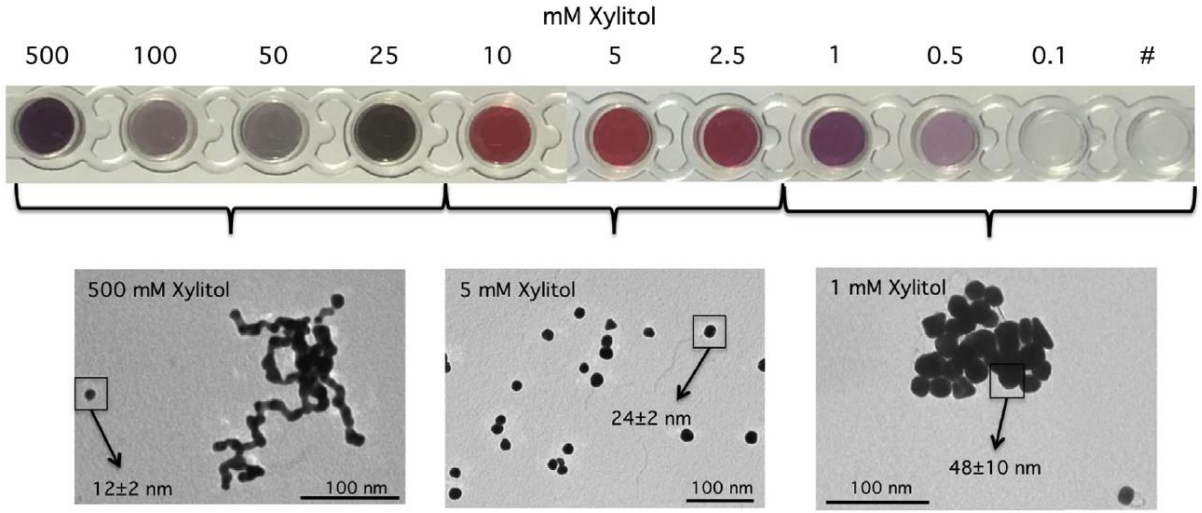
Main strategy



Metal nanoparticles growth

Xylitol monitoring trough AuNPs growth

Seed formation and growth phenomena study



Analytica Chimica Acta xxx (2017) 1–8

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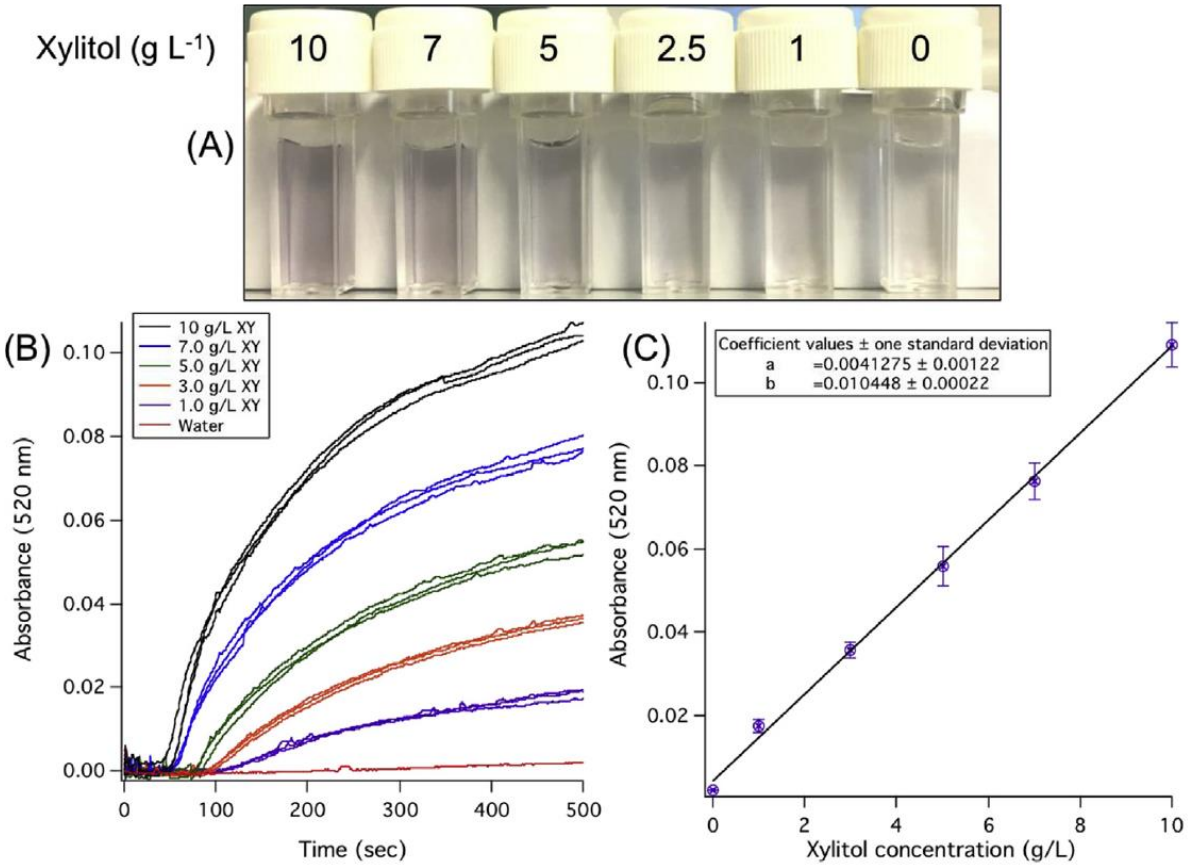
journal homepage: www.elsevier.com/locate/aca

The early nucleation stage of gold nanoparticles formation in solution as powerful tool for the colorimetric determination of reducing agents: The case of xylitol and total polyols in oral fluid

S. Scarano*, E. Pascale, M. Minunni

Dose-response kinetic and curve

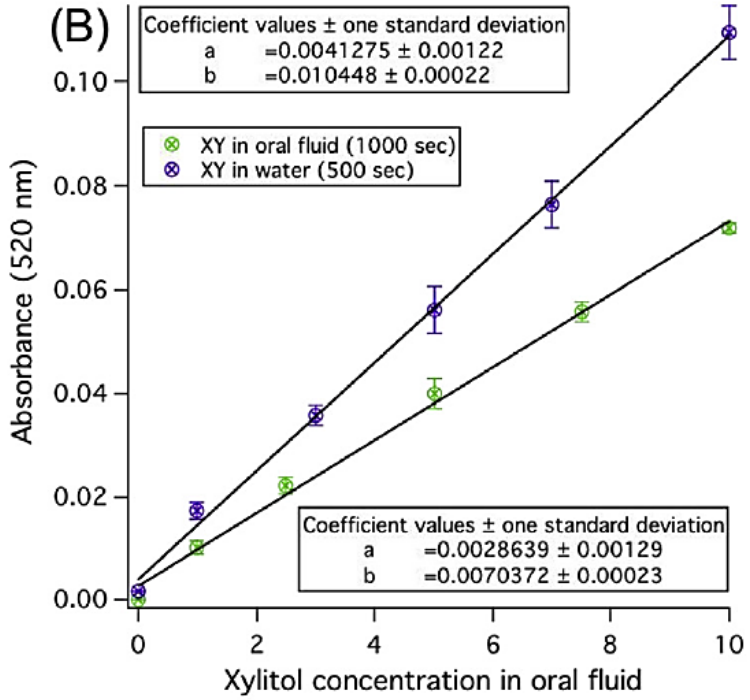


Metal nanoparticles growth

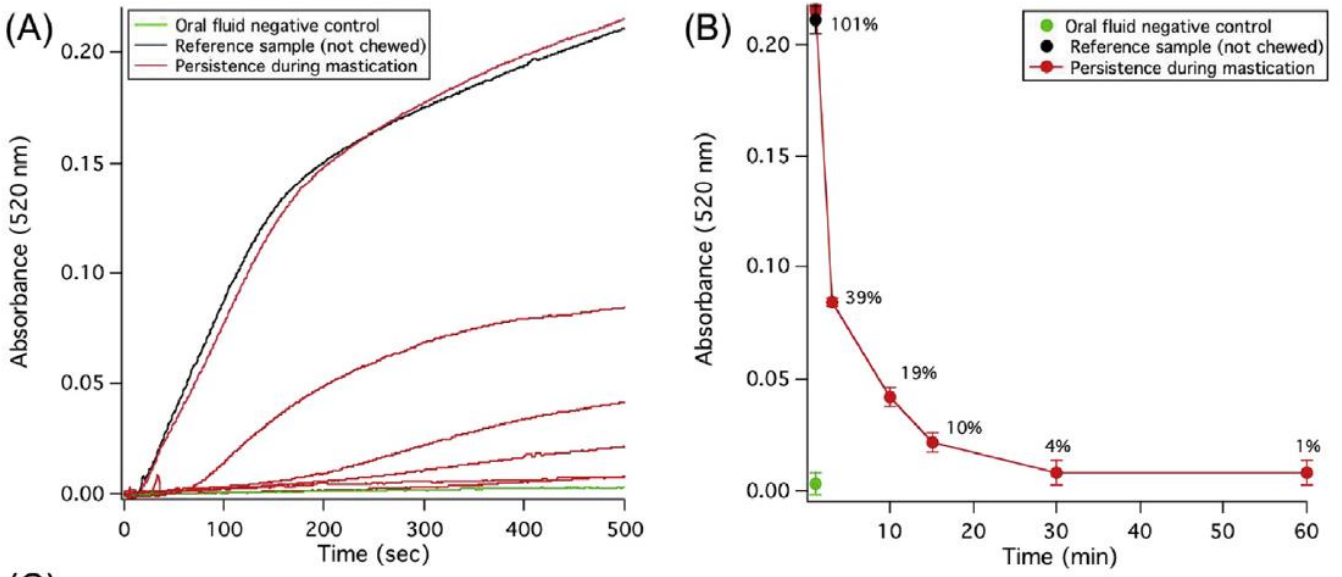
Xylitol monitoring in human saliva trough AuNPs growth

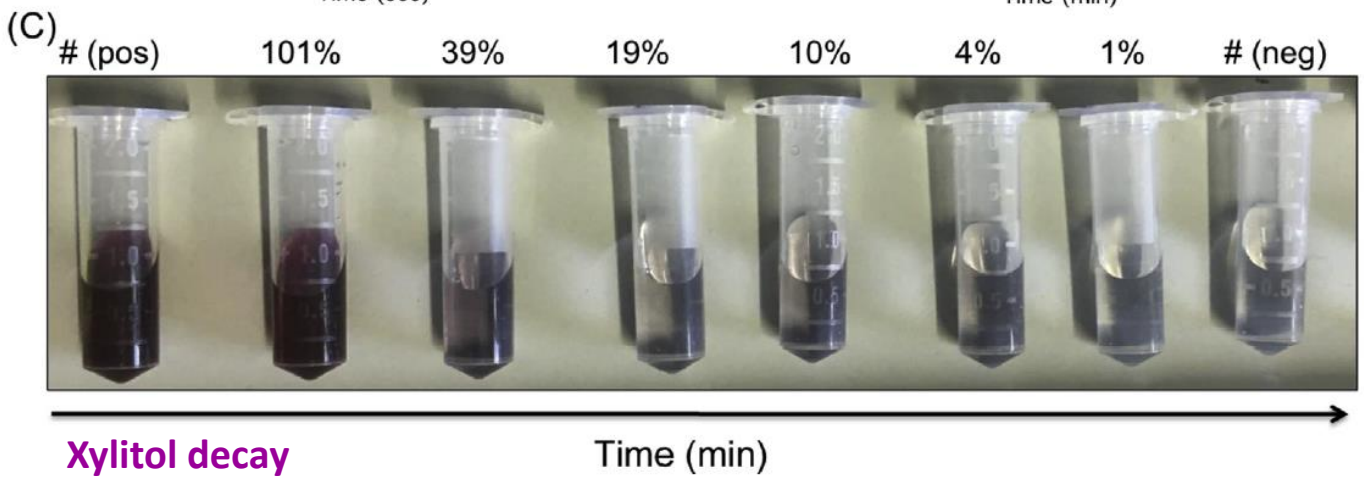
Recovery study

Methods evaluation for sample analysis

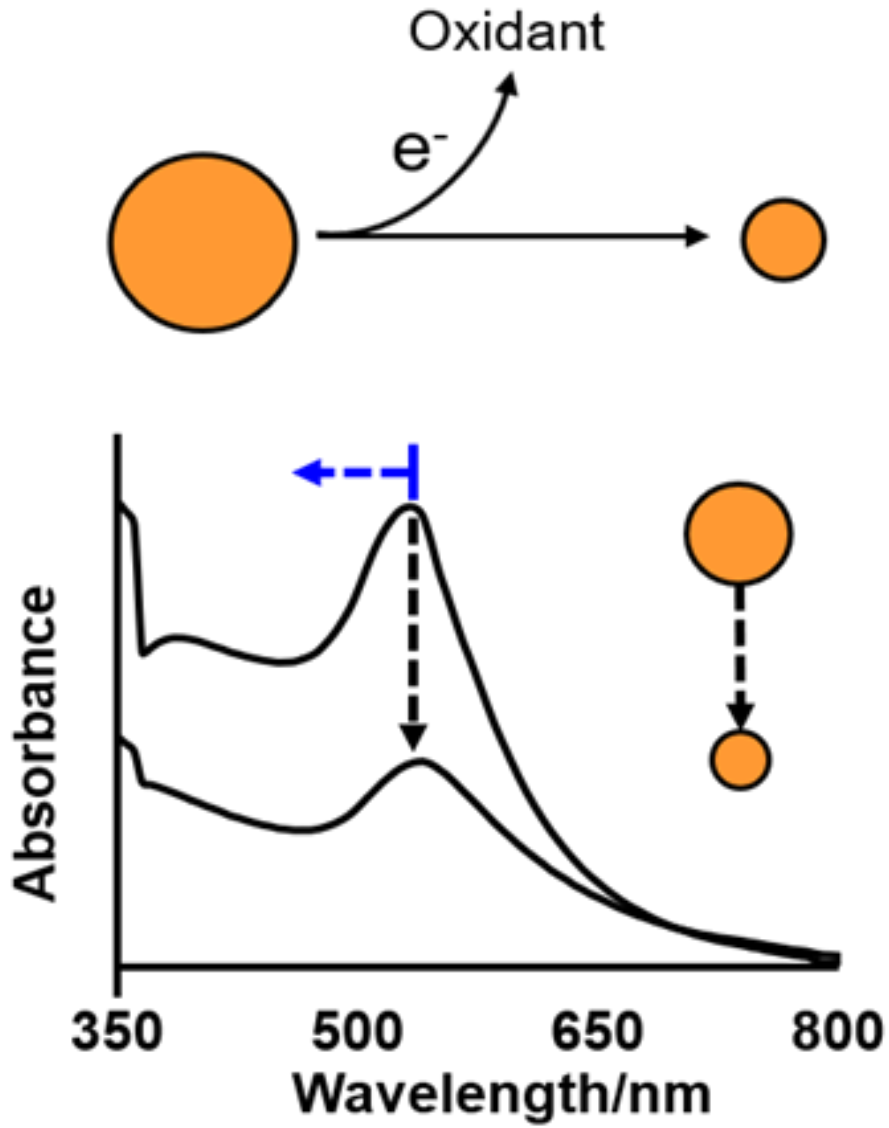


Xylitol monitoring 1 h of chewing-gum



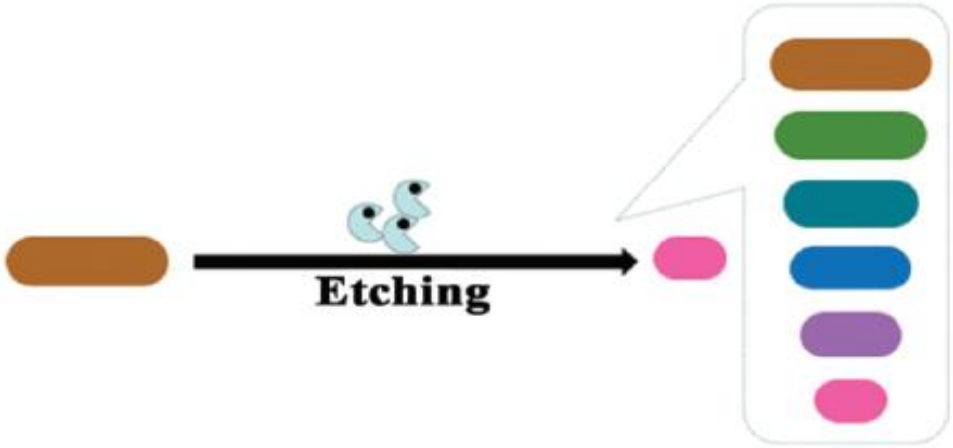


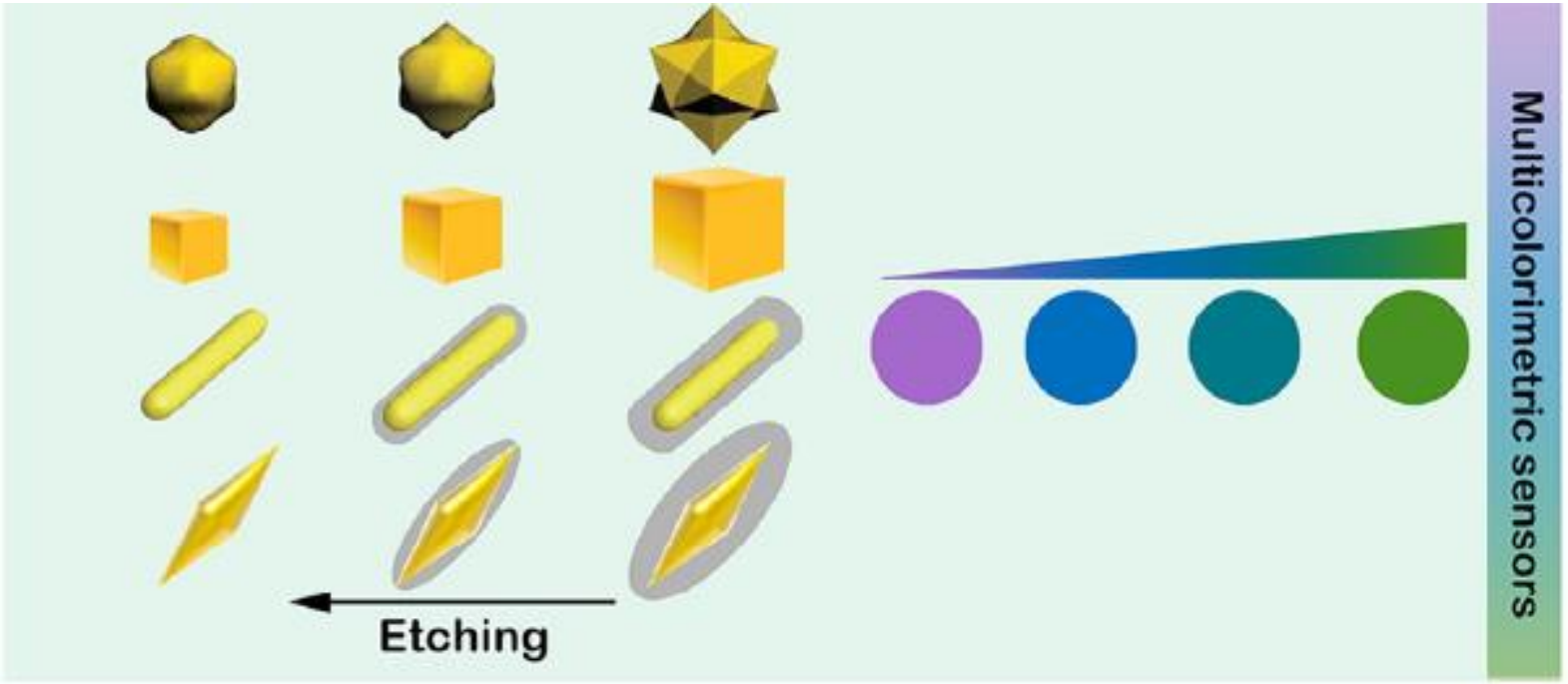
Metal nanoparticle etching



Metal nanoparticles etching

Main strategy

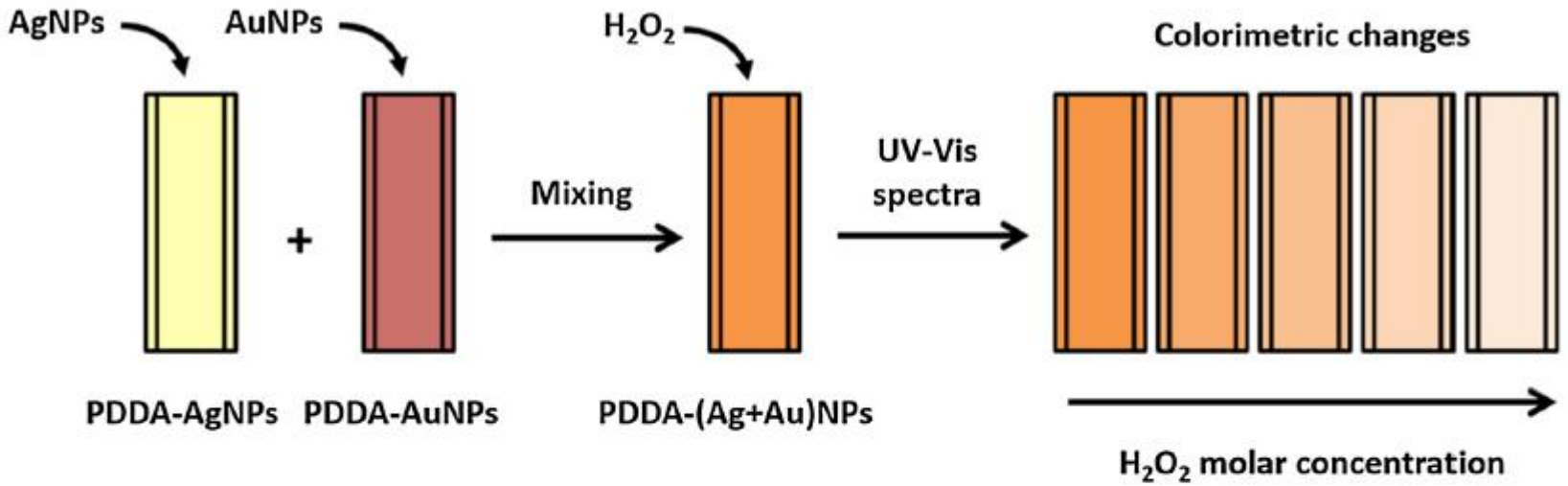


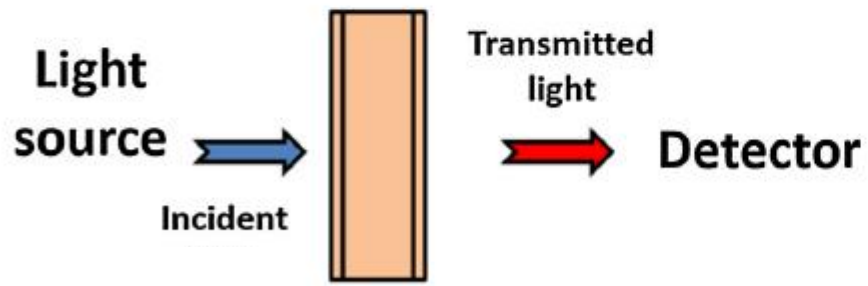


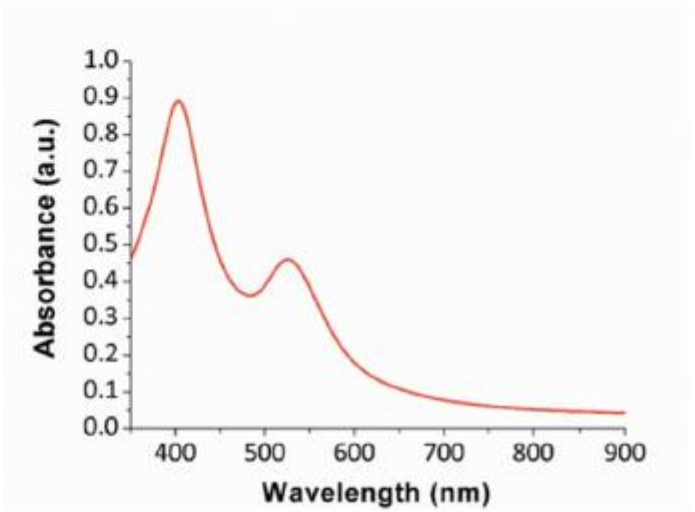
Metal nanoparticles etching

H_2O_2 determination trough MNPs etching

PDDA- Poly(diallyldimethylammoniumchloride)







Sensors and Actuators B 251 (2017) 624–631

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Sensors and Actuators B: Chemical

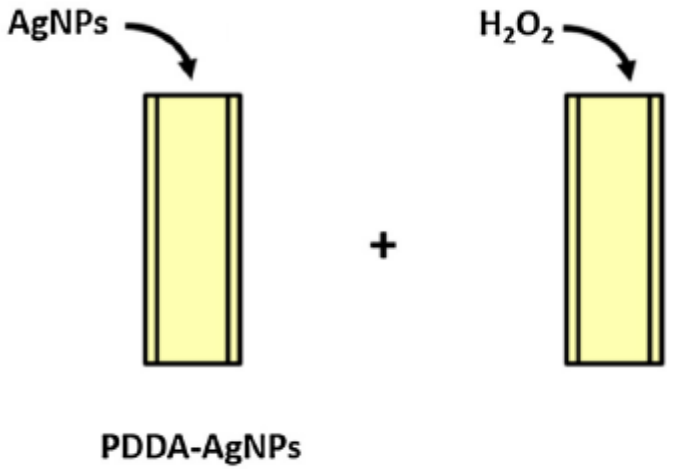
journal homepage: www.elsevier.com/locate/snb

A self-referenced optical colorimetric sensor based on silver and gold nanoparticles for quantitative determination of hydrogen peroxide

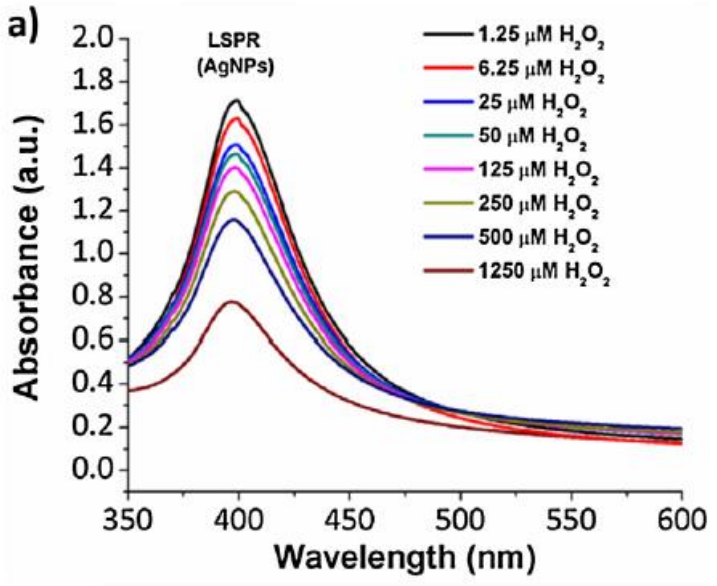
Pedro J. Rivero[a,*], Elia Ibañez[b], Javier Goicoechea[b], Aitor Urrutia[b], Ignacio R. Matias[c], Francisco J. Arregui[b]

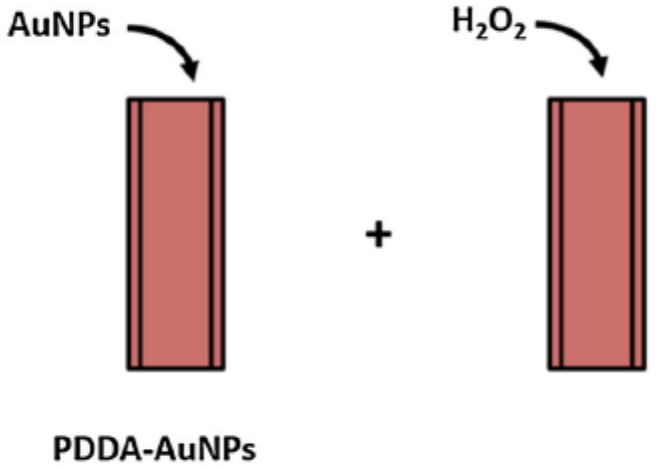
Metal nanoparticles etching

Etching phenomena study (polydopamine modified cuvette)

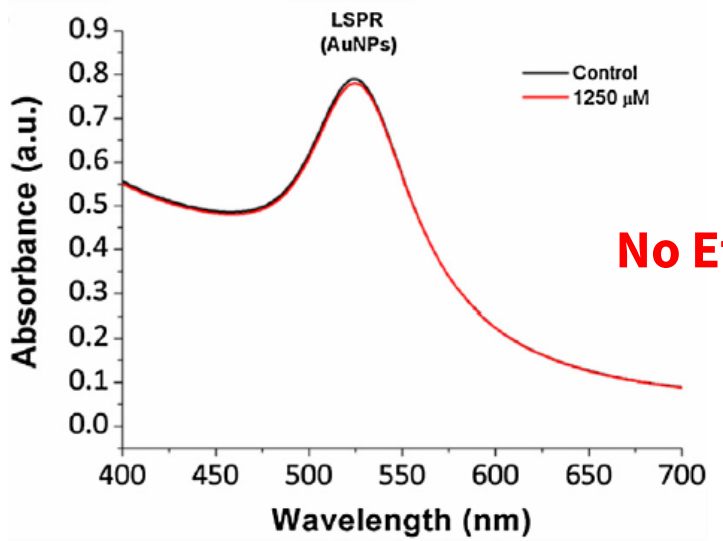


UV-Vis spectra →





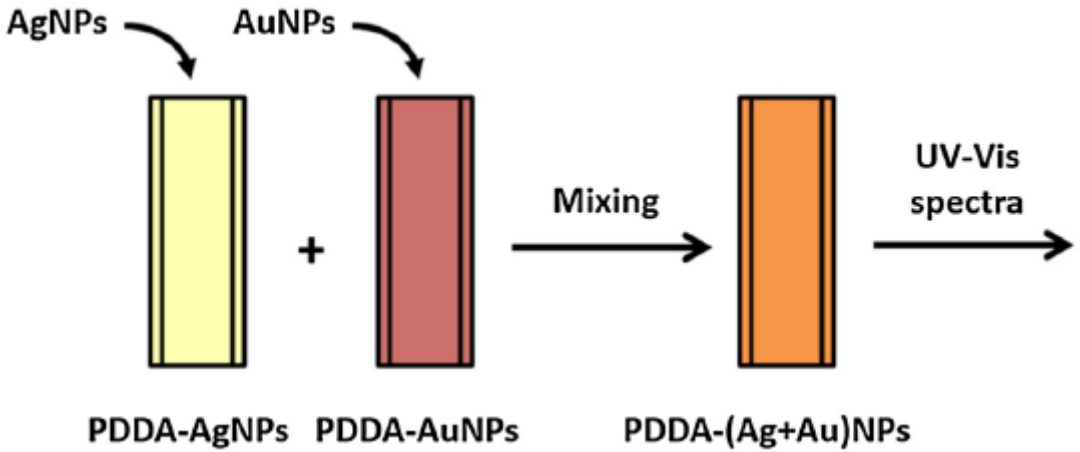
UV-Vis spectra →

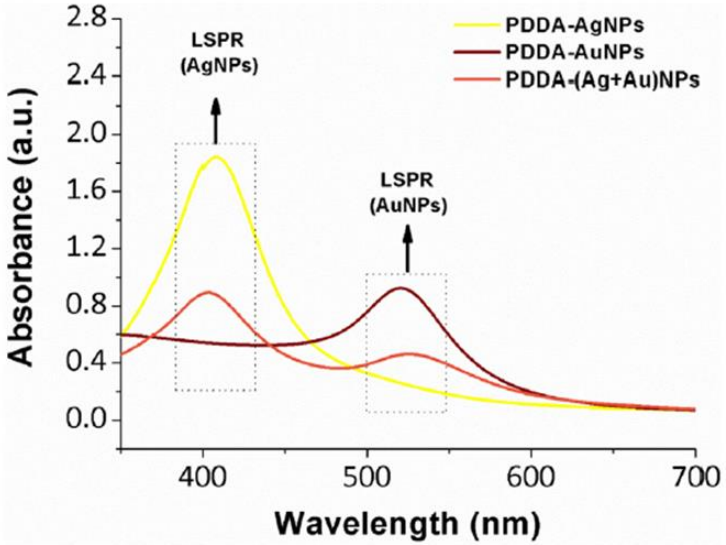


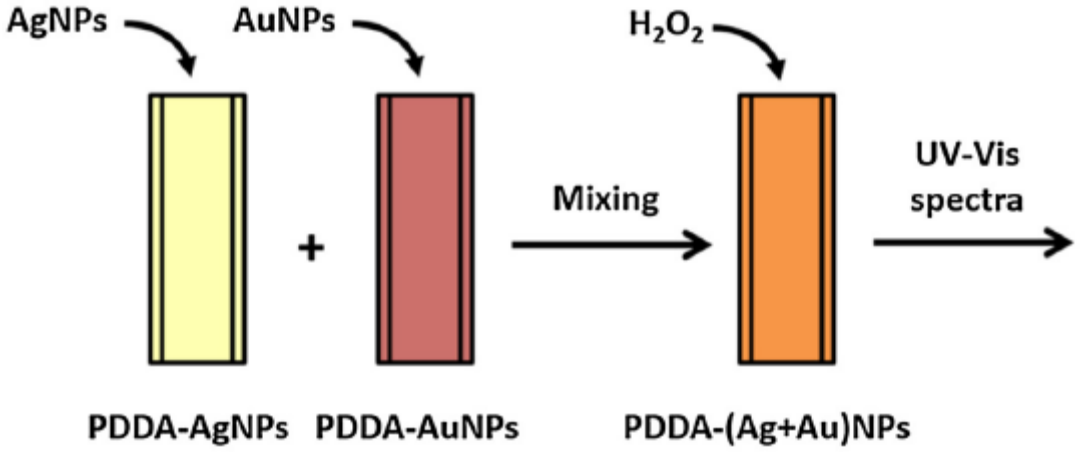
No Etching phenomena

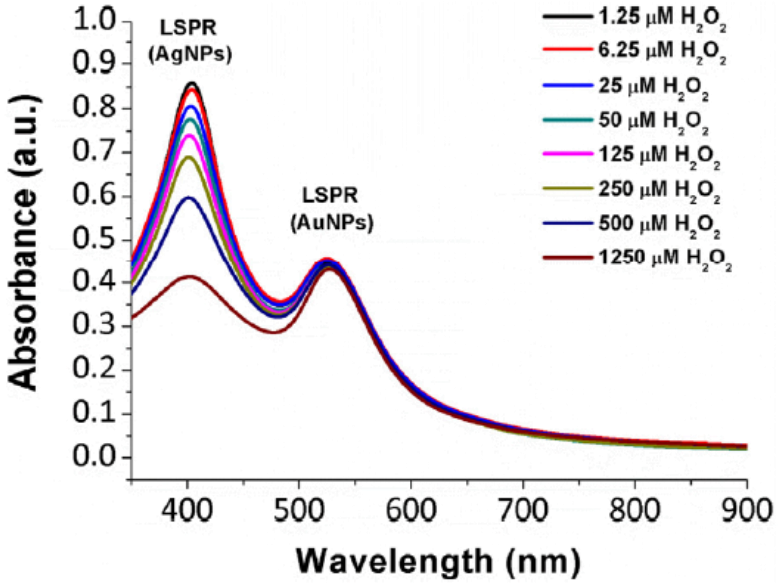
Metal nanoparticles etching

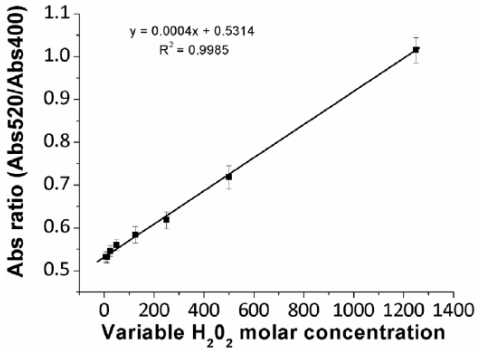
Etching phenomena study. H_2O_2 determination

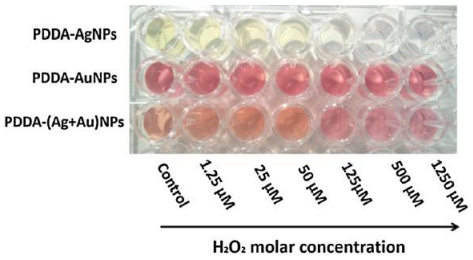










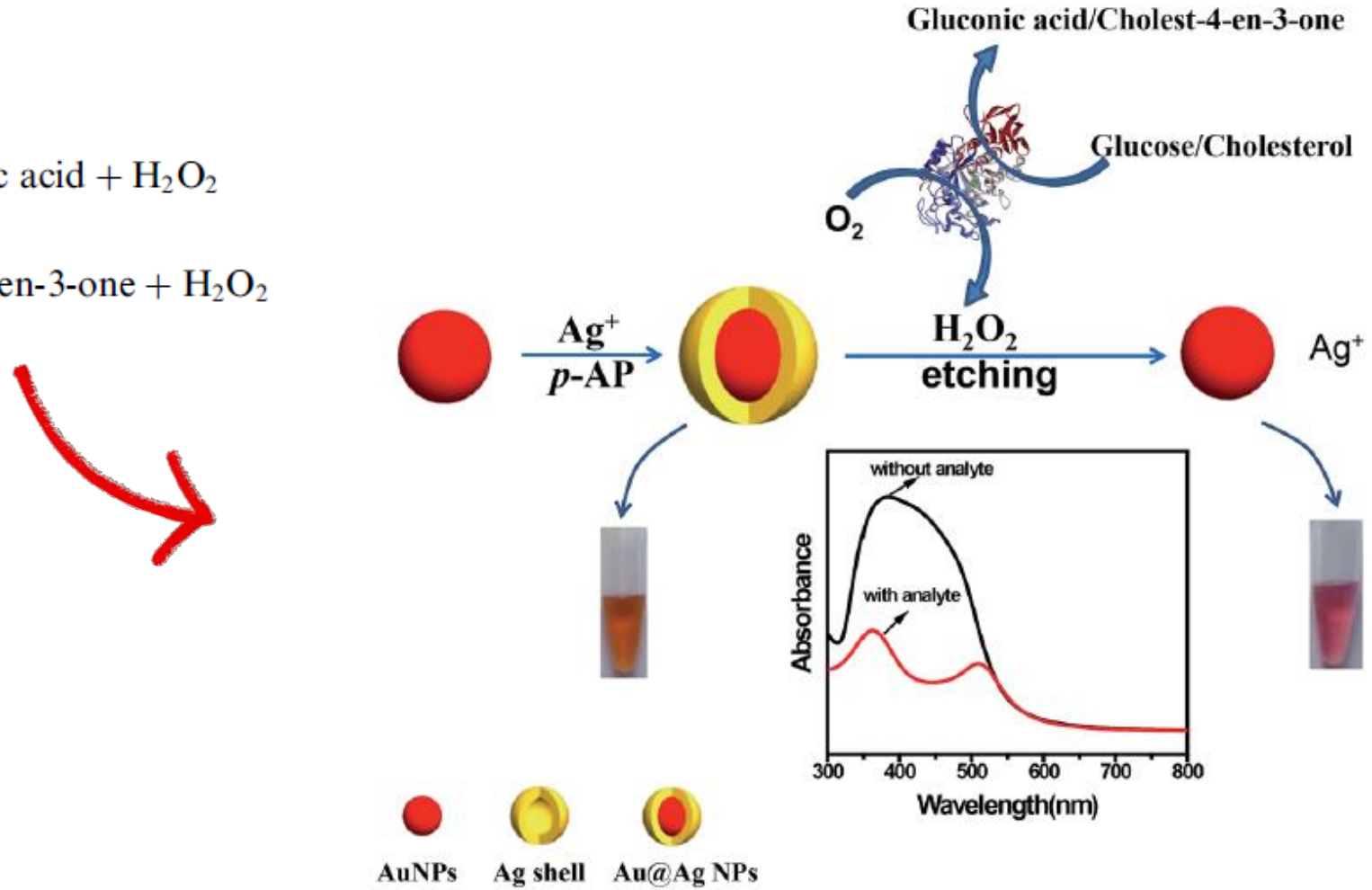


Metal nanoparticles etching

Glucose and cholesterol evaluation trough MNPs etching

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\text{GOx}} \text{gluconic acid} + H_2O_2$$

$$\text{Cholesterol} + O_2 + H_2O \xrightarrow{\text{ChOx}} \text{cholest-4-en-3-one} + H_2O_2$$



Scheme 1 Schematic illustration of the formation of Au@Ag NPs and its application for the colorimetric detection of H_2O_2 and glucose/cholesterol.

RSC Advances

PAPER View Article Online View Journal | View Issue

Cite this: *RSC Adv.*, 2016, 6, 35001

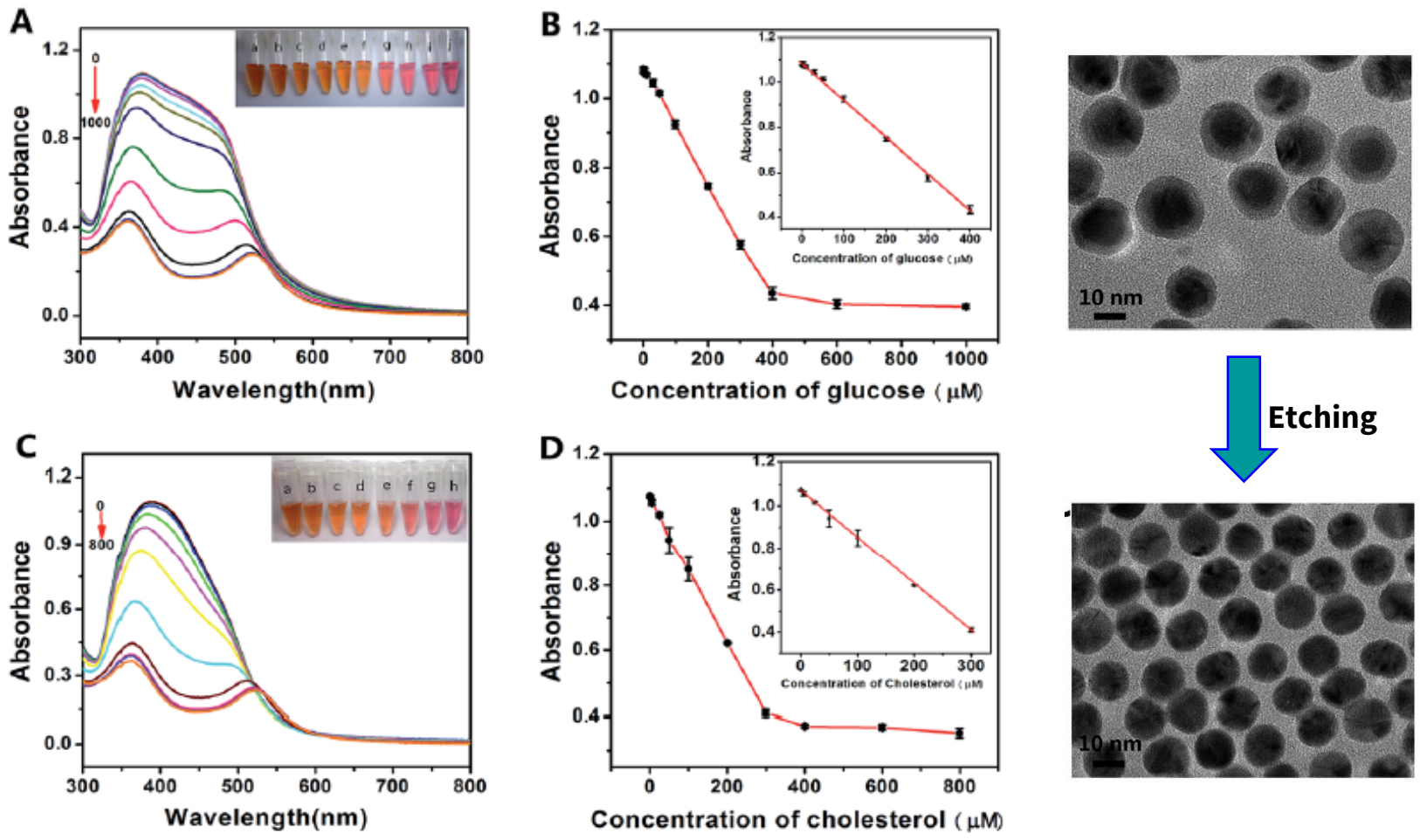
Sensitive colorimetric detection of glucose and cholesterol by using Au@Ag core–shell nanoparticles†

Xuehong Zhang,[a] Min Wei,[b] Bingjing Lv,[a] Yuanjian Liu,[a] Xu Liu[a] and Wei Wei*[a]

Metal nanoparticles etching

Glucose and cholesterol detrmination trough MNPs etching

Dose-response curve



Recovery study

Table 1 Recovery measurements of glucose in human urine samples and free cholesterol in human serum samples

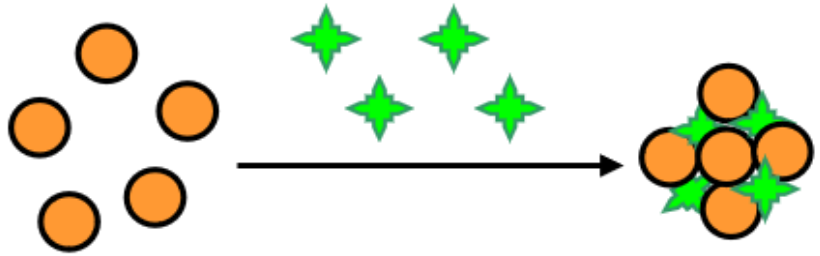
Analytes	Spiked (mM)	Found (mM)	Recovery (%)	RSD (%) ($n = 3$)
Glucose	0	0.580	—	0.84
	1	1.552	97.2	0.51
	5	5.530	99.0	1.02
	10	11.041	104.6	2.66
	30	31.037	101.5	3.83
Cholesterol	0	1.544	—	0.90
	1	2.610	106.6	0.43
	5	6.320	95.6	2.69
	10	11.715	101.7	1.88
	30	31.283	99.1	5.88

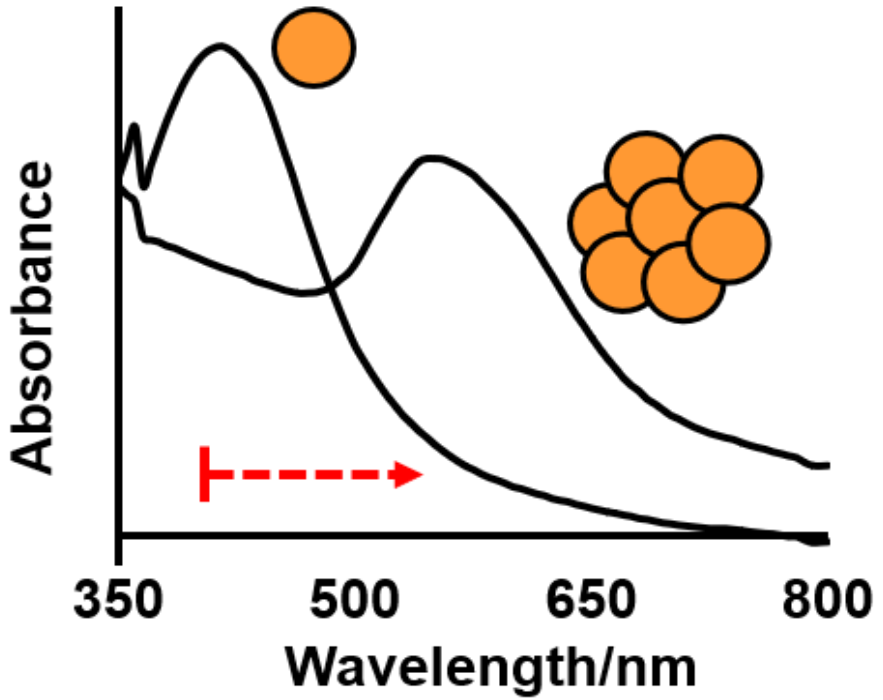
Sample analysis

Table 2 Determination of glucose concentration in human serum samples

Sample	This work (mM)	RSD (%) ($n = 3$)	Glucometer (mM)	RSD (%) ($n = 3$)
1	4.83	2.69	4.70	4.26
2	7.30	4.46	7.53	3.34
3	8.79	4.82	8.97	1.70
4	10.36	3.09	10.23	2.46

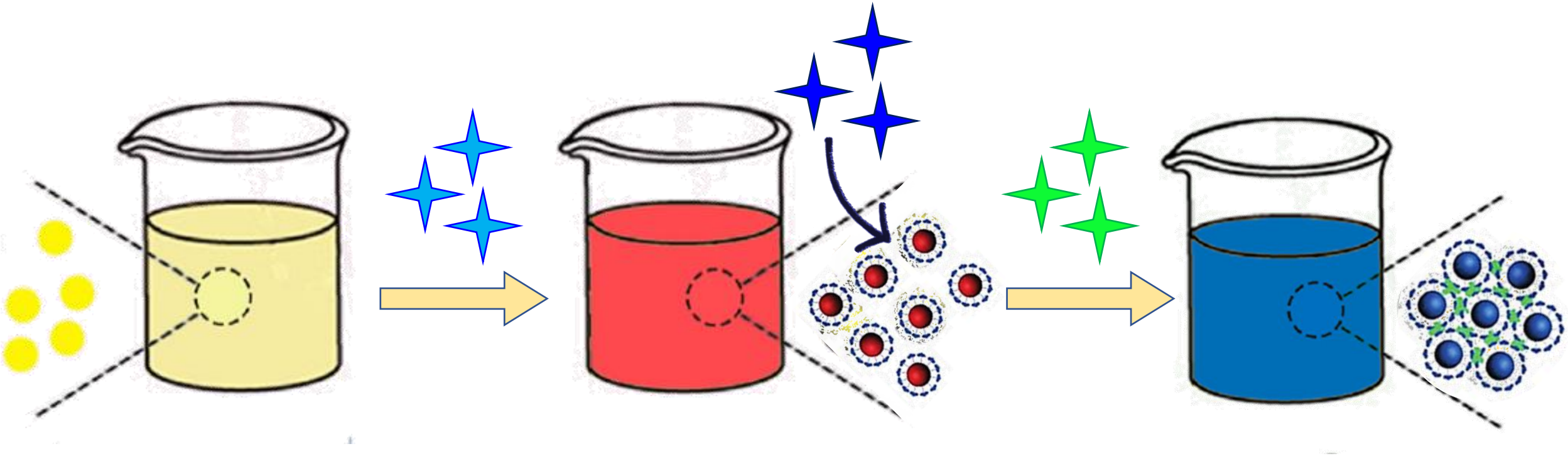
Metal nanoparticle aggregation





Metal nanoparticles aggregation

Main strategy



Metal salts

Reductant

MNPs

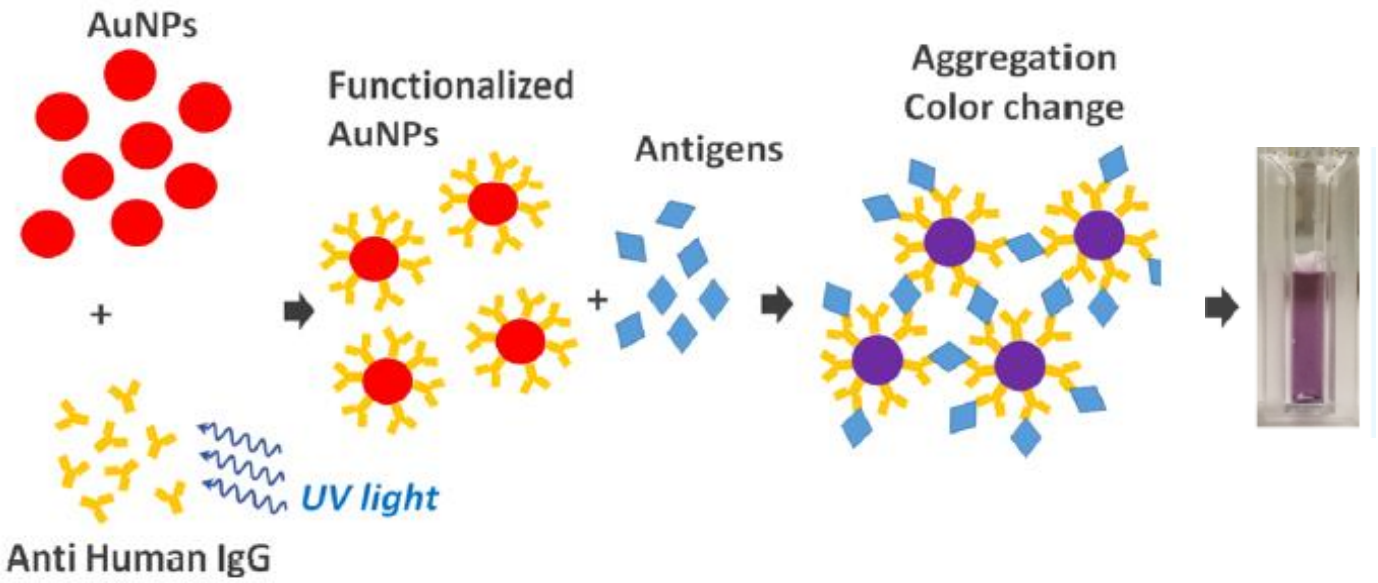
Functionalization

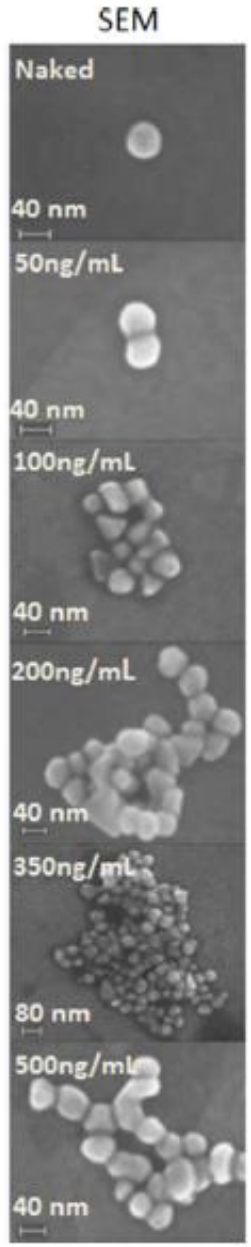
Analytes

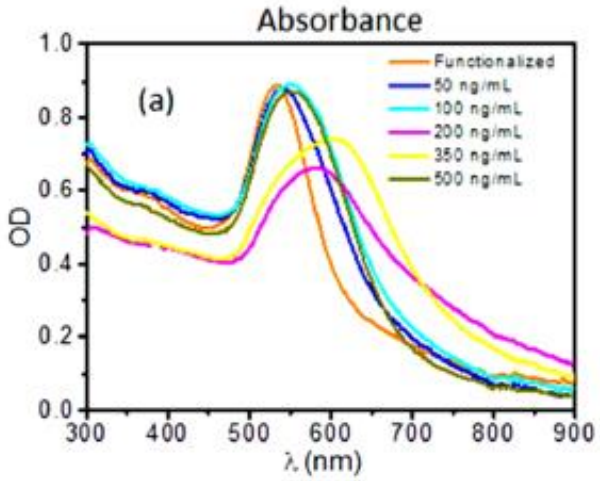
Aggregated MNPs

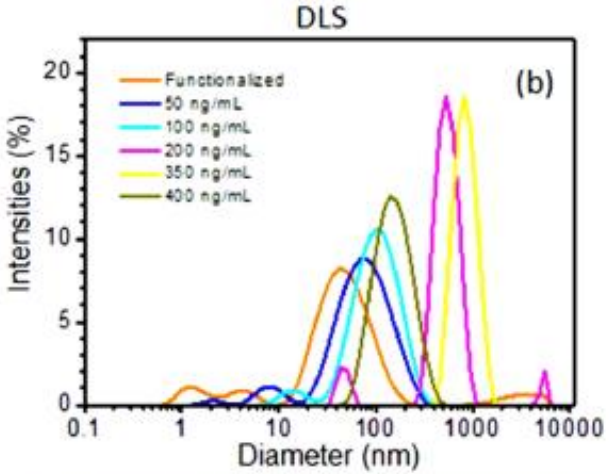
Metal nanoparticles aggregation

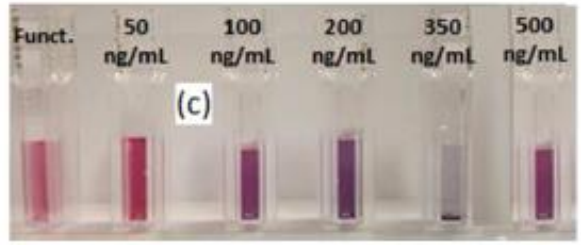
Immuno-based determination of HIgG









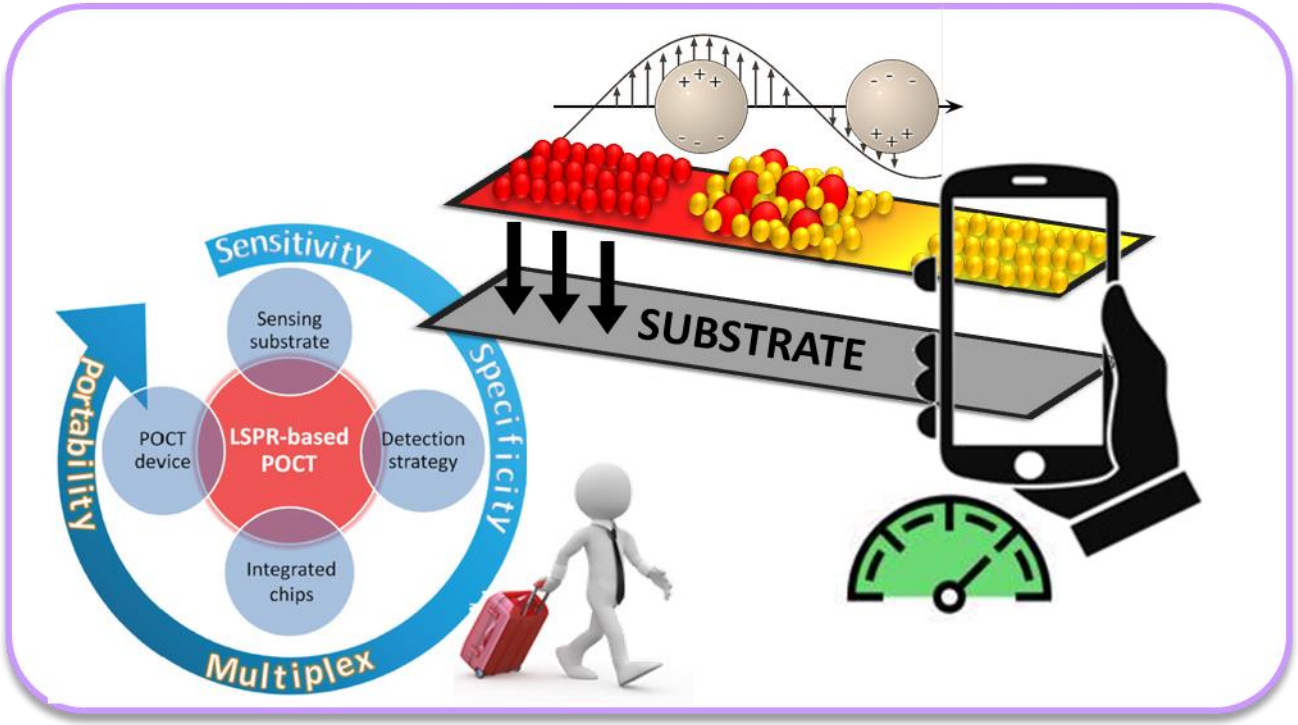


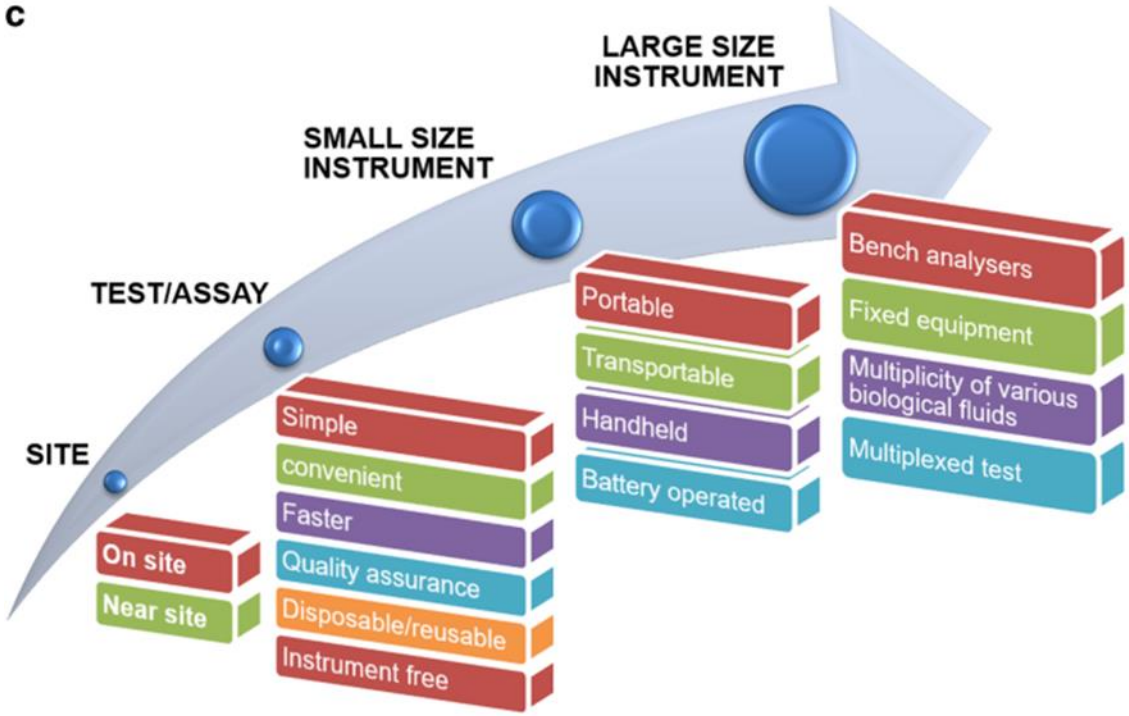
ACS OMEGA
Article
Cite This: ACS Omega 2018, 3, 3805−3812

Colorimetric Immunosensor by Aggregation of Photochemically Functionalized Gold Nanoparticles

Marzia Iarossi,[†,∥] Chiara Schiattarella,[†,‡] Ilaria Rea,[‡] Luca De Stefano,[‡] Rosalba Fittipaldi,[§] Antonio Vecchione,[§] Raffaele Velotta,[*,†] and Bartolomeo Della Ventura[†]

Metal nanoparticles integration onto solid substrates

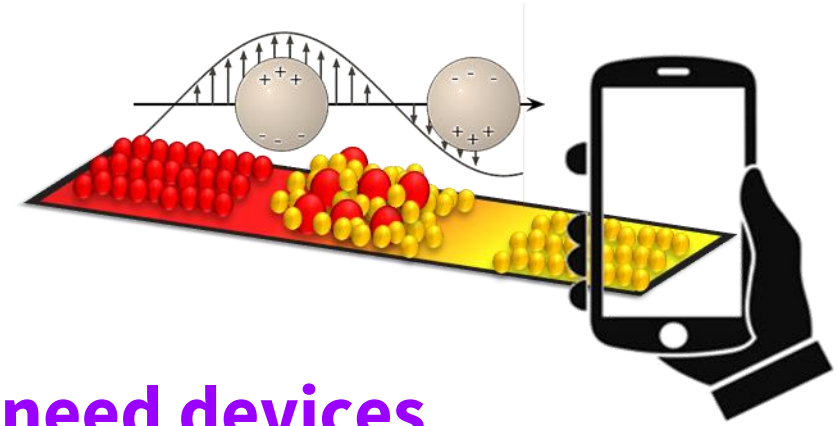




!!! Lab-on-a-strip Device !!!

Metal nanoparticles integration onto solid substrates

Main POC and PON requirements



Point of care/need devices

A ffordable
S ensitive
S pecific
U ser friendly
2 x R apid & **r**obust
E quipment-free
D elivered

Cost performance

Manufacturing

Mass production

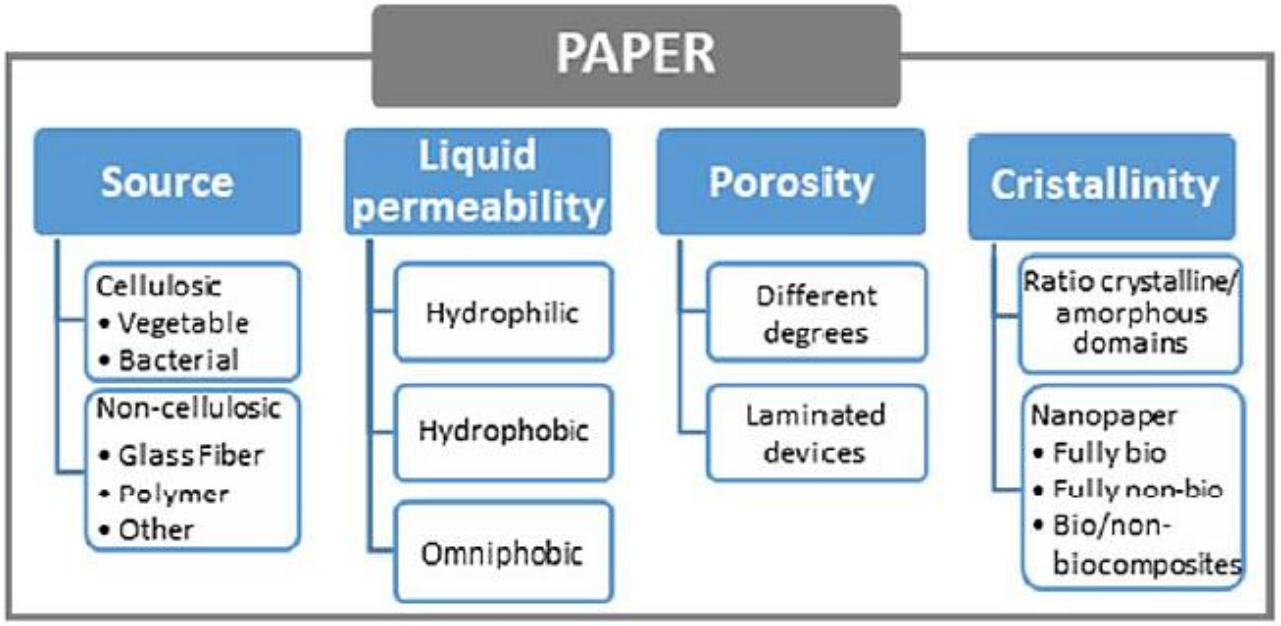
Paper as elective substrate

Paper as substrate

Paper can…
Store
Filter
React

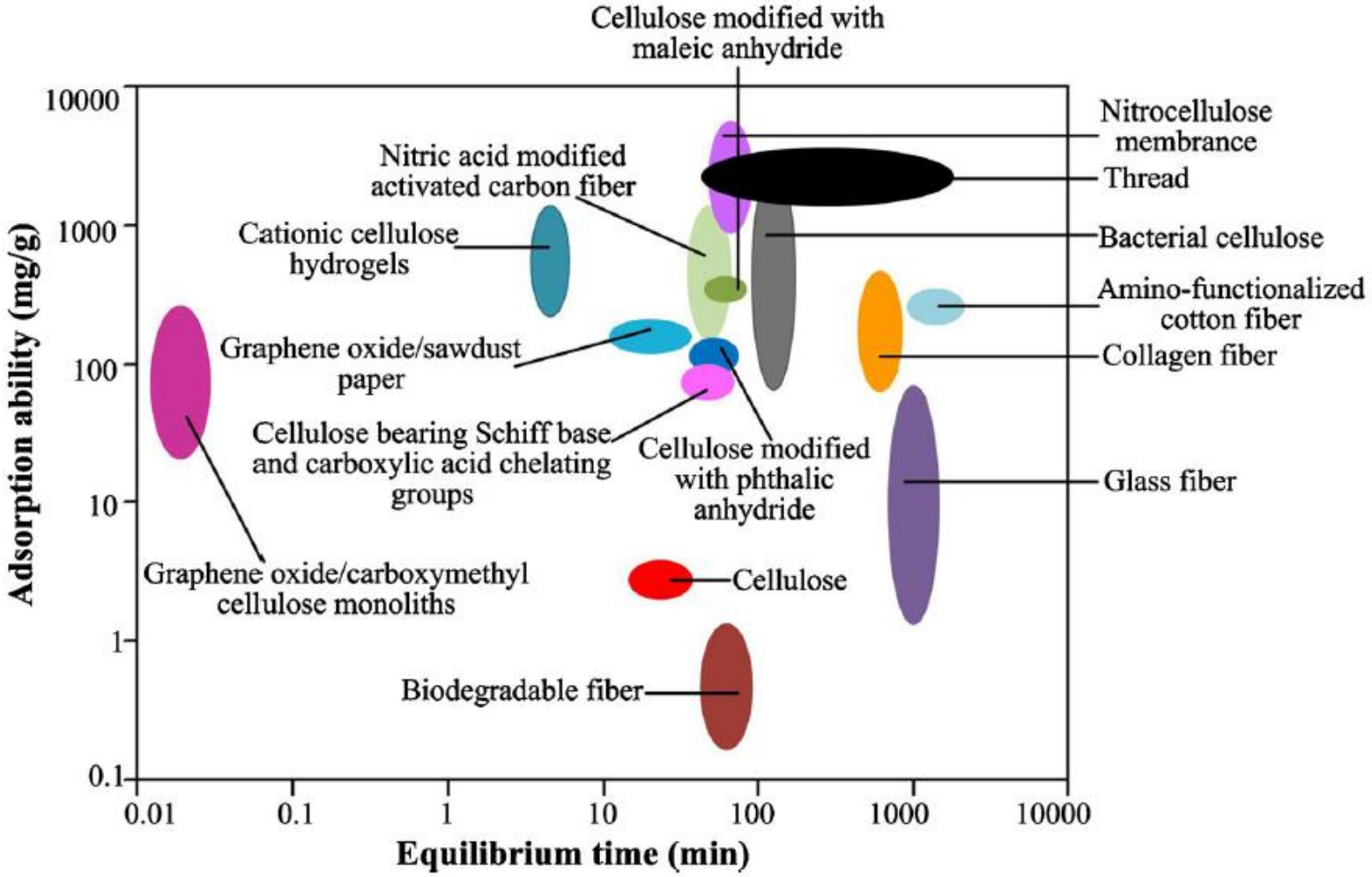
Drawbacks…
Reagents diffusion…
Electrical noise! ☹

An hydrophobic barrier is needed…



Paper as elective substrate

Kind of paper based substrates



Paper as elective substrate

Paper ca be tailored

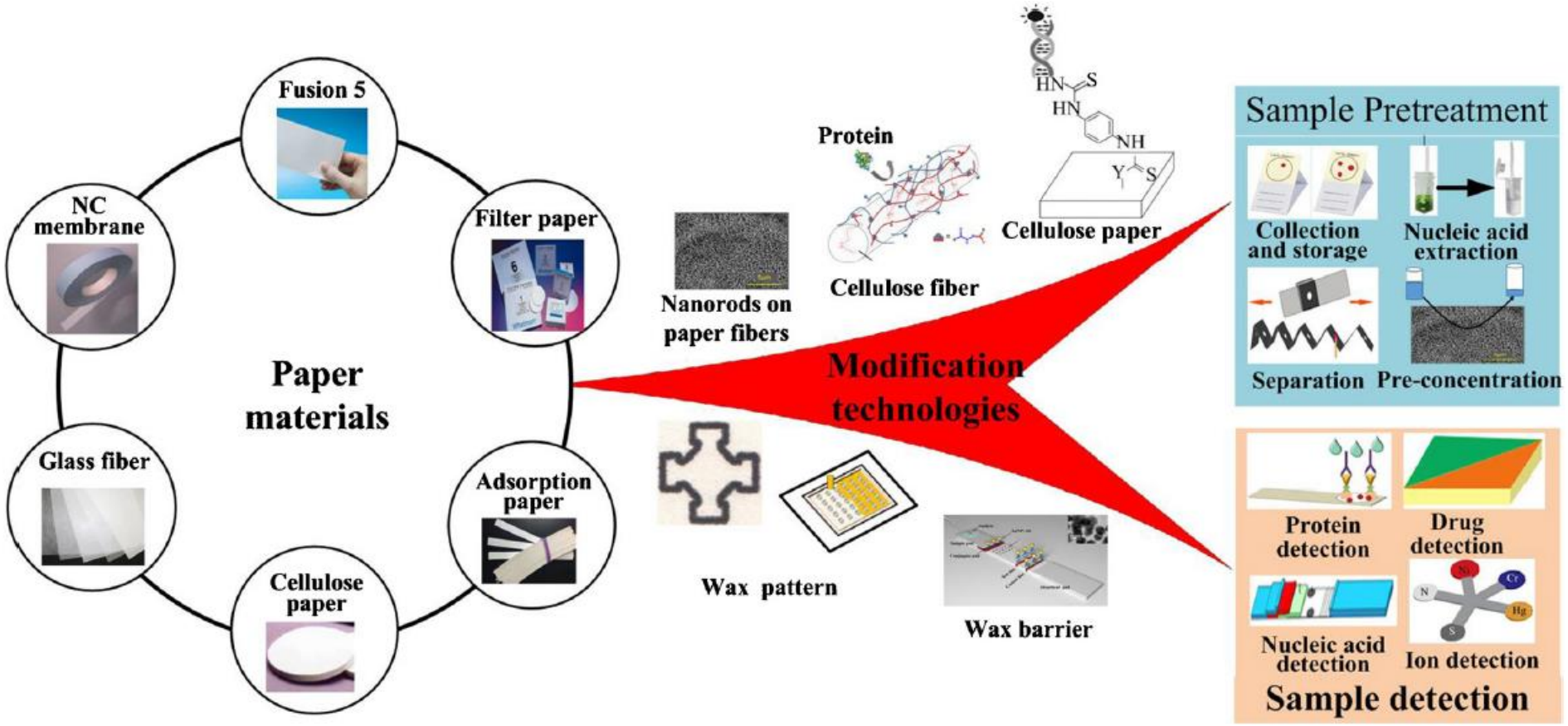
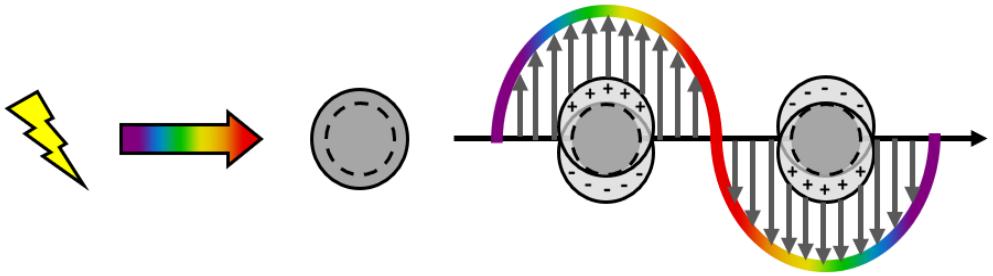


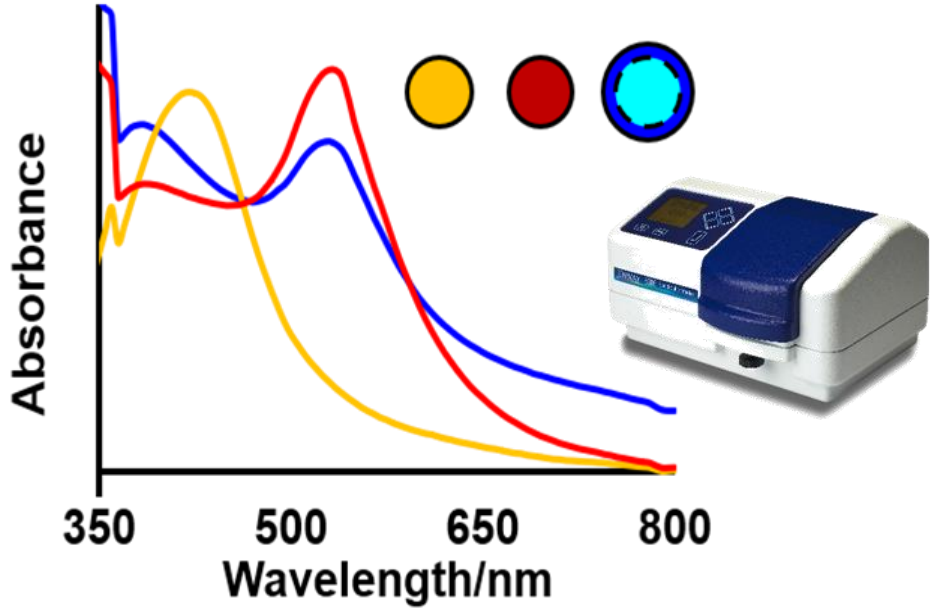
Fig. 1 Existing paper modification approaches for paper-based POCT. Different paper materials, including Fusion 5, filter paper, chromatography paper, cellulose paper, Whatman® No.1 filter paper and NC membrane, have been modified with various reagents for paper-based sample pretreatment and paper-based detection

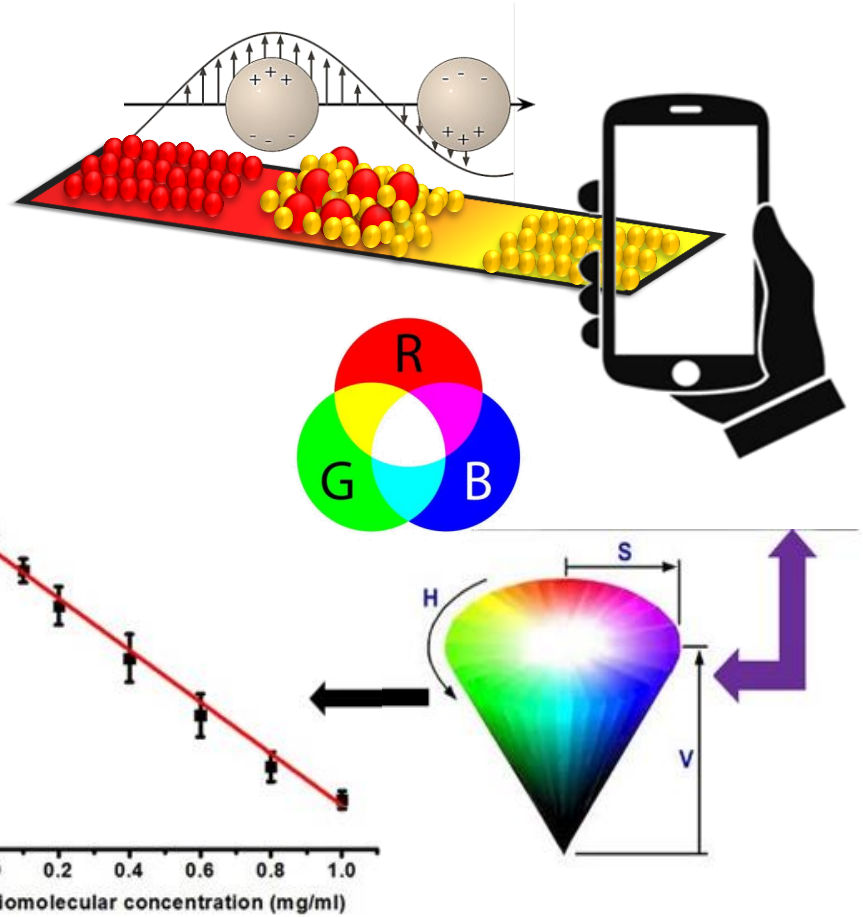
Paper as elective substrate

From plasmonic… Towards colorimetric strategies



Localized Surface Plasmon Resonance



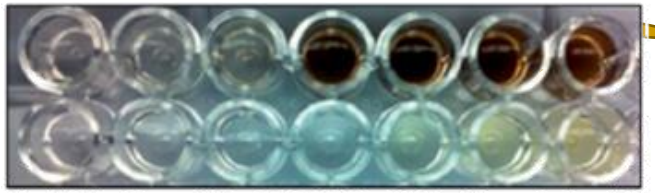


Paper-based colorimetric sensor

Phenolic content and antioxidant capacity evaluation trough NanoCeria formation

$[CeO_2]$ 0.0025, 0.005, 0.01, 0.1, 1, 2, and 4%

Optimization



Caffeic acid (0,45 mM) reacted $[CeO_2]$

$[CeO_2]$= 4%

Analyst RSCPublishing

PAPER View Article Online View Journal

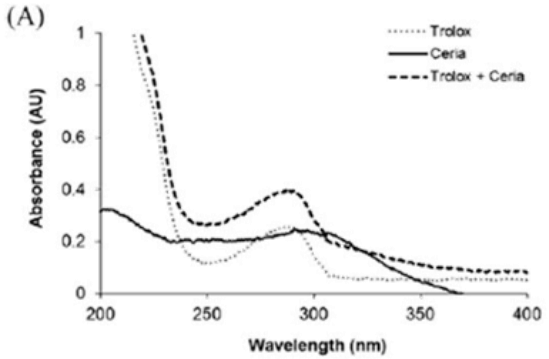
Portable ceria nanoparticle-based assay for rapid detection of food antioxidants (NanoCerac)

Cite this: DOI: 10.1039/c2an36205h

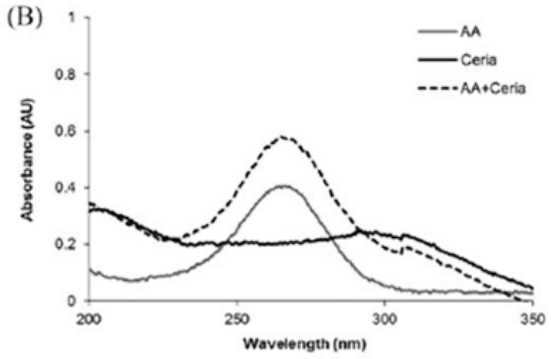
Erica Sharpe, Thalia Frasco, Daniel Andreescu and Silvana Andreescu*

Uv-vis spectra of ceria nanoparticles dispersion (13 ppm) in the presence and abesence of selected antioxidants.

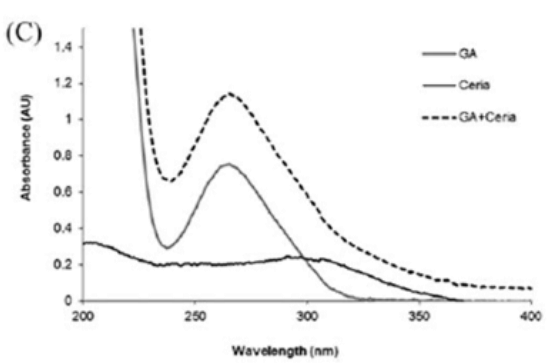
Trolox



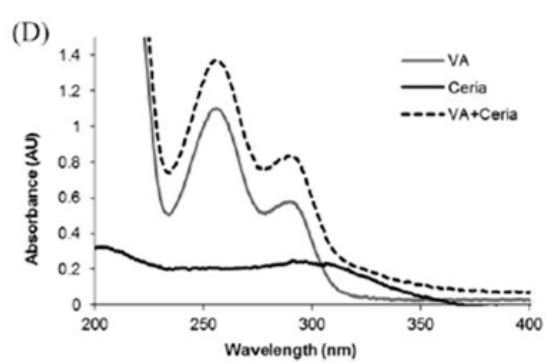
Ascorbic acid



Gallic acid



Vanillic acid



$2\ CeO_2 + 3\ C_6H_8O_6 \rightarrow Ce_2O_3 + 3\ C_6H_6O_6 + 2\ H_2O$

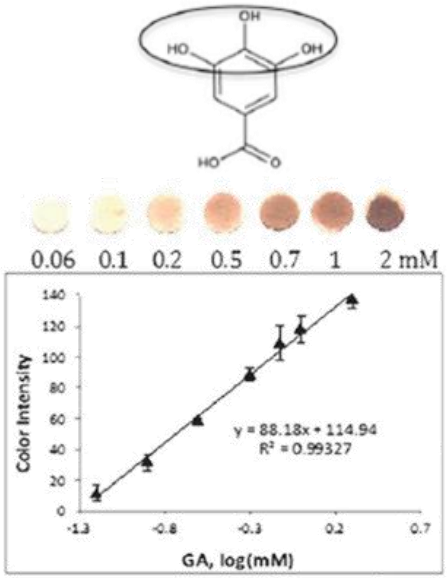
From dispersed system

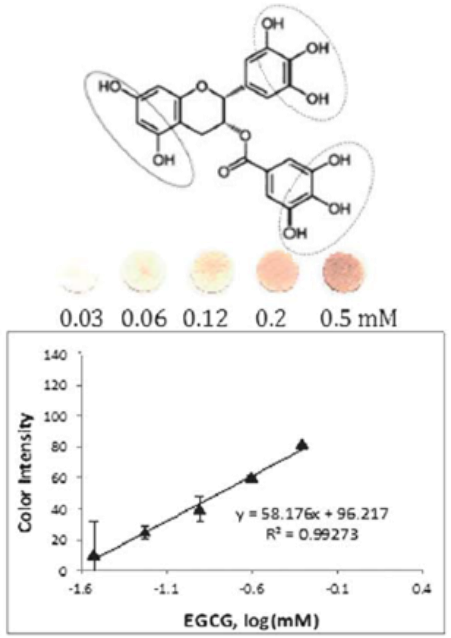
to paper support

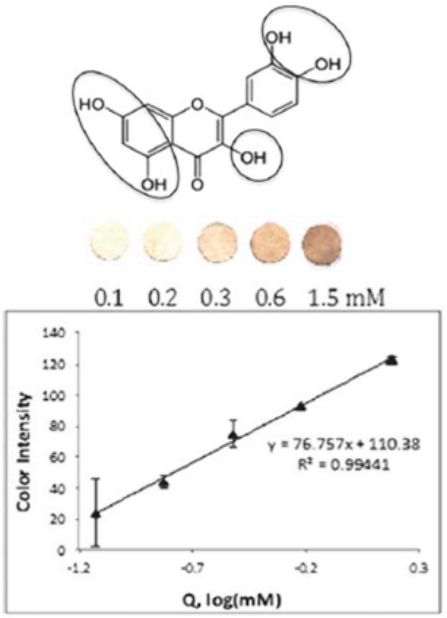
Paper-based colorimetric sensor

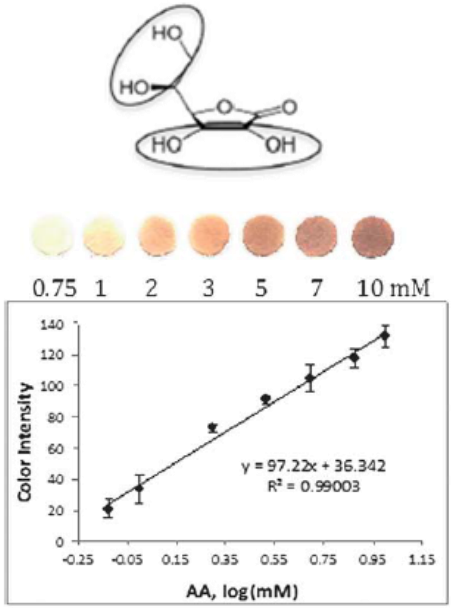
Phenolic content and antioxidant capacity evaluation trough NanoCeria formation

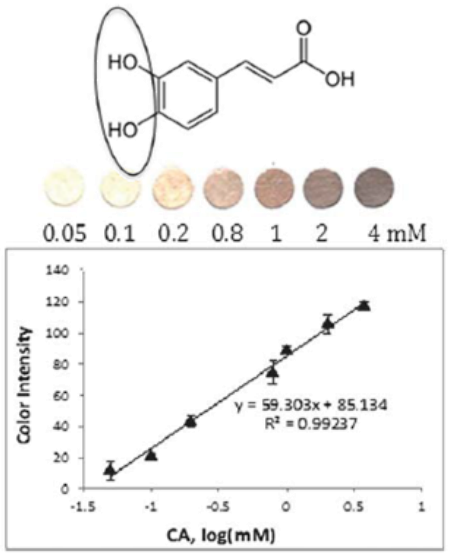
Dose-response curve

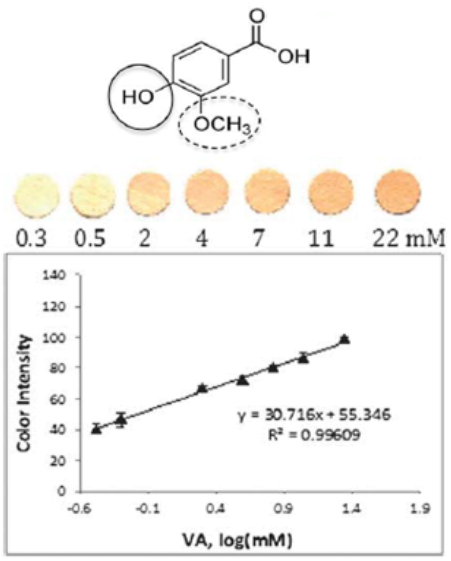




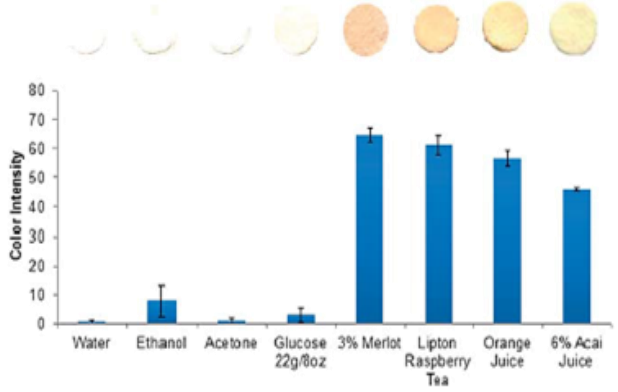








Interferents evaluation



Tested interfering compounds

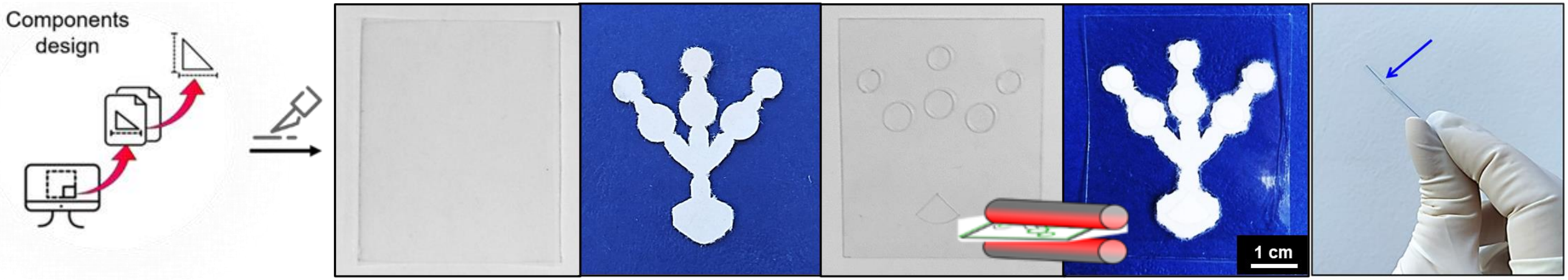
Common lab solvent:
- water,
- ethanol,
- acetone

Common sugar presents in:
- juice,
- wine,
- commercial teas

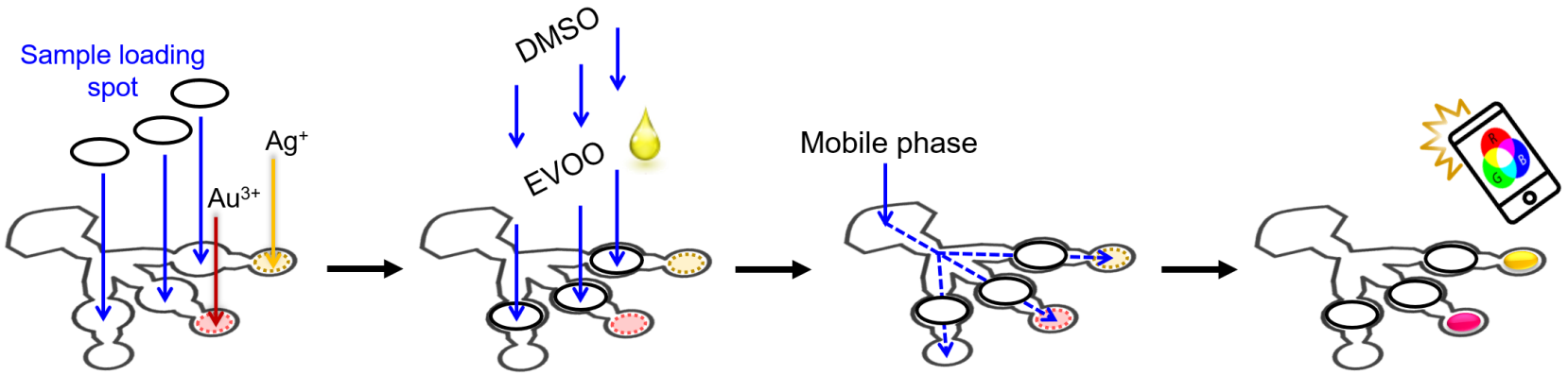
Paper-based colorimetric sensor

Extraction-free olive oil phenolic compounds evaluation trough a seed growth strategy

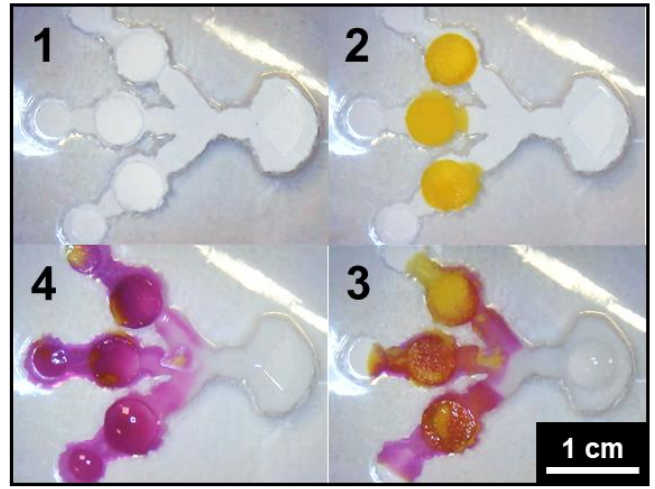
Lab-on-a-strip fabrication



Assay format



Assay simulation with a colorimetric dye

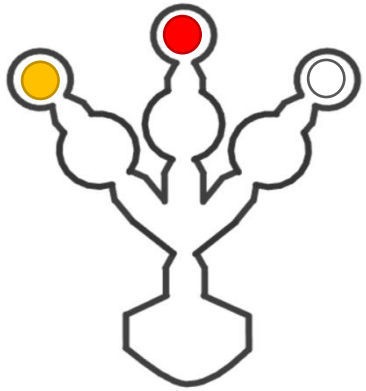


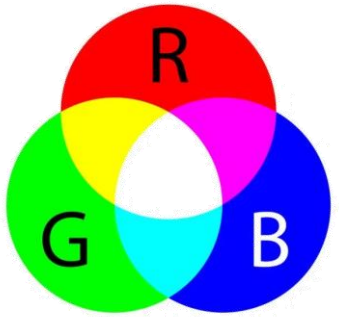
Total assay volume: ~ 80 uL

Paper-based colorimetric sensor

Extraction-free olive oil phenolic compounds evaluation trough a seed growth strategy

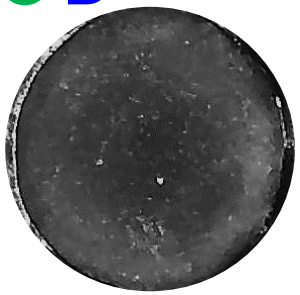
Color analysis

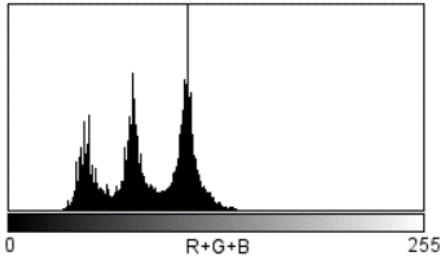




Google Play

R G B

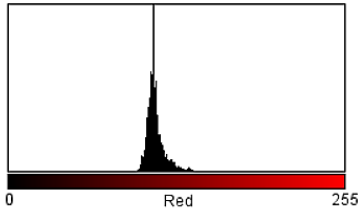




Count: 132192
Mean: 85.191
StdDev: 26.054

Min: 30
Max: 177
Mode: 110 (6566)

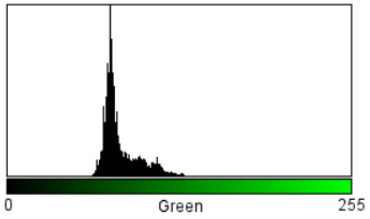
R



Count: 44064
Mean: 111.774
StdDev: 7.450

Min: 96
Max: 172
Mode: 110 (6143)

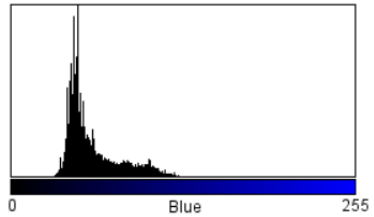
G



Count: 44064
Mean: 83.949
StdDev: 14.490

Min: 61
Max: 177
Mode: 76 (4141)

B



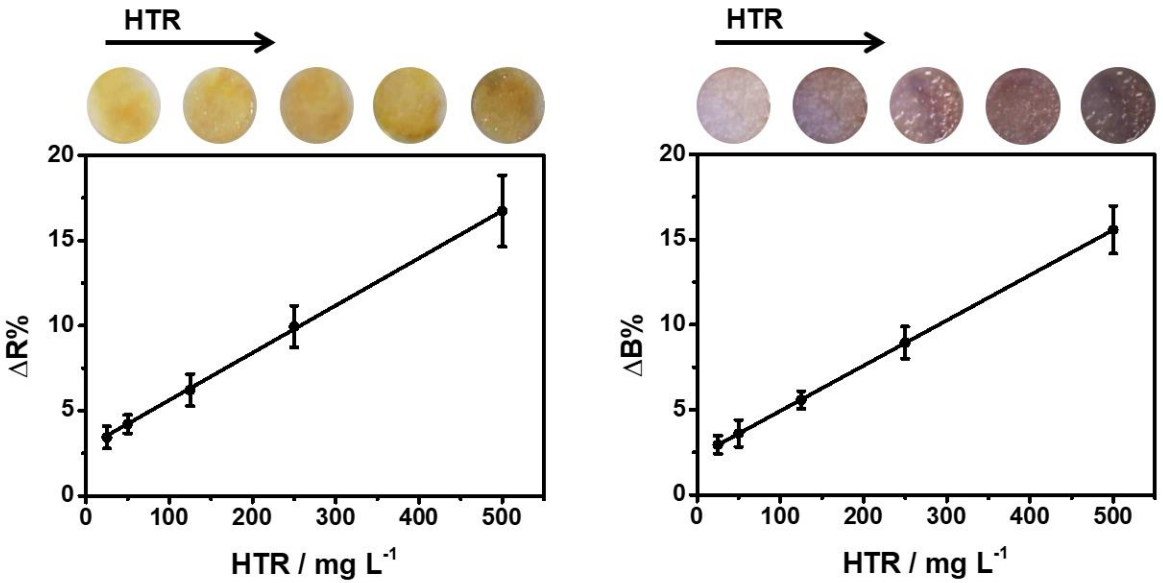
Count: 44064
Mean: 59.850
StdDev: 20.508

Min: 30
Max: 170
Mode: 49 (3039)

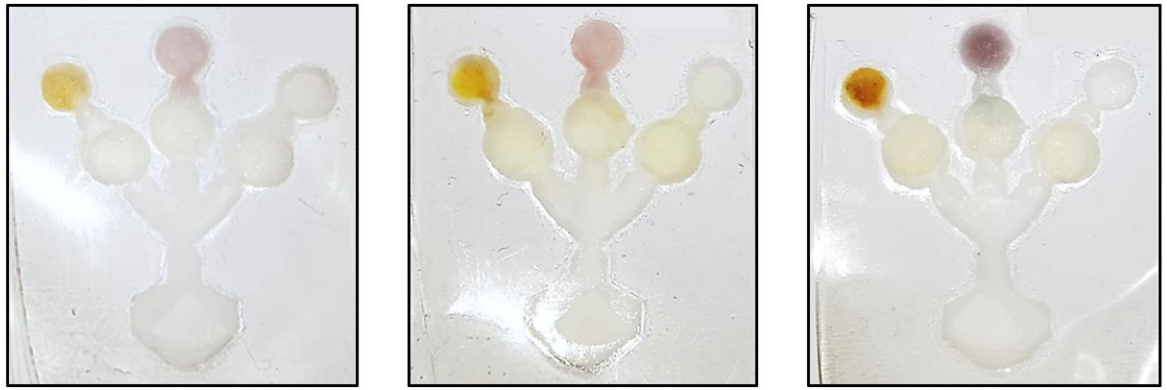
Paper-based colorimetric sensor

Extraction-free olive oil phenolic compounds evaluation trough a seed growth strategy

Dose-response curve

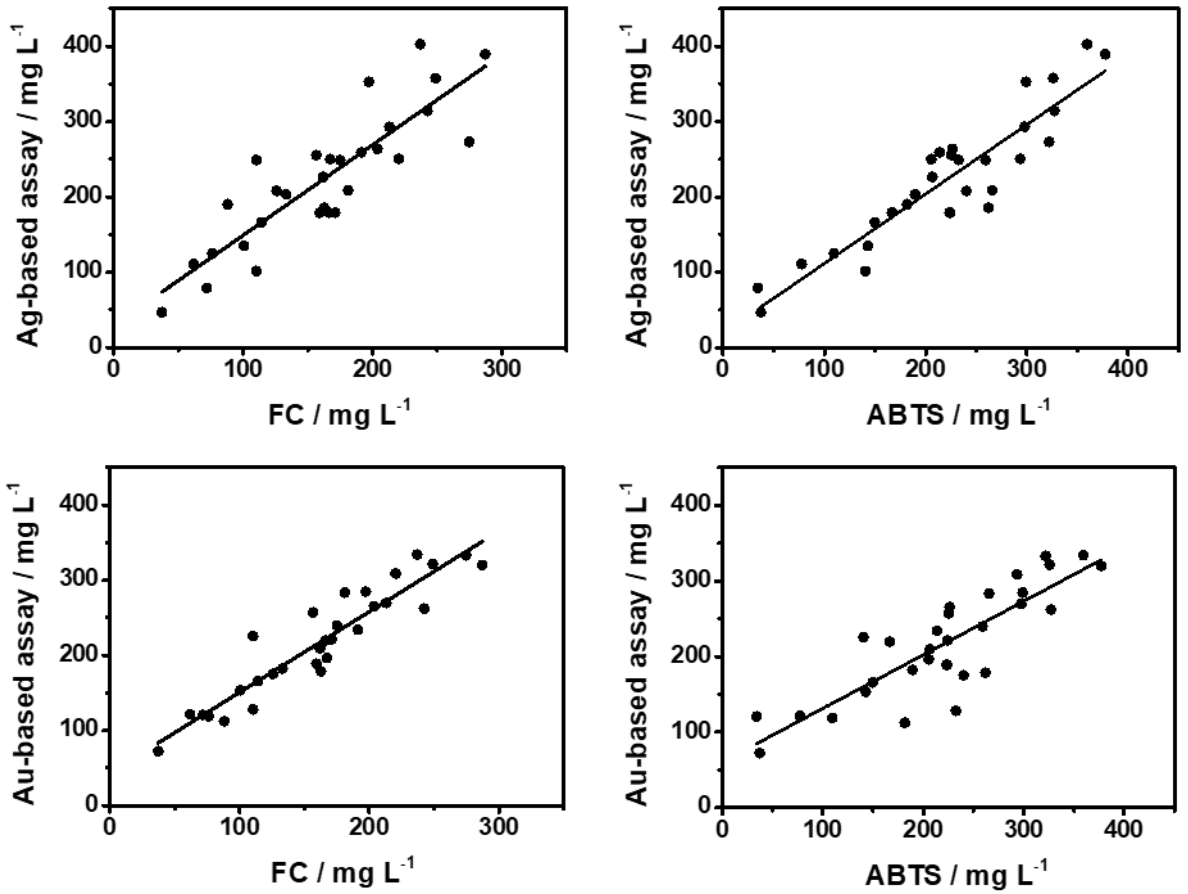


EVOO samples' phenolyc compounds content



Low Mean High

Sample analysis, analytical performances



No interterferences by compounds commonly present in EVOO