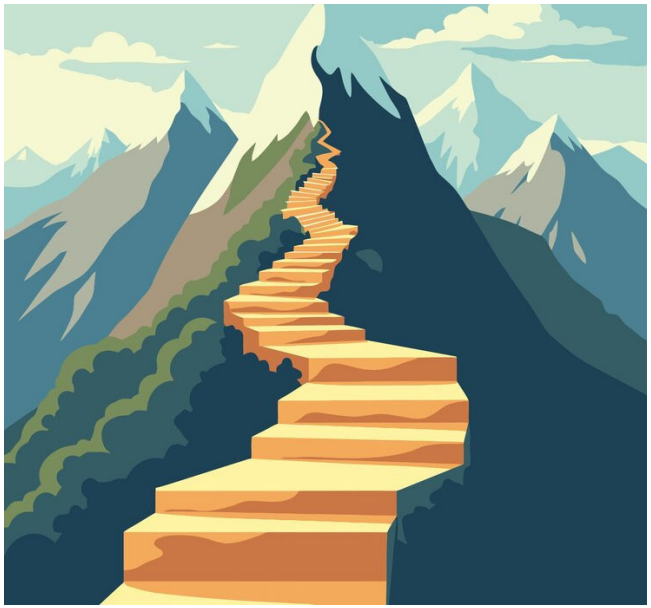


CARBON NANOMATERIALS AS VERSATILE PLATFORMS

ESMOLNA-ESAM2026, M. ANTONIA HERRERO, 18/05/2026

http://www.msocnanochemistrygroup.com/

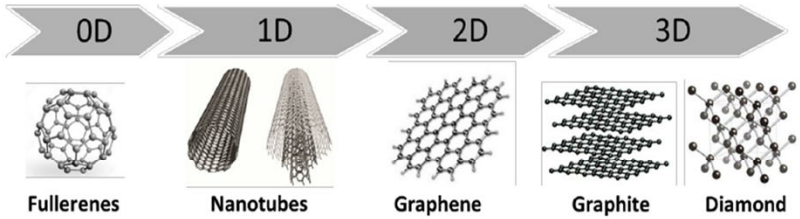
Inauguración de la 2ª Escuela Europea sobre Materiales Avanzados (ESAM2025).

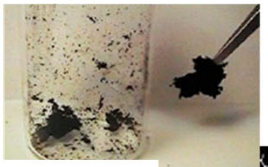
El evento se celebra en Almagro (Ciudad Real) hasta el 14 de marzo

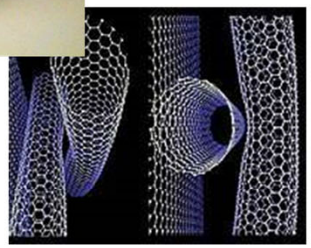
La UCLM reúne a destacados investigadores y nuevas generaciones del campo de los materiales avanzados en la 2ª Escuela Europea

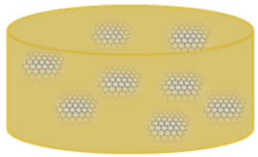
10/03/2025

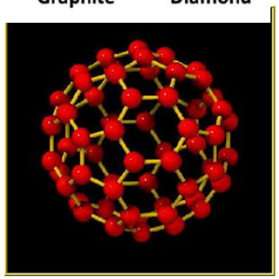
2000 2002 2006 2007 2008 2011 2025

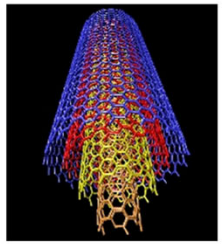




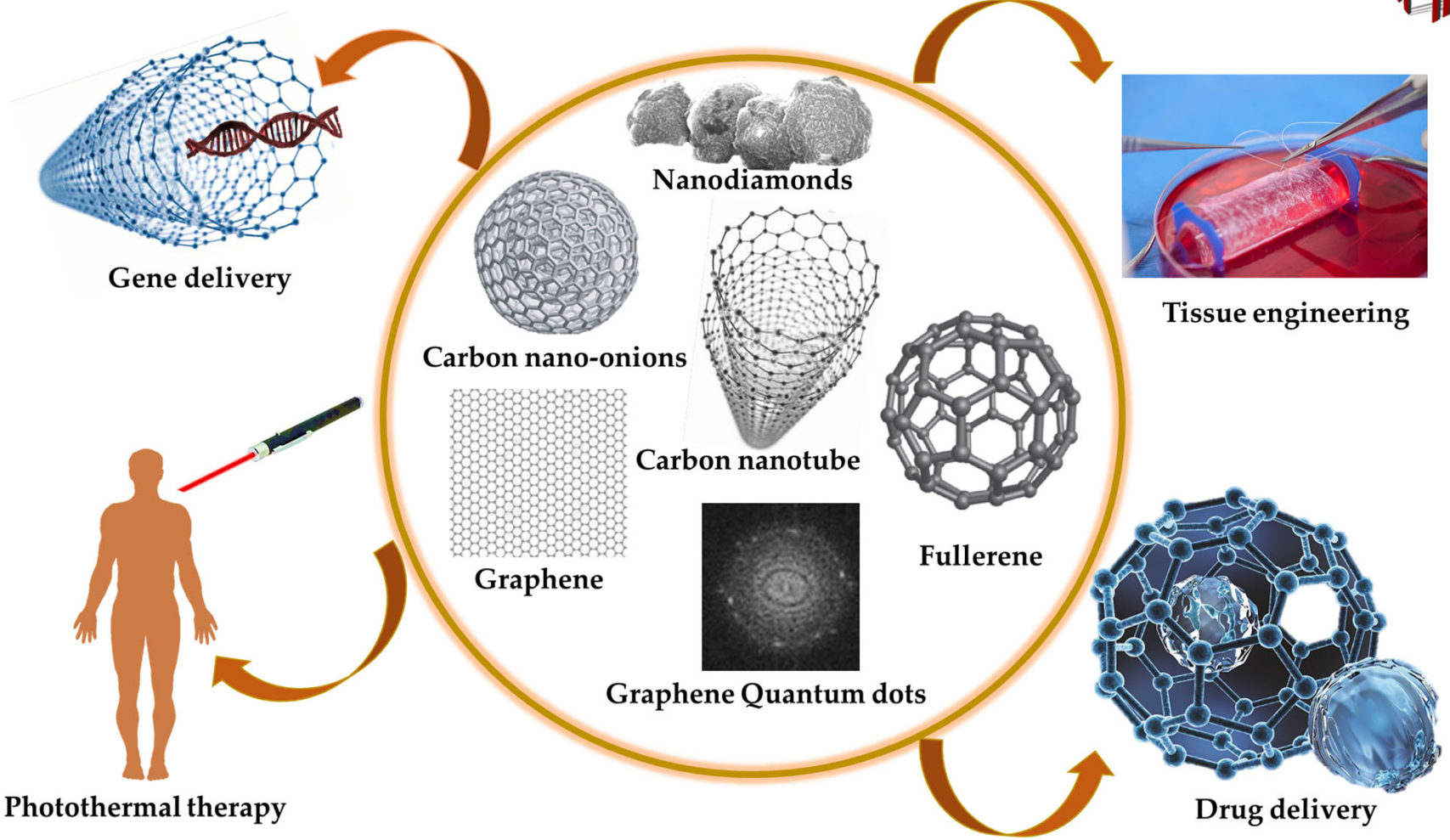






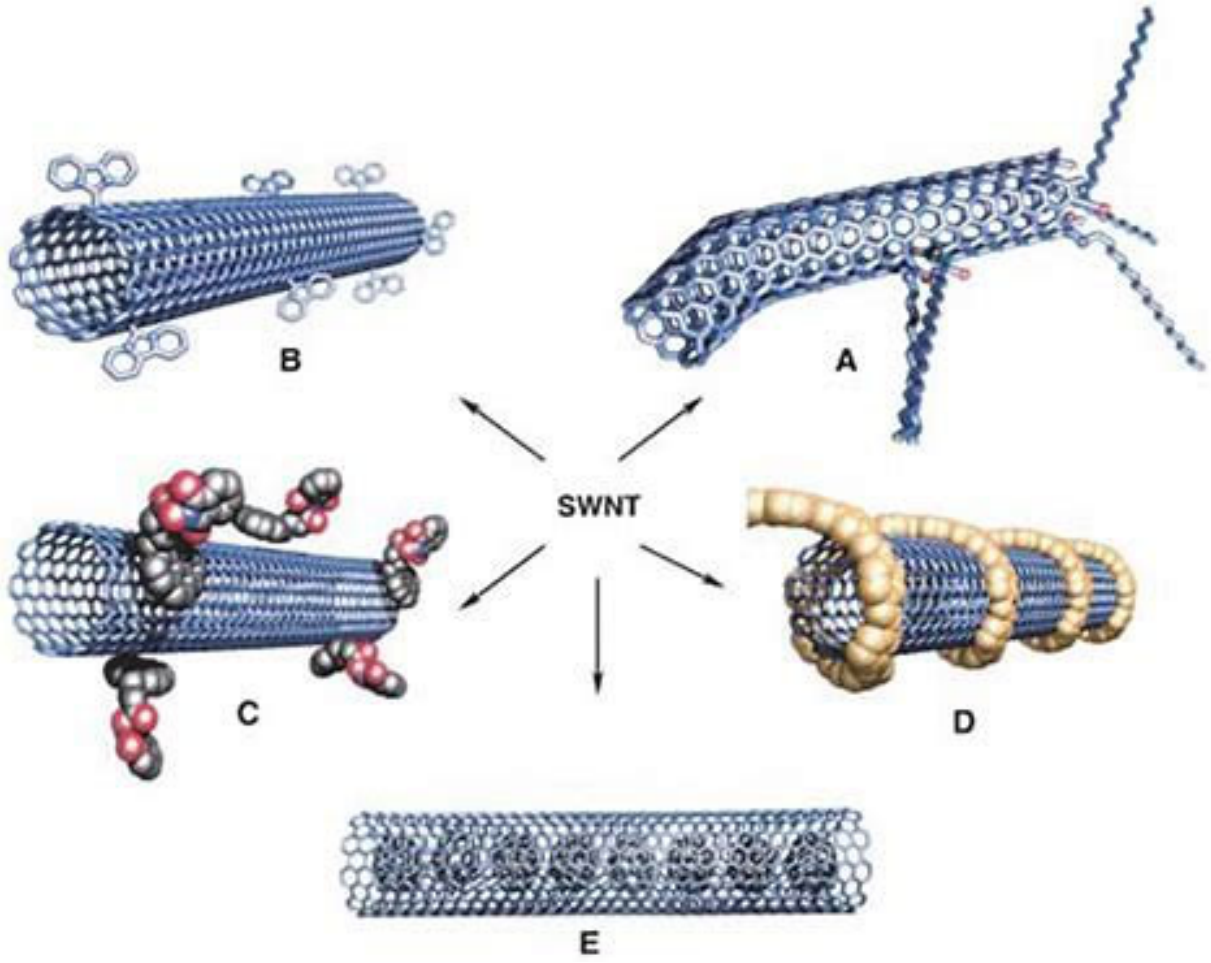


Carbon Nanomaterials



Journal of Carbon Research, ***2021,*** *7*

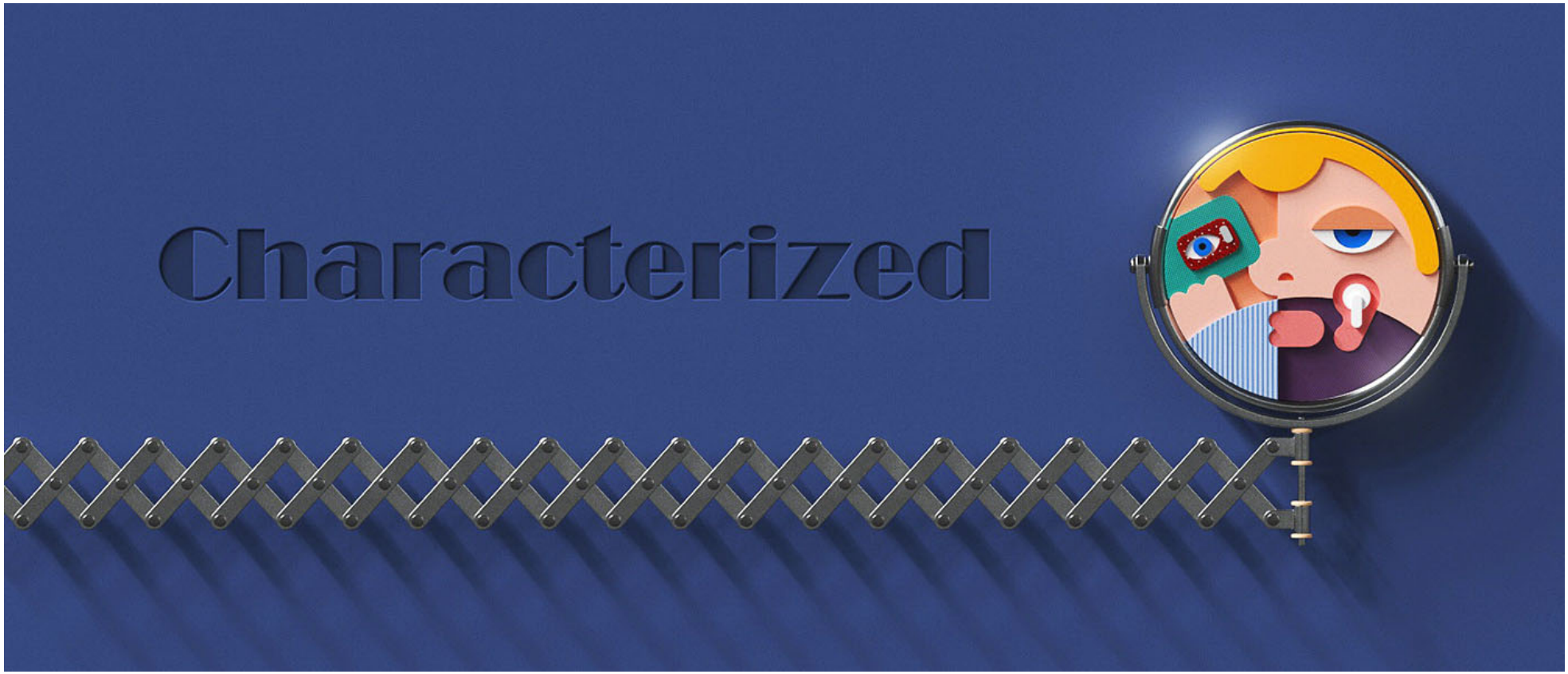
Carbon Nanomaterials



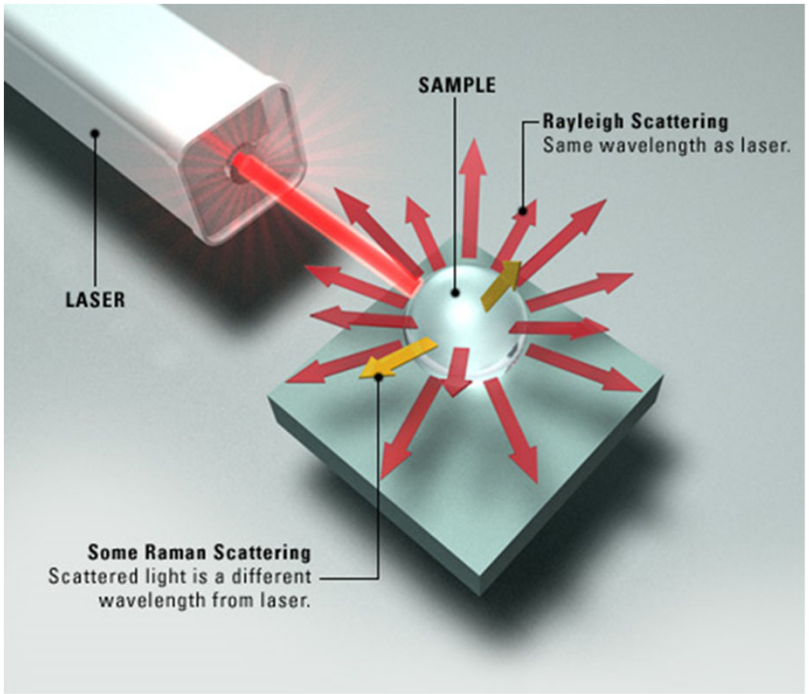
Angew, Chem, Int. Ed. **2002**, 41, (11), 1853

UCLM

Characterized



Raman Spectroscopy

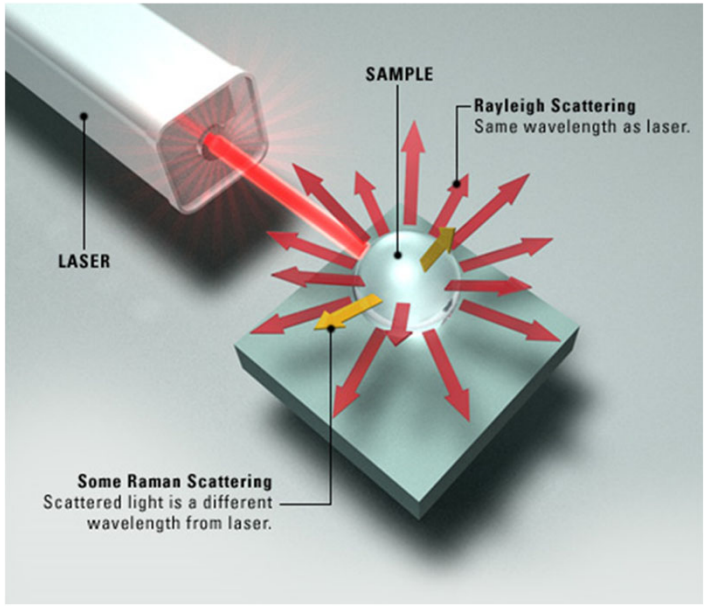


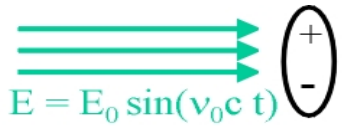
Non-destructive characterization

No sample preparation

Characterization of π-conjugated molecules

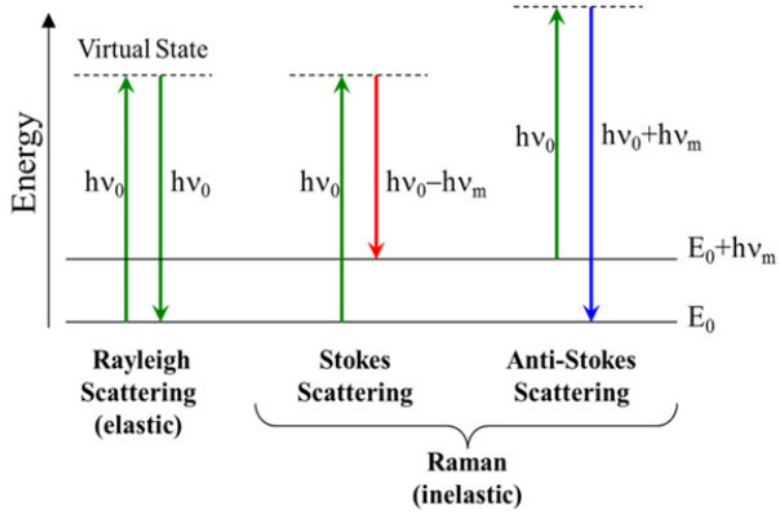
Raman Spectroscopy





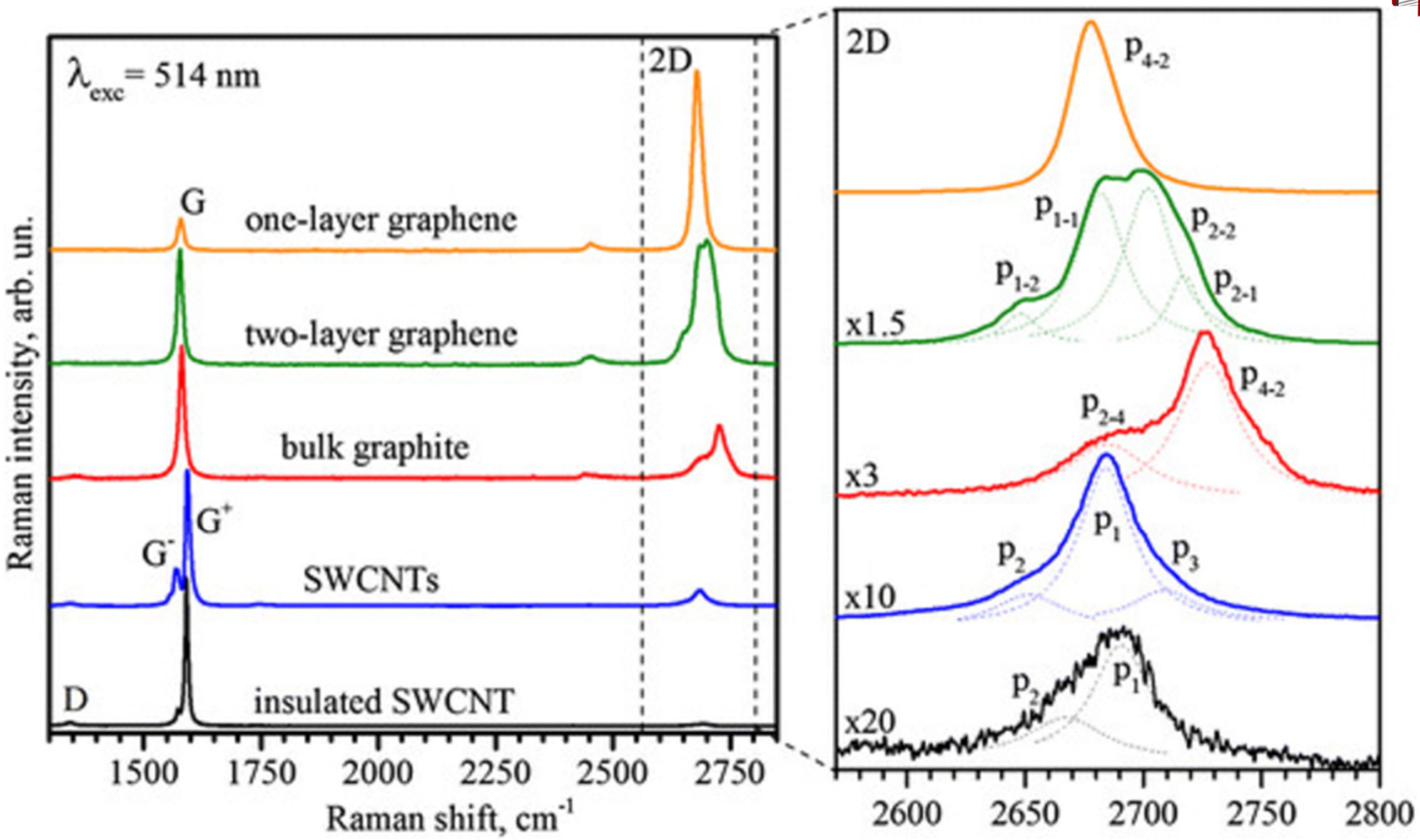
$E = E_0 \sin(\nu_0 c\, t)$

$\mu = \alpha E$

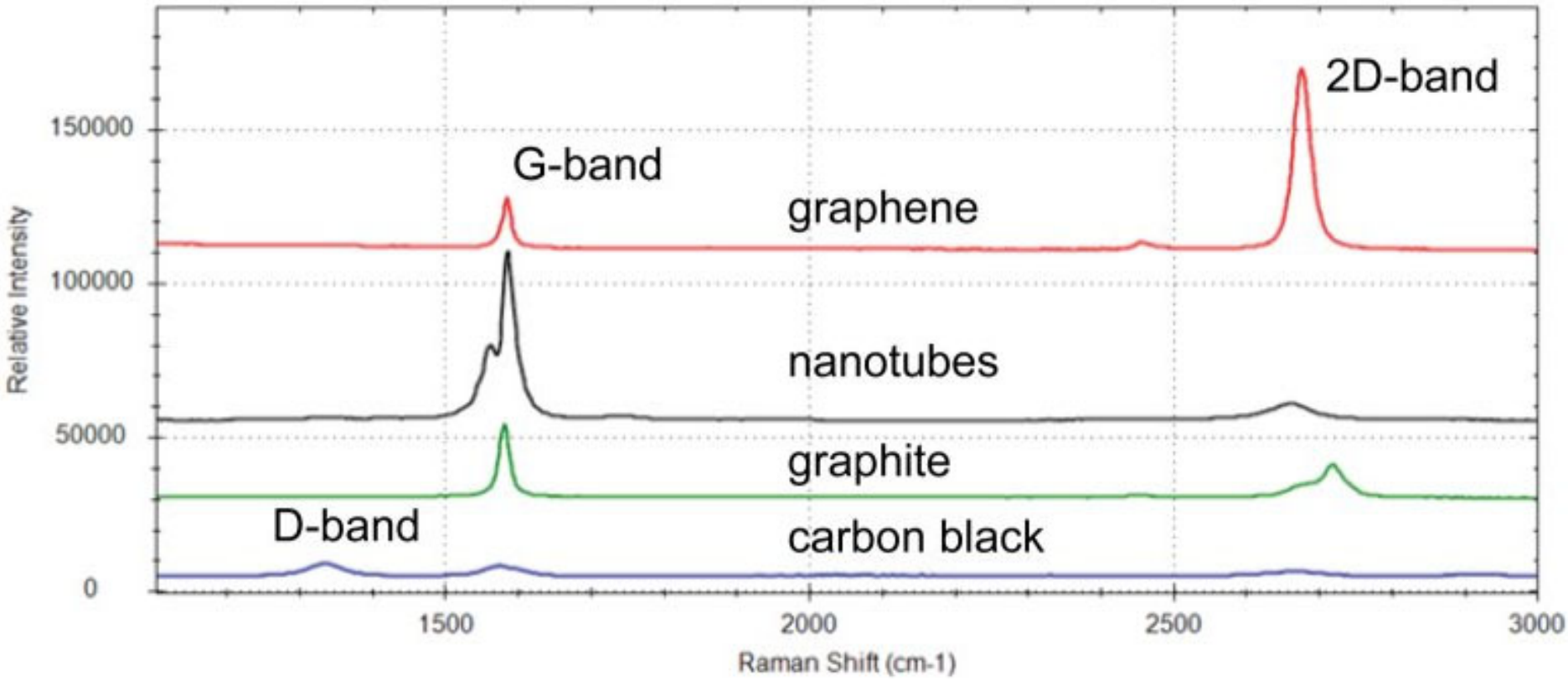


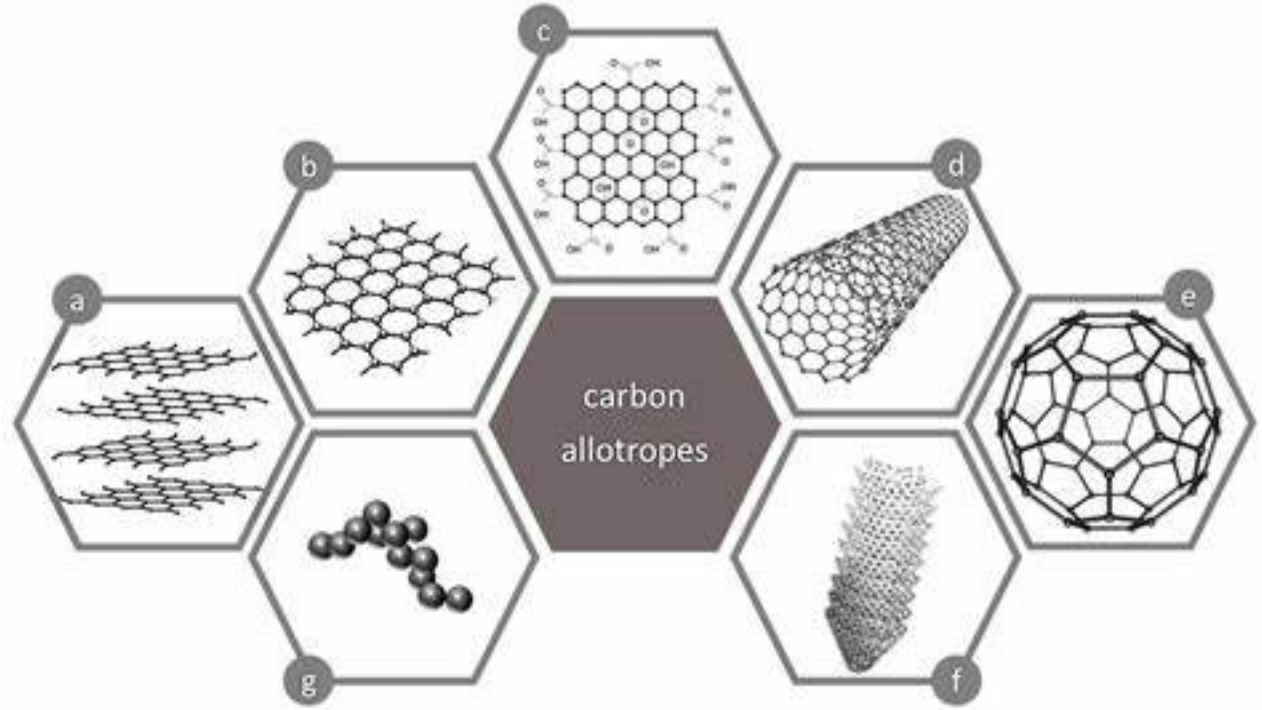
- **Raman effect** is based on **inelastic light scattering** (different energy as the incident radiation)
- **Very weak effect** (only one in a million of the scattered light particles actually exhibits the change in wavelength)

Raman Spectroscopy



Raman Spectroscopy





HYBRIDIZATION OF THE CARBON NANOMATERIALS?

Small 2013, 9, 341-350

Raman Spectroscopy

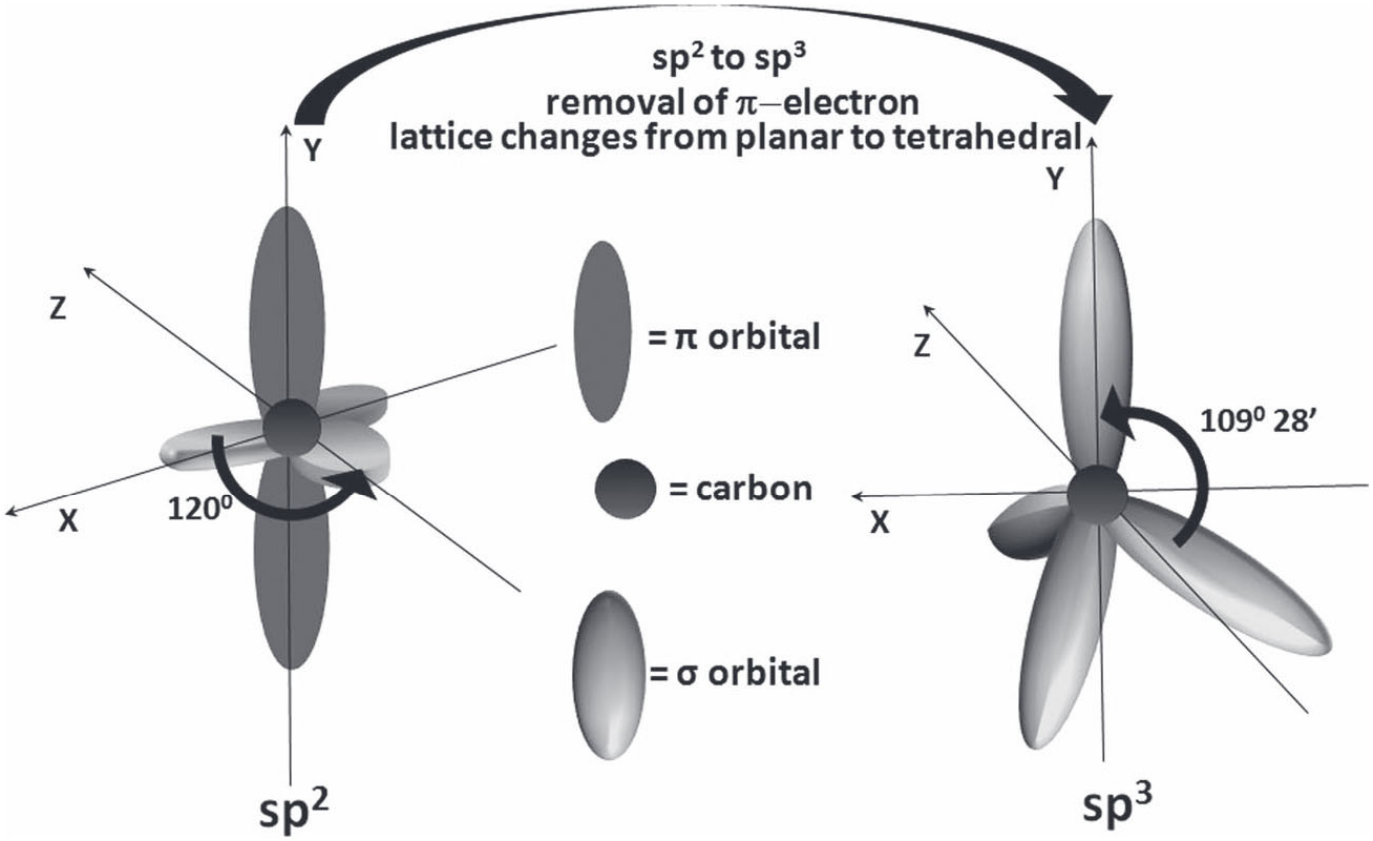


Figure 2. (A) Schematic representation of the effect of change in hybridization of carbon. Conversion of sp^2 to sp^3 leads to removal of the π electron and conversion of the planar lattice to tetrahedral.

Small 2013, 9, 341-350

Carbon Nanomaterials

JACS
ARTICLES
Published on Web 05/31/2008

Microwave-Induced Multiple Functionalization of Carbon Nanotubes

Fulvio G. Brunetti,[†,‡] M. Antonia Herrero,[†,‡] Juan de M. Muñoz,[‡] Angel Díaz-Ortiz,[‡] Jessica Alfonsi,[§] Moreno Meneghetti,[§] Maurizio Prato,[*,†] and Ester Vázquez[*,‡]

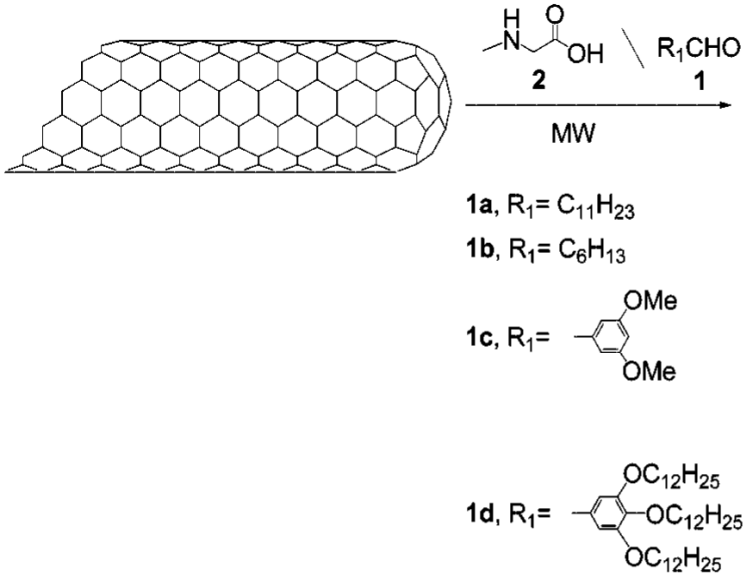


Table 2. Comparative Study of the Functionalization of **3c** at Different Reaction Times

reaction time (min)	TGA wt loss (%)[a]	functional group coverage[b]	Raman D/G ratio[c]
60	16	87	0.12
40	8	187	0.08
10	6	252	0.06

[a] TGA-determined weight loss. [b] The functional group coverage was calculated following ref.[24] [c] Calculated D/G ratios from Raman spectra.

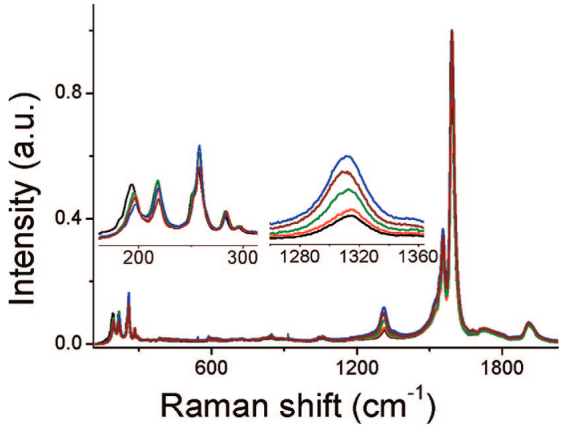


Figure 1. Raman spectra (633 nm) of pristine SWNTs (black line), f-SWNTs **3a** (green line), f-SWNTs **3b** (brown line), f-SWNTs **3c** (blue line), and f-SWNTs **3d** (red line).

Table 1. Comparative Study of the Functionalization of Compounds **3a**−**d**

product	TGA wt loss (%)[a]	functional group coverage[b]	Raman D/G ratio[c]
3a	13	118	0.08
3b	11	96	0.10
3c	16	87	0.12
3d	21	216	0.05

[a] TGA-determined weight loss. [b] See ref 24. [c] Calculated D/G ratios from Raman spectra.

J. Am. Soc. **2008**, 130, 8094-8100

Carbon Nanomaterials

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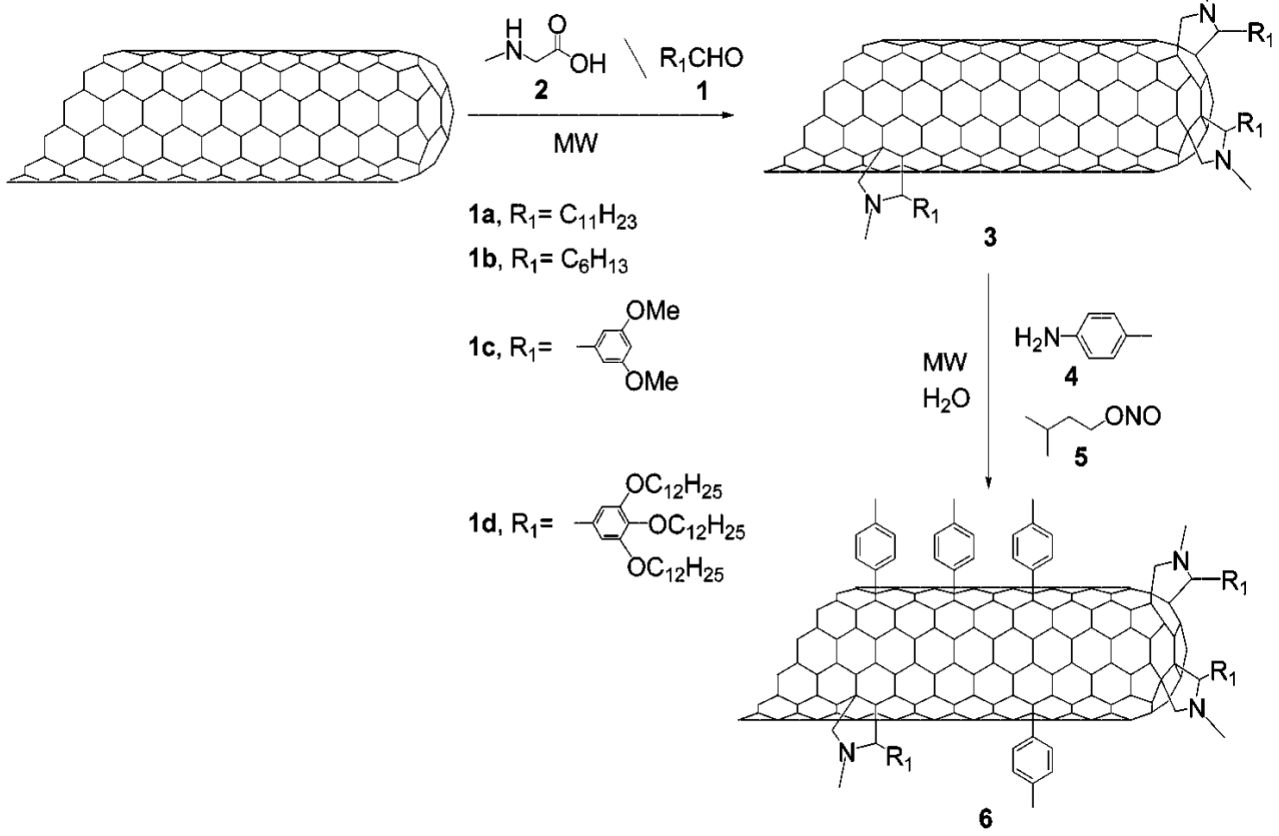

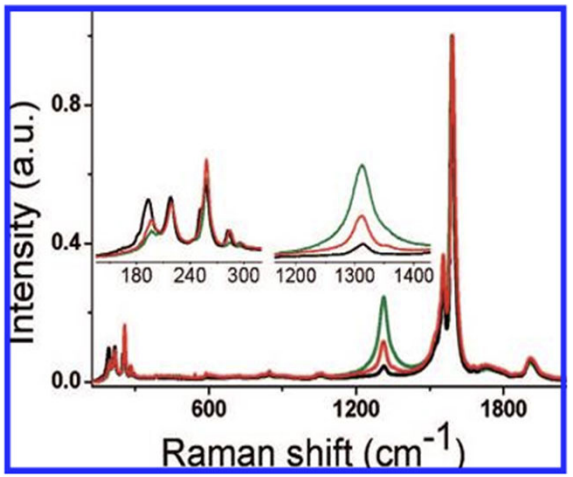

Figure 3. Raman spectra (633 nm) of pristine SWNTs (black line), f-SWNTs **3c** (red line), and ff′-SWNTs **6c** (green line).

Table 3. Comparative Study of the Functionalization of Compounds **6a**–**d**

product	TGA wt loss (%)[a]	functional group coverage (1,3-dipolar cycloaddition)[b]	functional group coverage (arene radical addition)[c]	Raman D/G ratio[d]
6a	21	118	89	0.30
6b	23	96	57	0.24
6c	36	87	31	0.24
6d	25	216	192	0.18

J. Am. Soc. **2008**, 130, 8094-8100

Carbon Nanomaterials

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ARTICLES
Published on Web 05/31/2008

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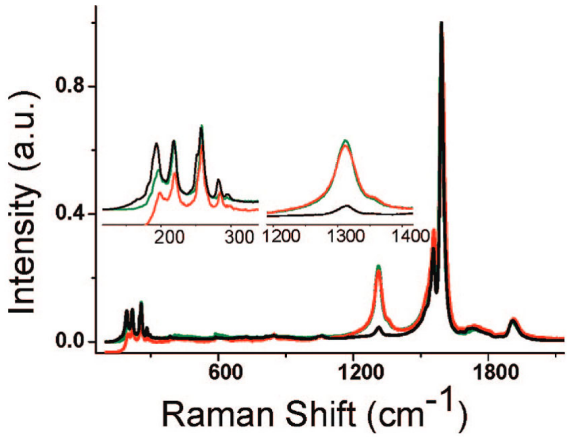


Figure 7. Raman spectra (633 nm) of pristine SWNTs (black line), f-SWNTs **7** (green line), and ff′-SWNTs **8** (red line).

J. Am. Soc. **2008**, 130, 8094-8100

Raman Spectroscopy and Carbon Nanomaterials

Chemistry–A European Journal | Research Article
doi.org/10.1002/chem.202302476
Chemistry Europe
European Chemical Societies Publishing
www.chemeurj.org

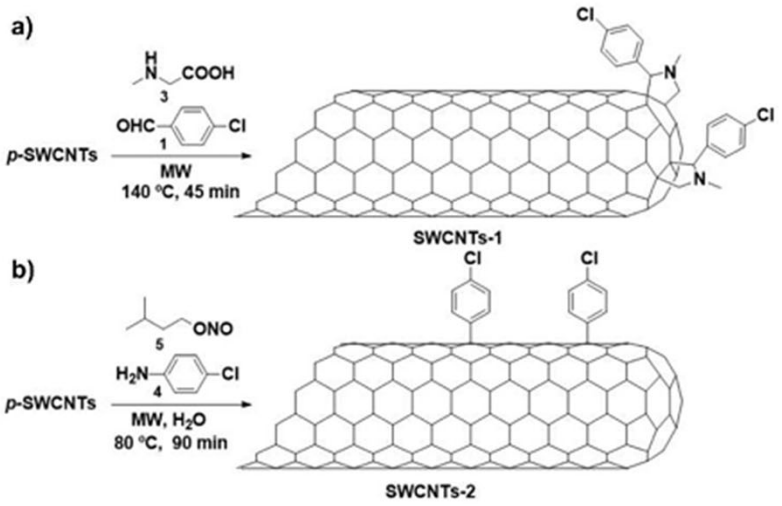
Special Collection

A Prato Tour on Carbon Nanotubes: Raman Insights

María Isabel Lucío,[a, b, c] Francesco Giacalone,[d] Valeria La Parola,[e] Sergio Gámez-Valenzuela,[f] Fernando Muñoz-Alba,[f] M. Carmen Ruiz Delgado,[f] M. Antonia Herrero,*[a, b] and Ester Vázquez*[a, b]

Dedicated to Professor Maurizio Prato on the occasion of his retirement

Raman Spectroscopy and Carbon Nanomaterials



Scheme 1. a) Prato reaction of 4-chlorobenzaldehyde and sarcosine and ***p*-SWCNTs** using microwave activation. b) Diazonium-based radical addition of ***p*-SWCNTs** using 4-chloroaniline, isoamyl nitrite and microwave activation.

Table 1. Details of the TGA, Raman and XPS analysis of **SWCNTs-1** and **SWCNTs-2**.

Sample	TGA		Raman	XPS[d]	
	weight loss (%)[a]	C/FG[b]	I_D/I_G[c]	C/Cl	C/N
SWCNTs-1	19.5	57	0.10	50	50
SWCNTs-2	17.9	41	0.43	50	—

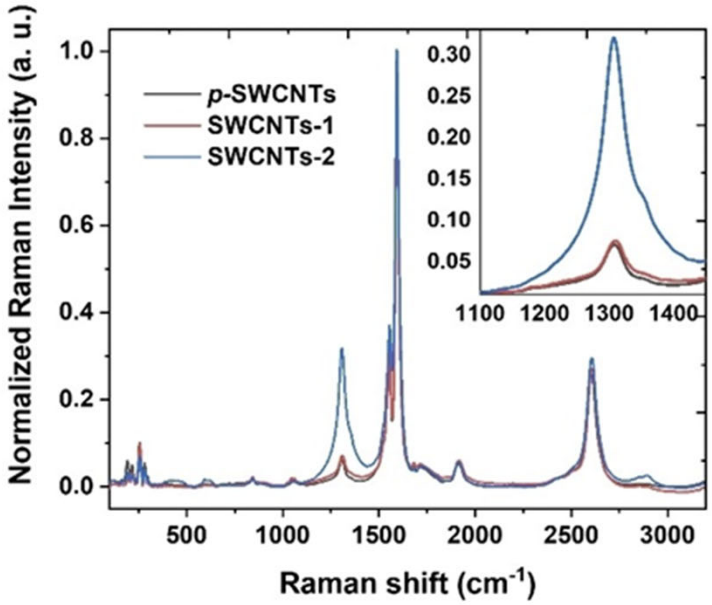
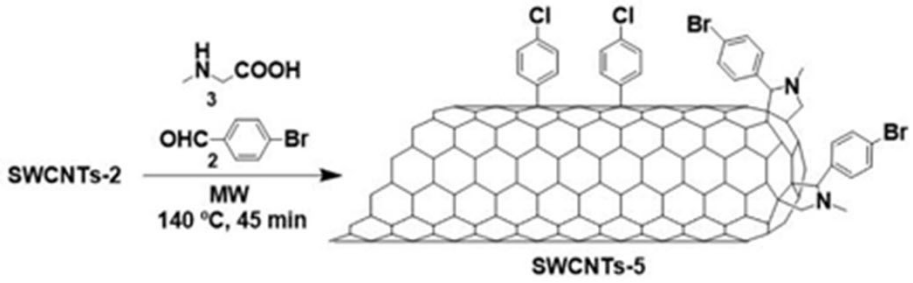


Figure 2. Normalized Raman spectra of ***p*-SWCNTs**, **SWCNTs-1** and **SWCNTs-2** using a laser source at 633 nm.

Raman Spectroscopy and Carbon Nanomaterials



Scheme 2. Double functionalisation of ***p*-SWCNTs**: Prato reaction between 4-bromobenzaldehyde and sarcosine on **SWCNTs-2** using microwave activation.

Table 2. Details of the TGA, Raman and XPS analysis of **SWCNTs-5**.

Sample	TGA			Raman	XPS[f]		
	weight loss (%)[a]	C/FG[b]		I_D/I_G[e]	C/Cl	C/Br	C/N
		Tour[c]	Prato[d]				
SWCNTs-5	25	41	188	0.19	33	166	100

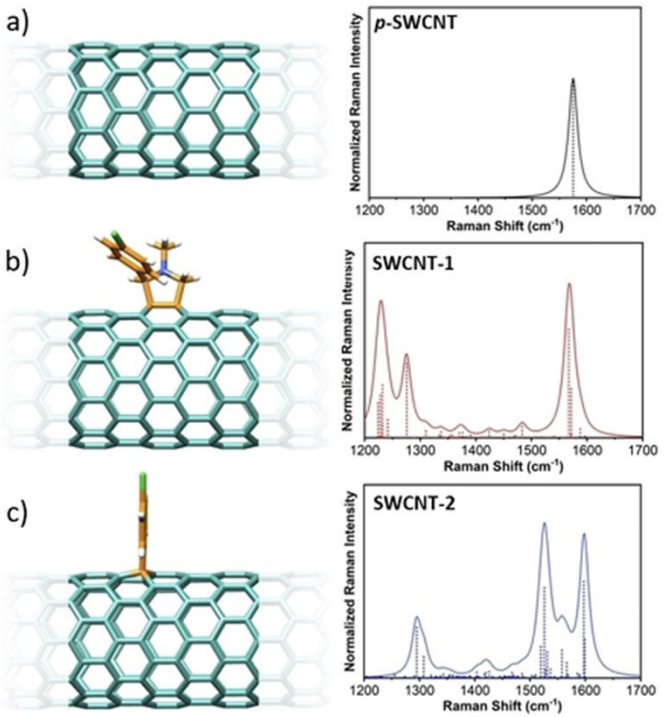
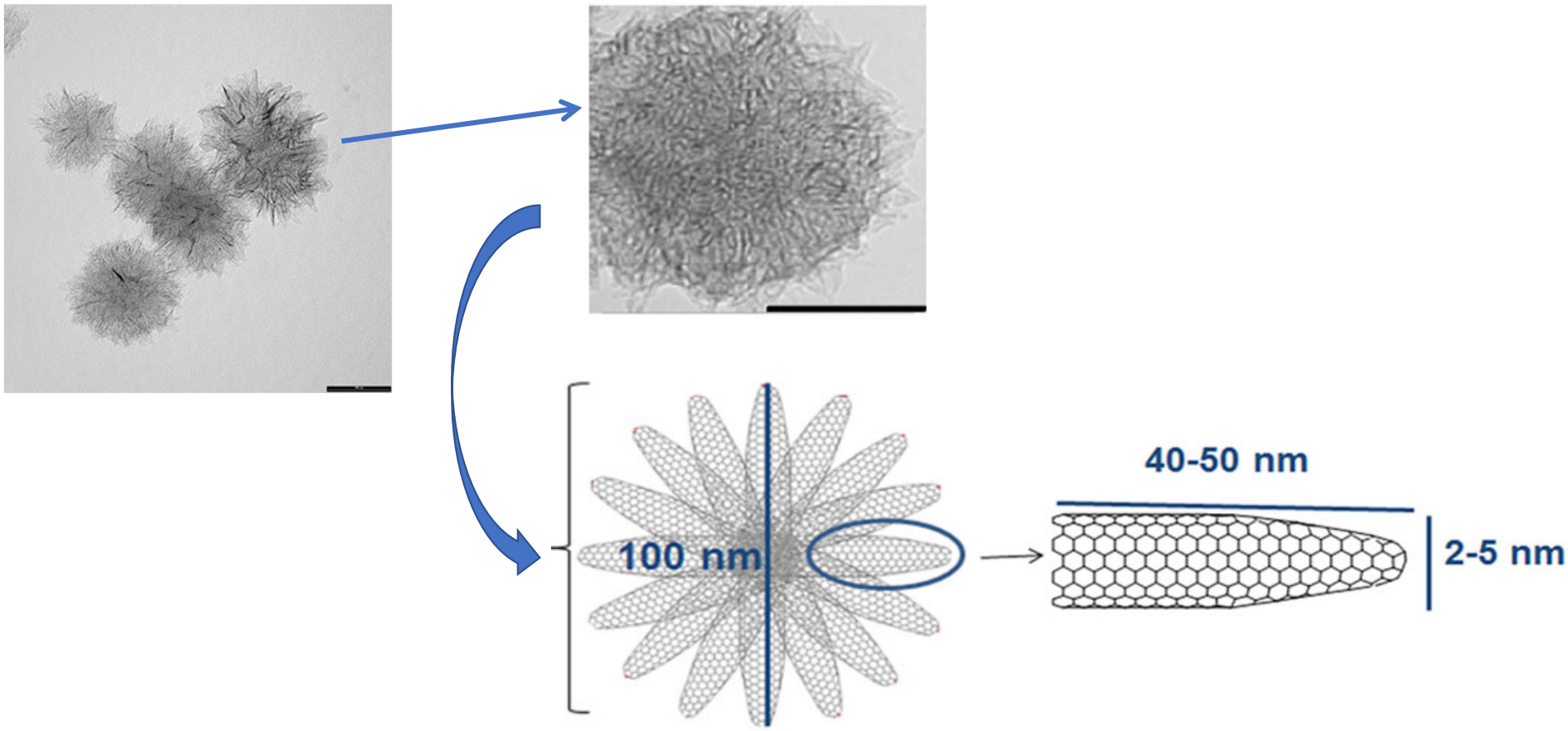


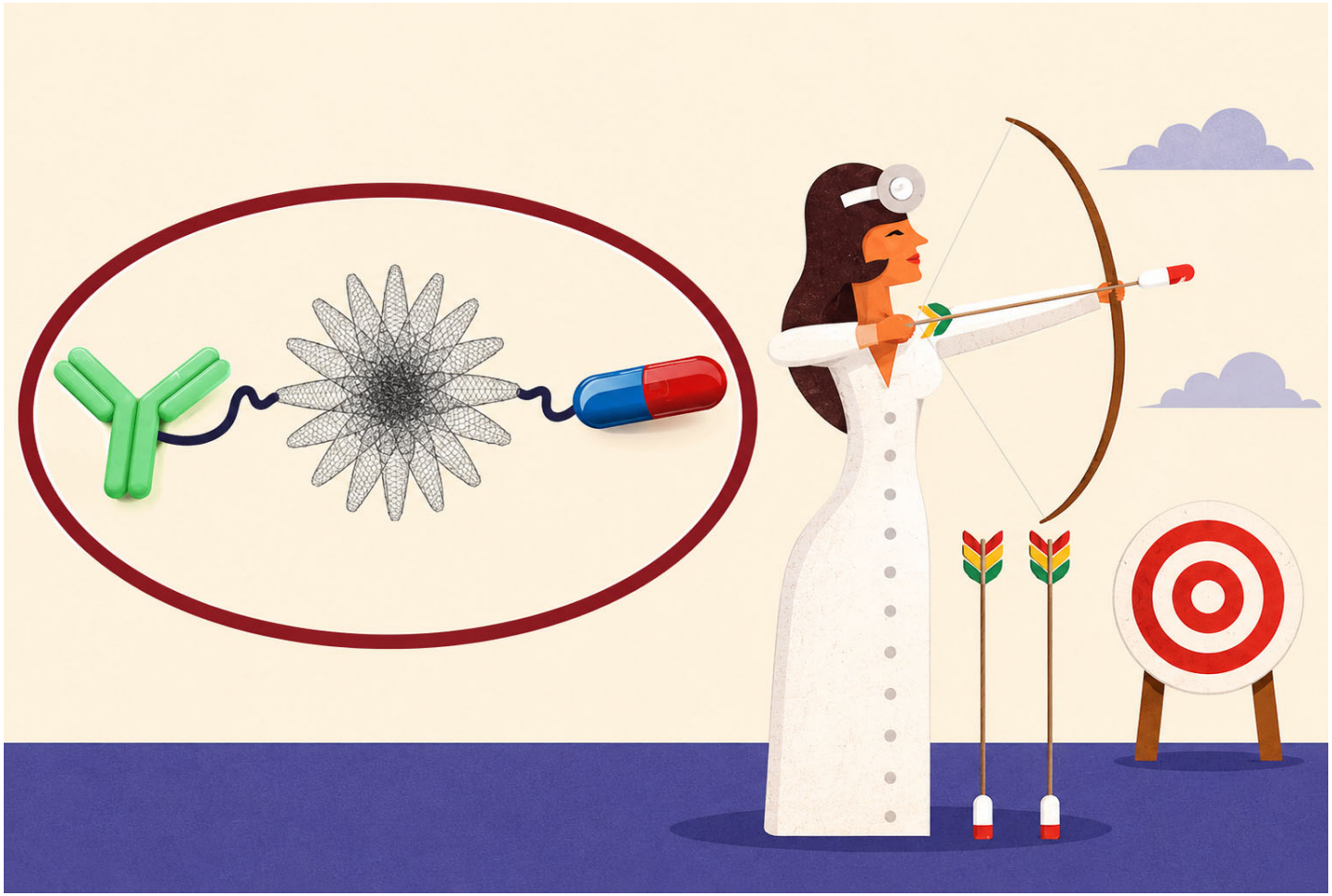
Figure 3. Optimized structures and Raman profiles of a) pristine, b) Prato- and c) Tour-functionalised (10,0) SWCNTs, with the dark-colored portion of the nanotubes indicating the unit cells. The Raman profiles for each nanotube are obtained by applying Lorentzian line broadening with a full width at half maximum of 20 cm^{-1}.

Carbon Nanohorns



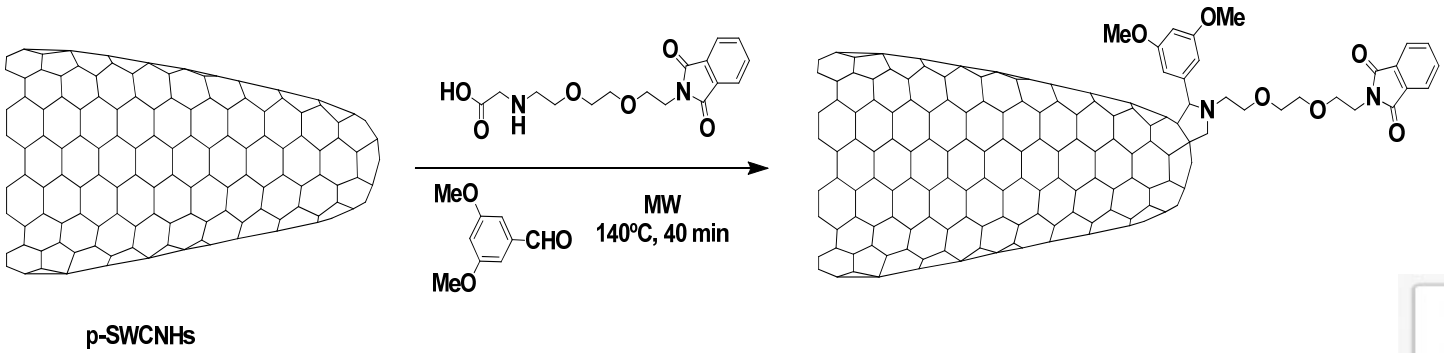
Carbon Nanohorns

Carbon Nanohorns



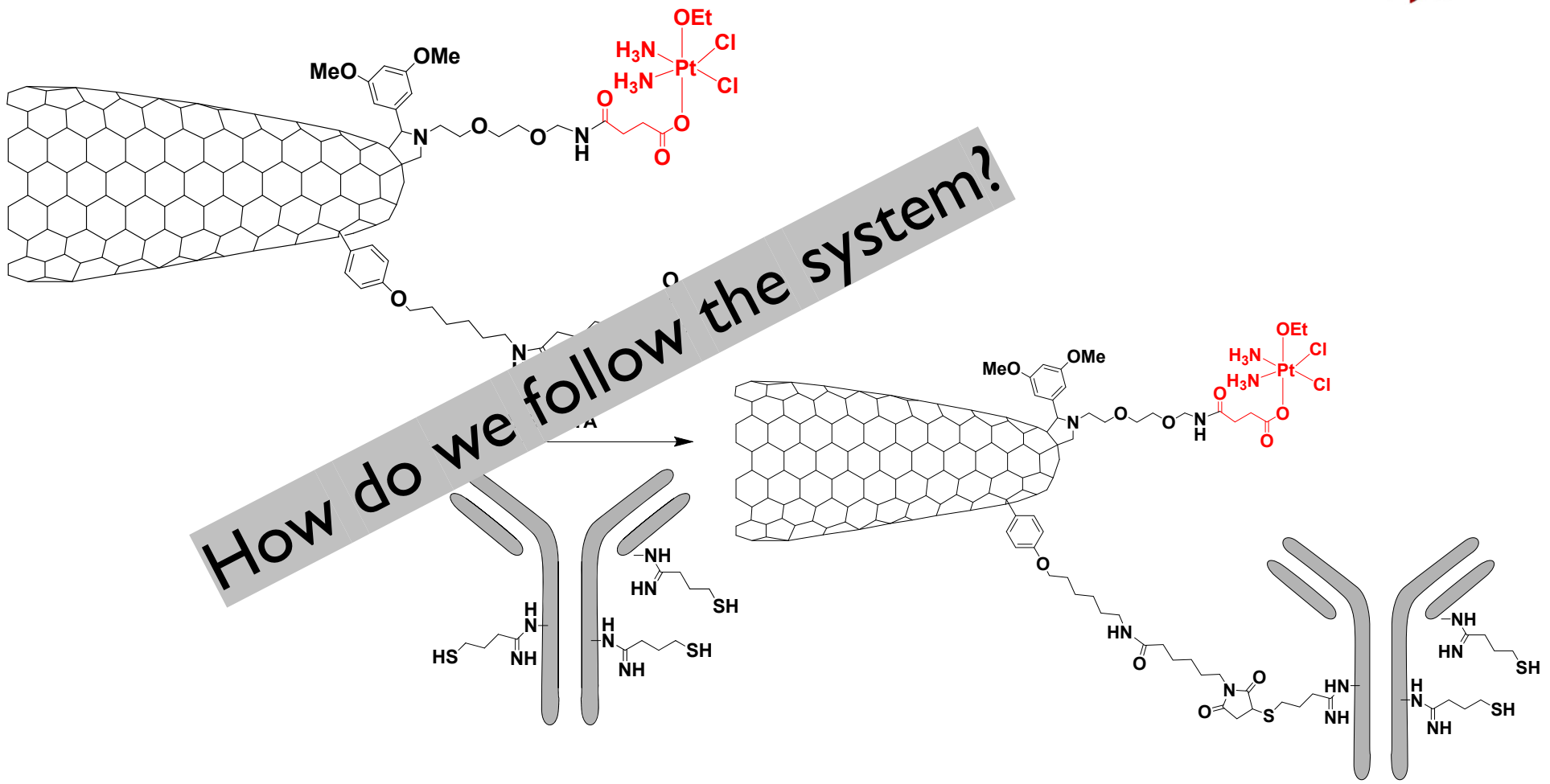
Biomaterials, **2012,** *33*, 8152-8159

Carbon Nanohorns



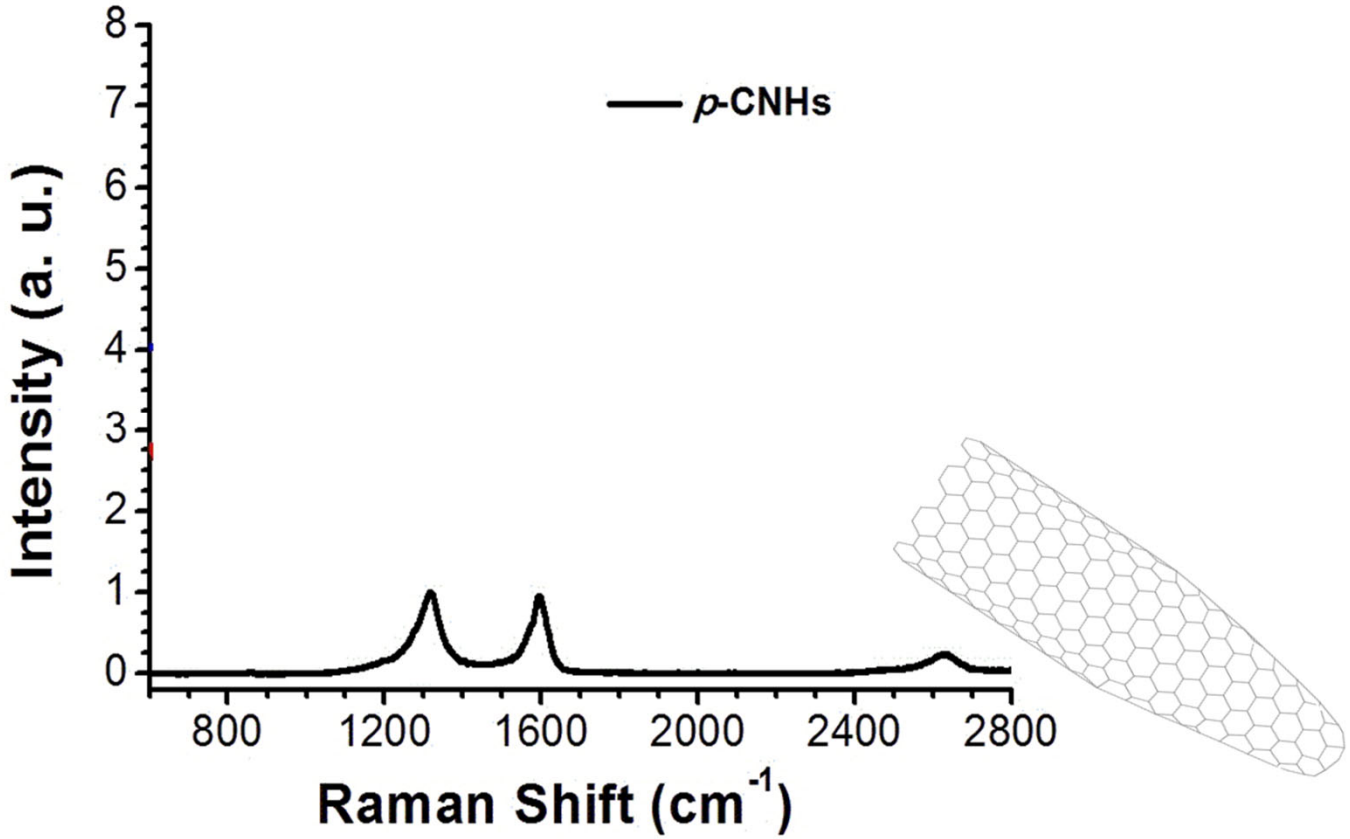
J. Mat. Chem B. 2017, 5, 8821-8832

Carbon Nanohorns



J. Mat. Chem B. 2017, 5, 8821-8832

Carbon Nanohorns

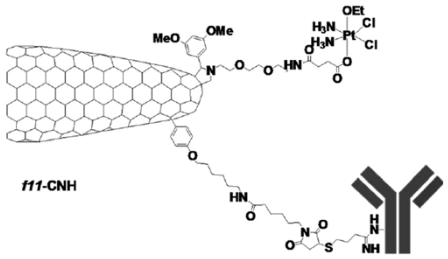


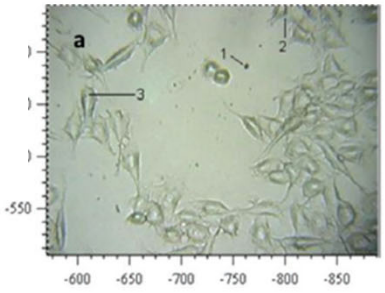
J. Mat. Chem B. 2017, 5, 8821-8832

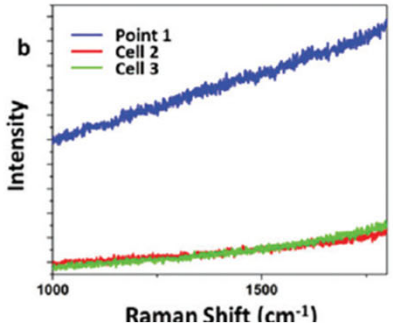
Cite this: *J. Mater. Chem. B*, 2017, 5, 8821

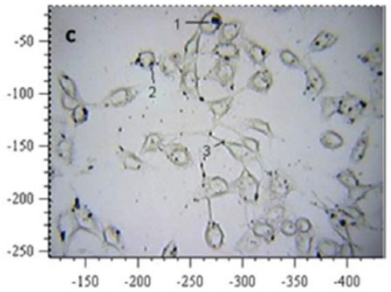
Targeted killing of prostate cancer cells using antibody–drug conjugated carbon nanohorns†

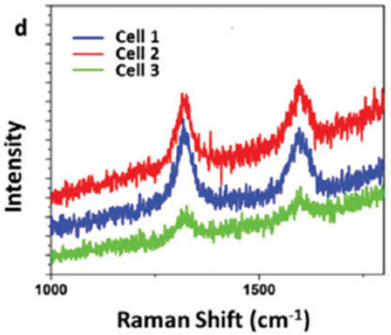
María Isabel Lucío,[abc] Roberta Opri,[d] Marcella Pinto,[d] Alessia Scarsi,[e] Jose L. G. Fierro,[f] Moreno Meneghetti,*[e] Giulio Fracasso,*[d] Maurizio Prato,[cgh] Ester Vázquez[ab] and María Antonia Herrero*[ab]





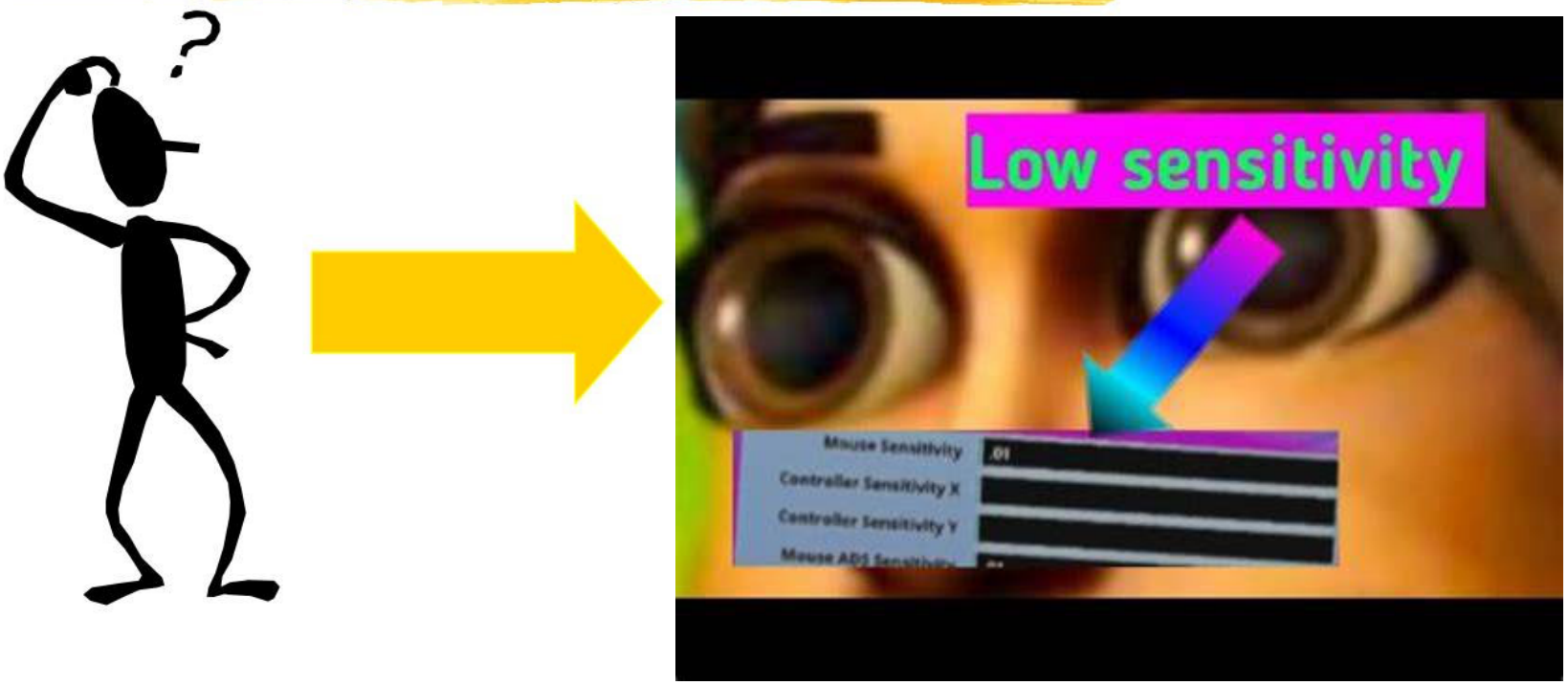




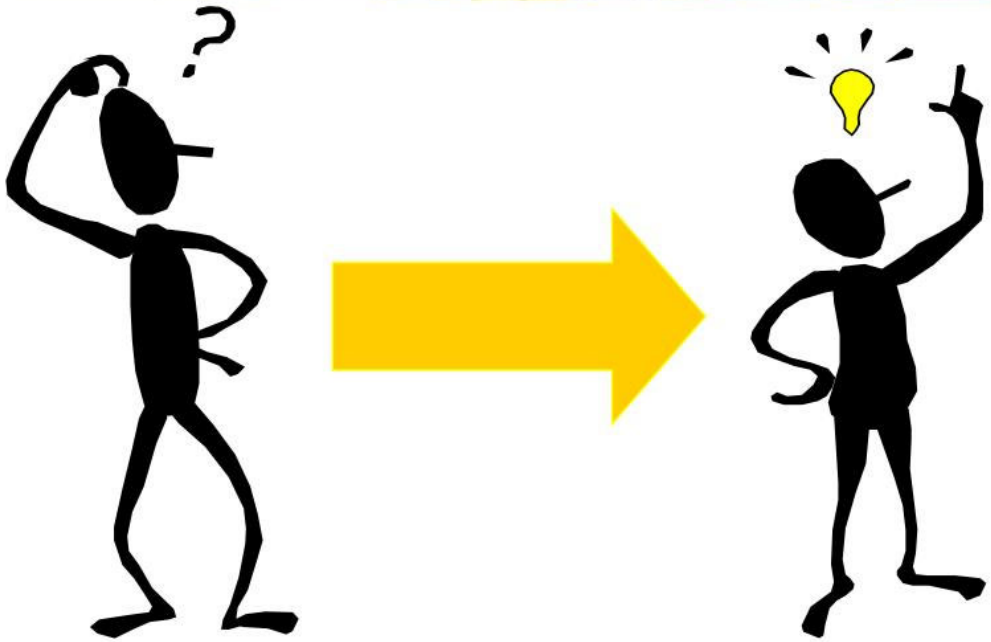


Raman Shift (cm⁻¹)

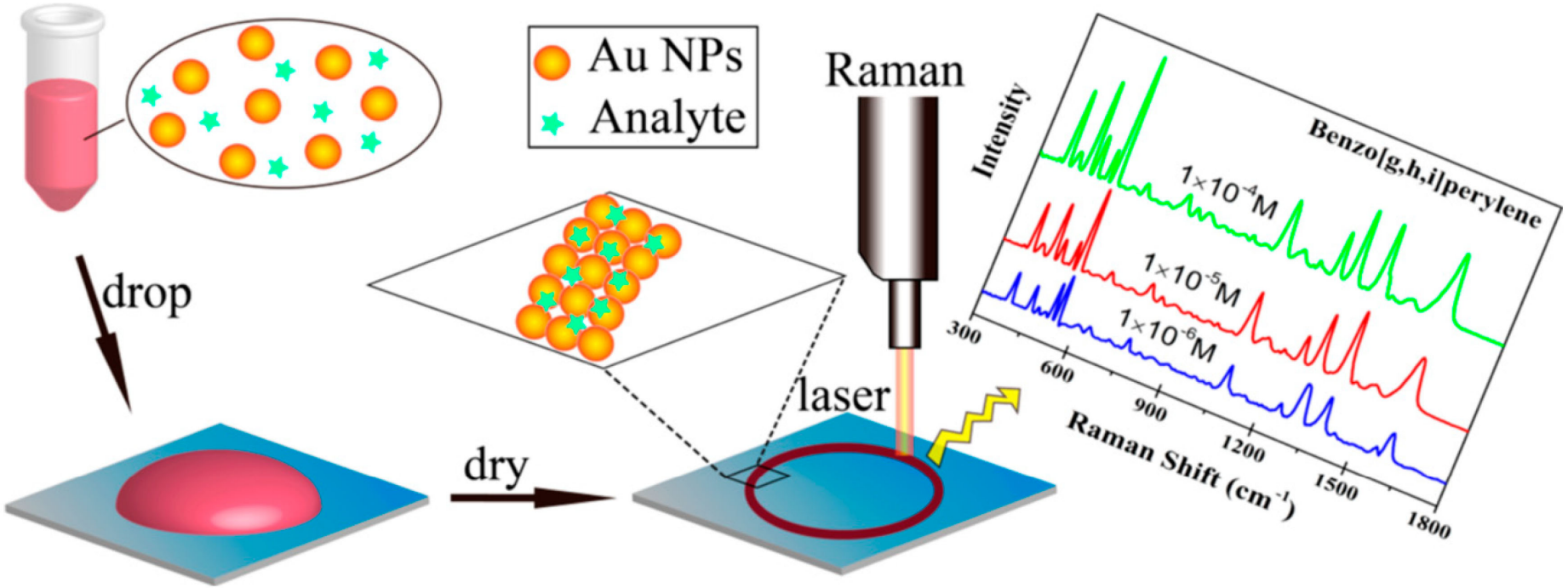
Problem Solving



Problem Solving



Surfaced enhacement raman spectrocopy (SERS)



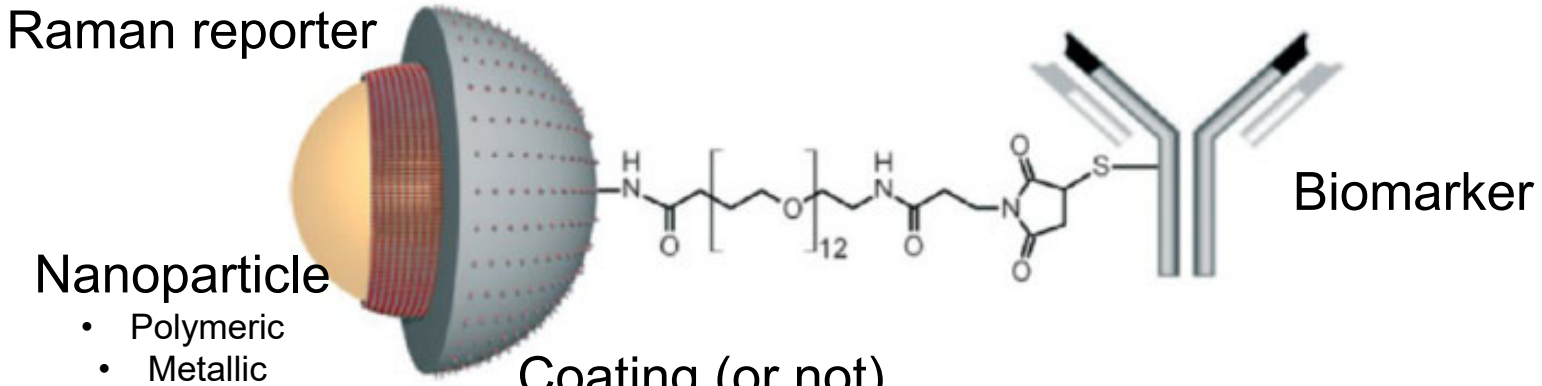
Nano Lett., **2010,** *10,* 553–561. | *PNAS*, **2012,** *109,* 9281–9286.

Surfaced enhacement raman spectrocopy (SERS)

Among the **10** Items to accomplished in SERS:

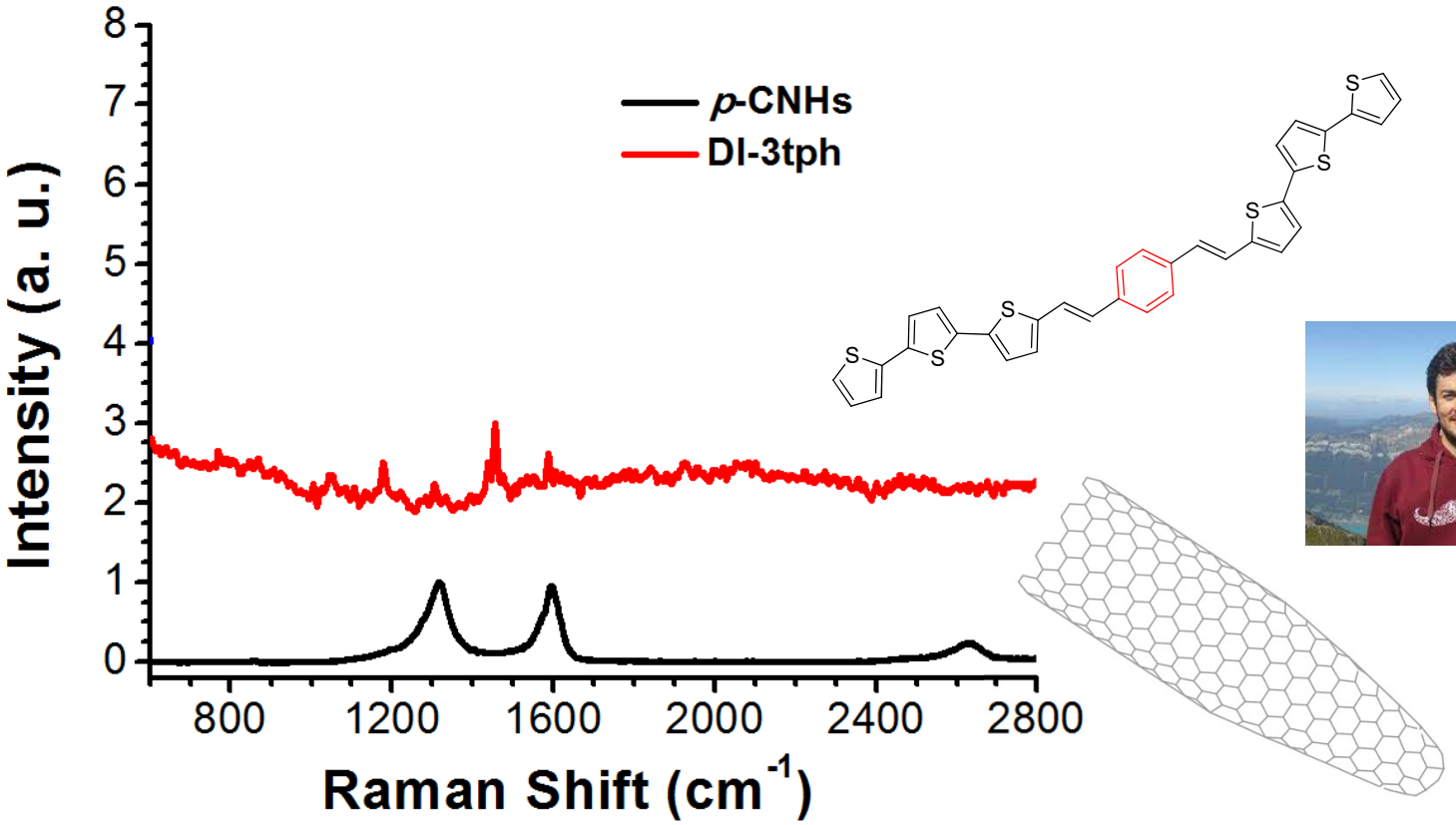
'Reliable methods for the synthesis/fabrication of uniform, highly reproducible, and efficient enhancing substrates, with a high degree of structural precision and robust, quantitative SERS response'

General structure of SERS nanotag



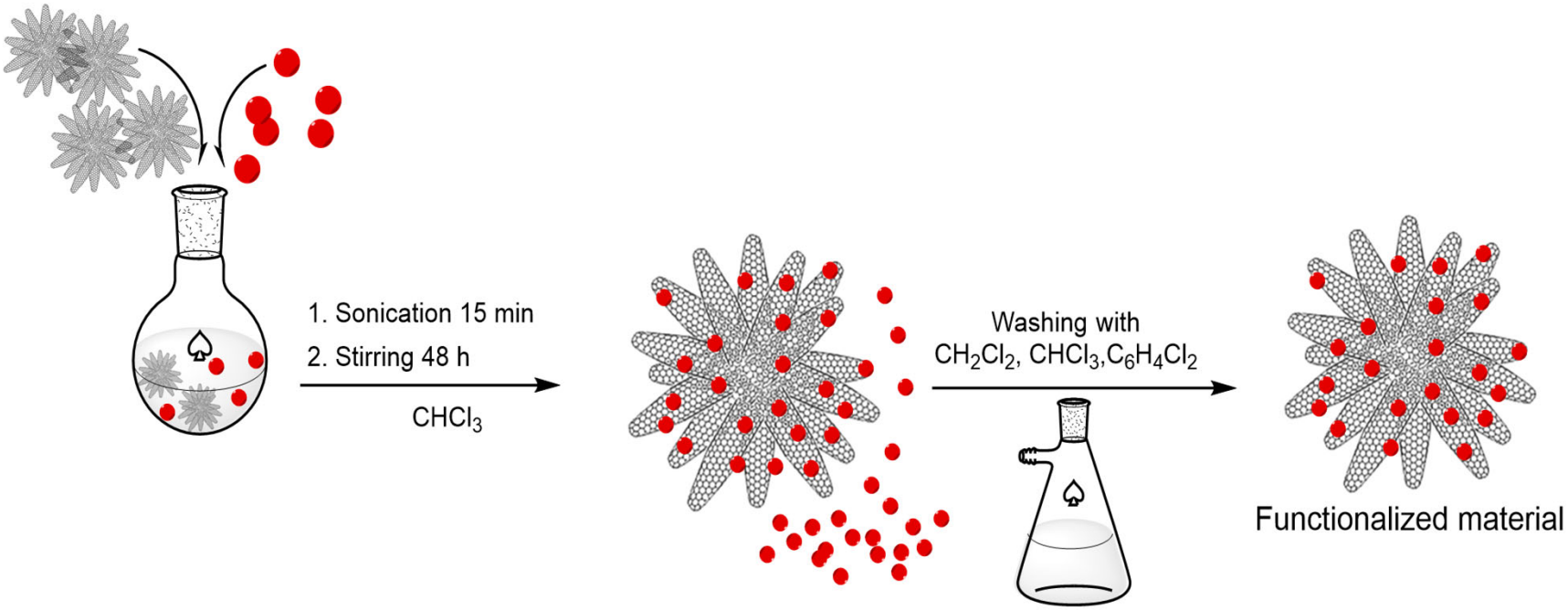
ACS Nano **2020**, *14,* 28

Non-covalent modifications with thiophene derivatives



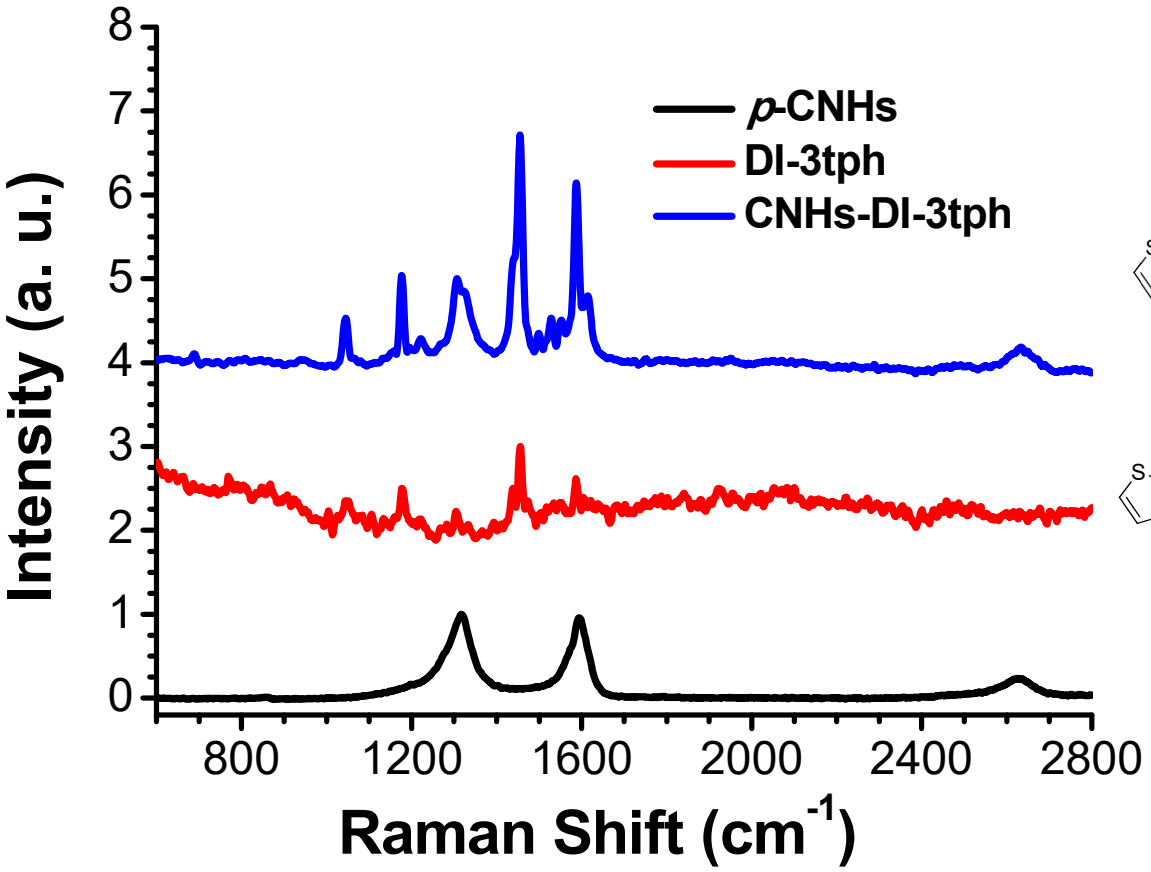
Chemistry-A Eur. J, **2016,** *22,* 11643-11651.

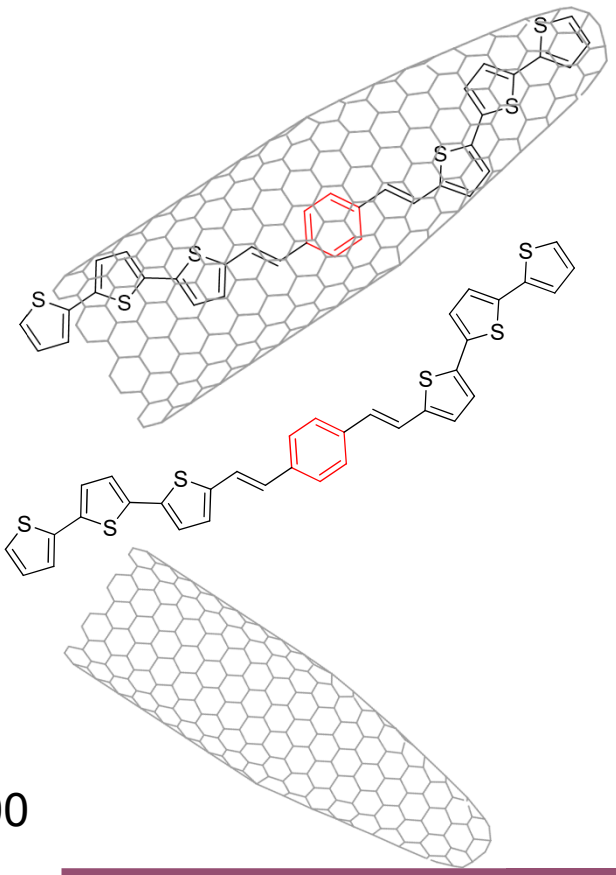
Non-Covalent modifications with thiophene derivatives



Chemistry-A Eur. J, **2016,** *22,* 11643-11651.

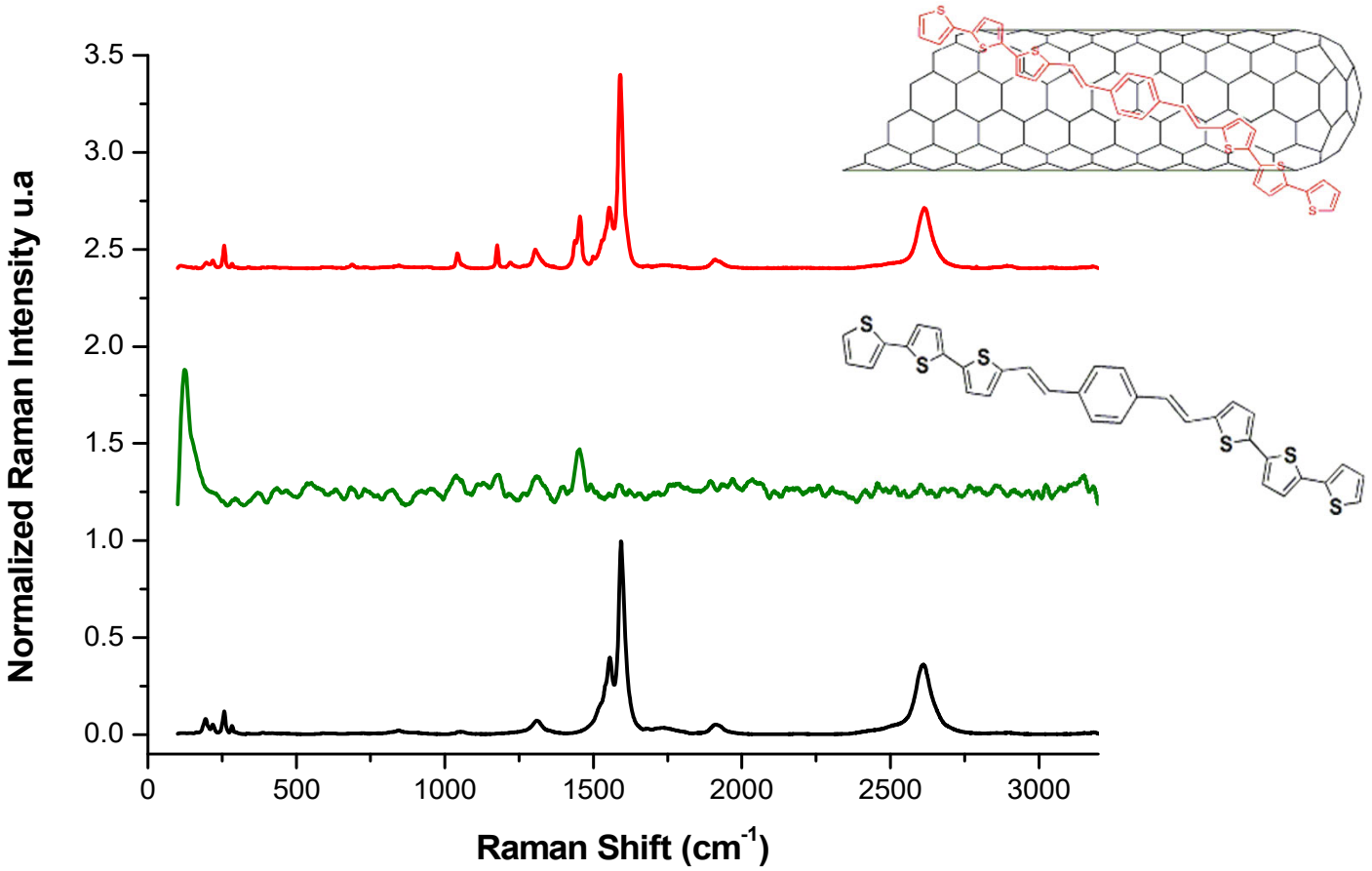
Non-Covalent modifications with thiophene derivatives



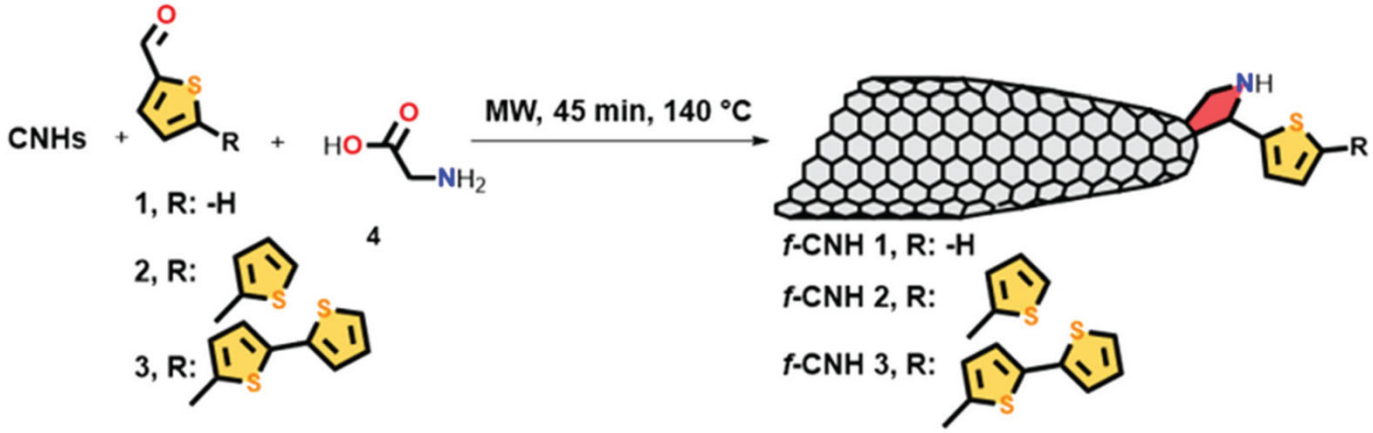


Chemistry-A Eur. J, **2016,** *22,* 11643-11651.

Non-Covalent modifications with thiophene derivatives

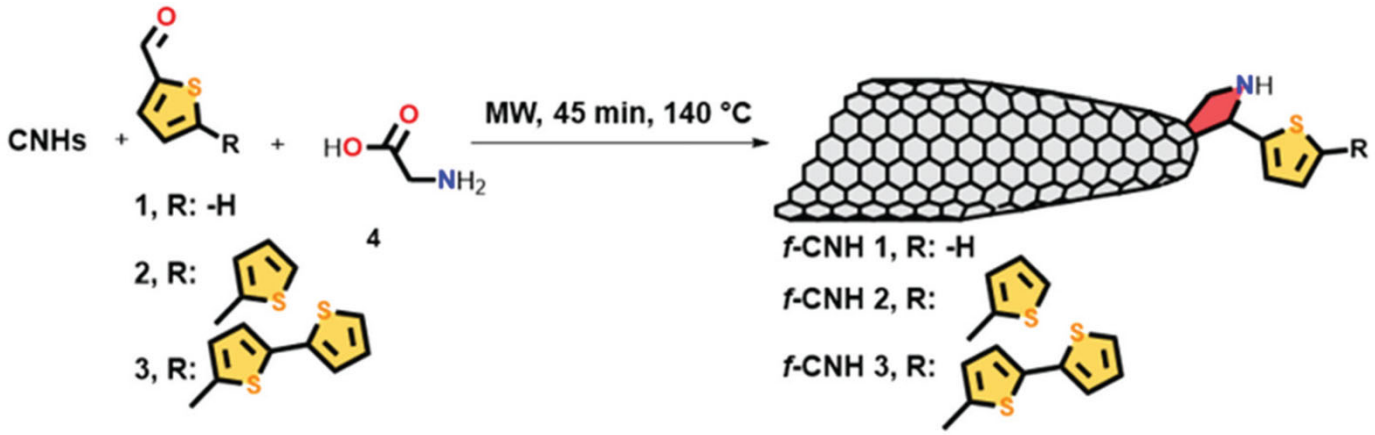


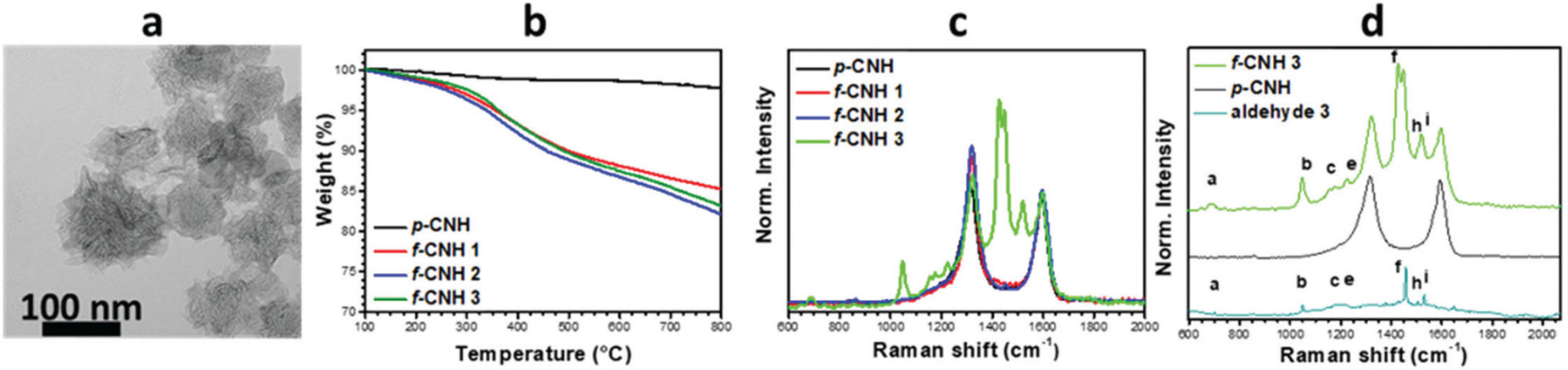
Surface-enhanced Raman Spectroscopy



Chem. Commun., 2020, 56, 8948--8951 | 8949

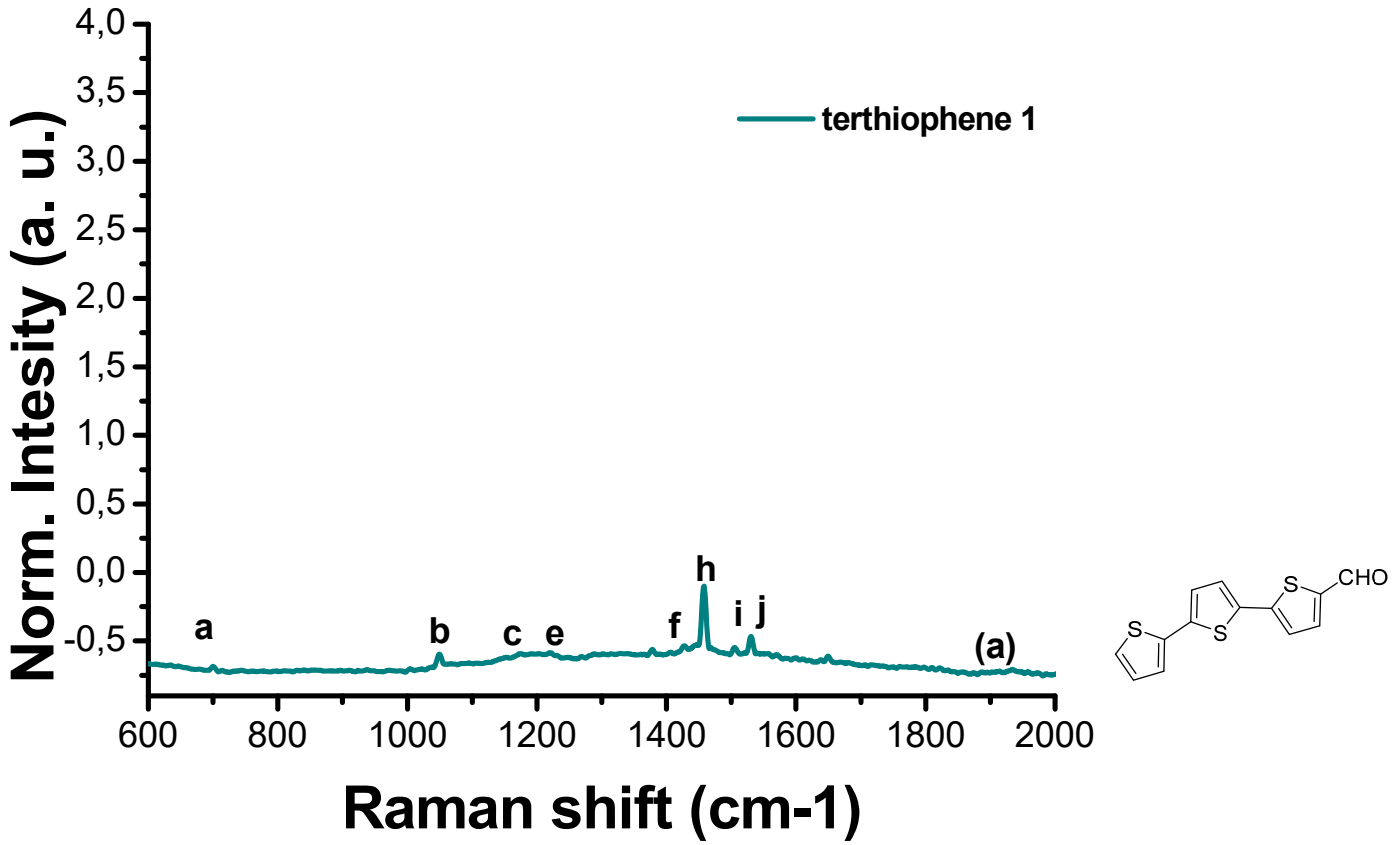
Surface-enhanced Raman Spectroscopy



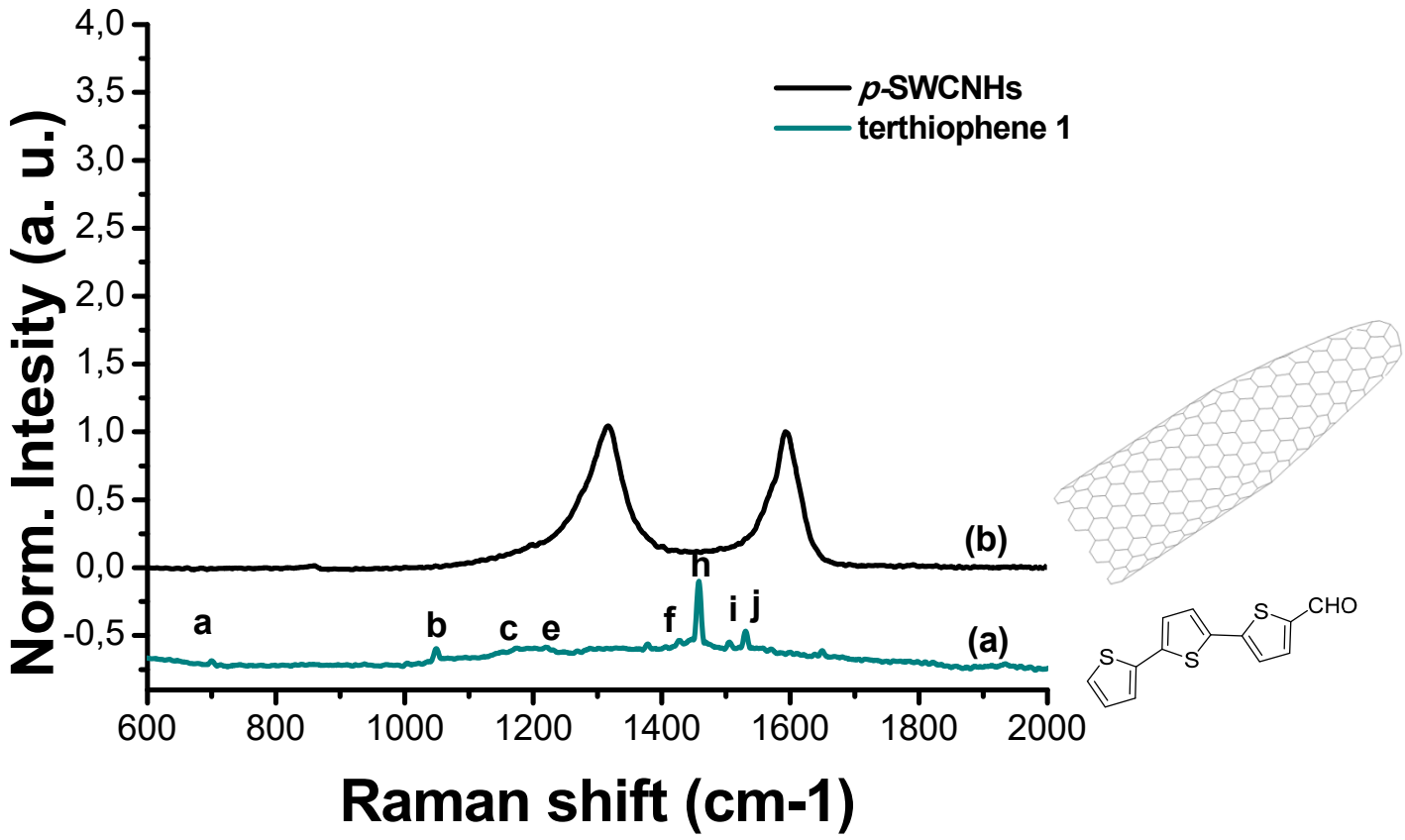


Chem. Commun., 2020, 56, 8948--8951 | 8949

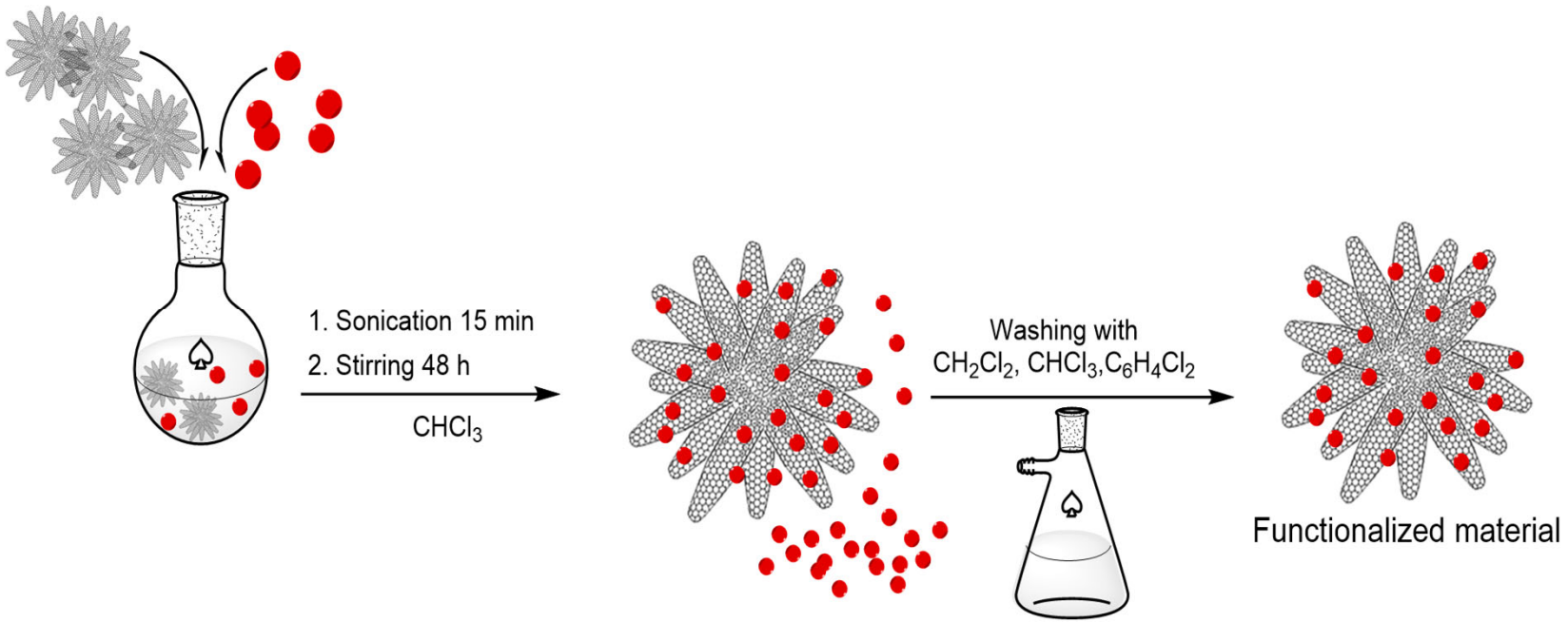
Non-Covalent modifications with thiophene derivatives



Non-Covalent modifications with thiophene derivatives

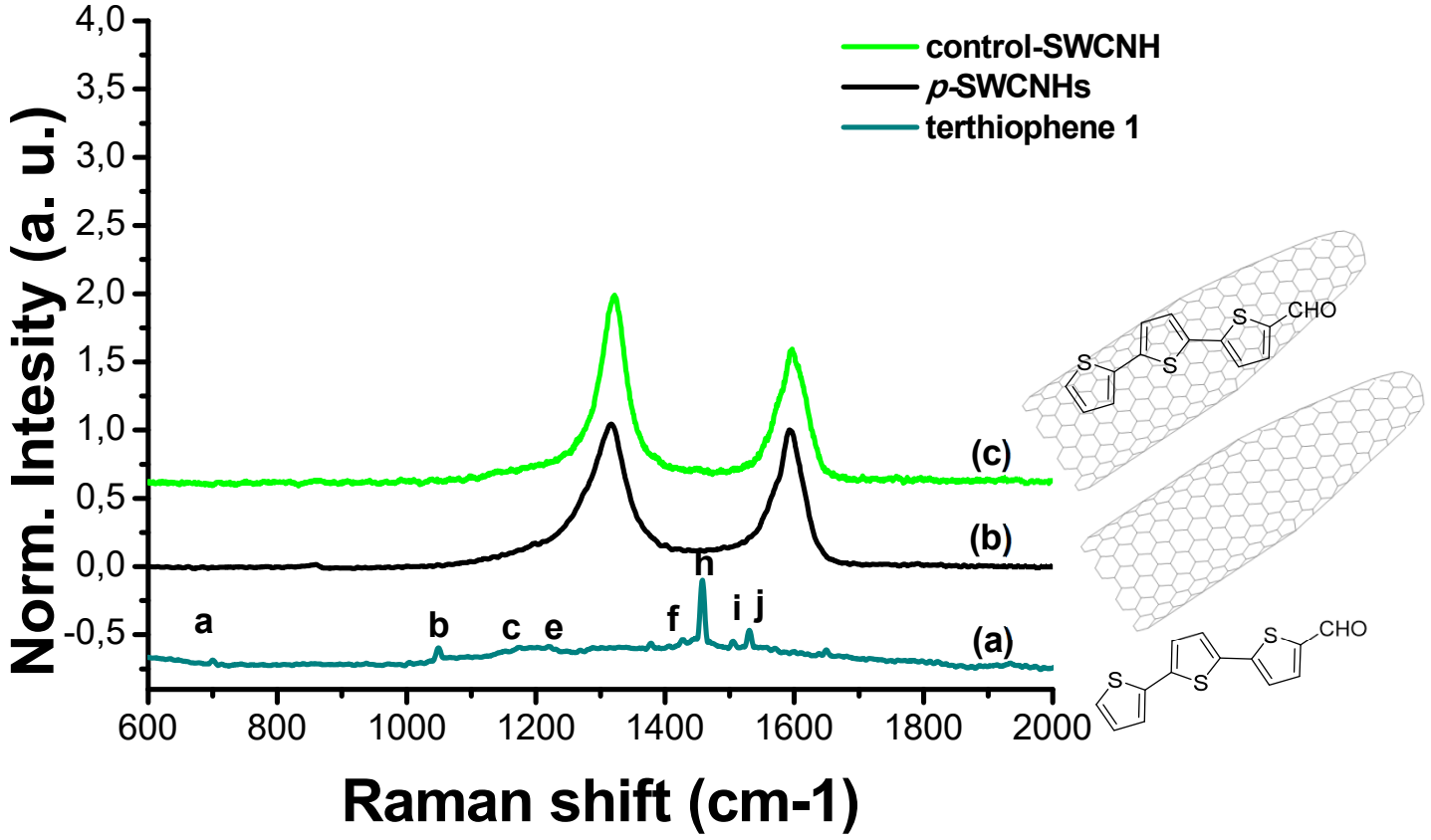


Non-Covalent modifications with thiophene derivatives

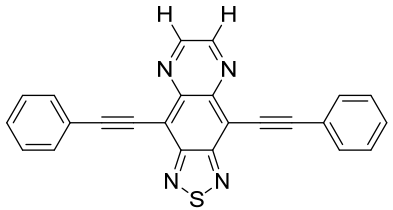


Chemistry-A Eur. J, **2016,** *22,* 11643-11651.

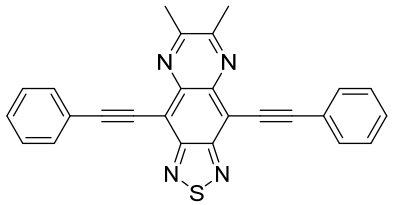
Non-Covalent modifications with thiophene derivatives



Synthesis of the Raman reporter

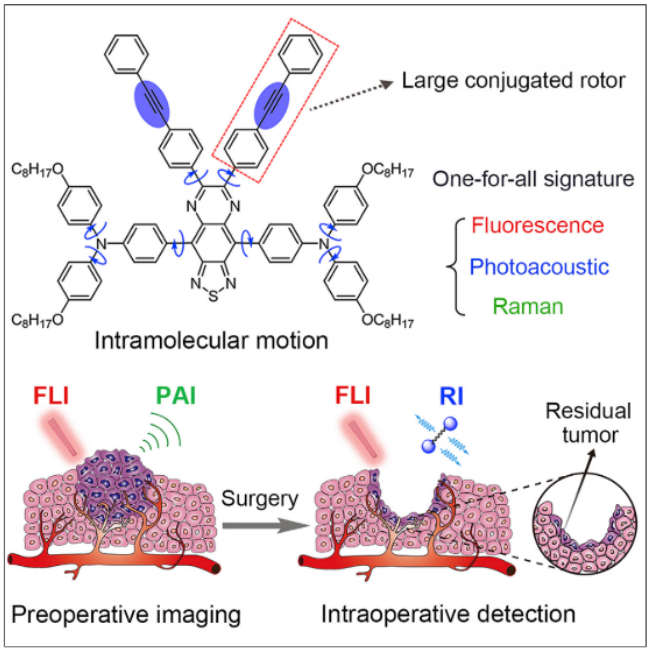


1

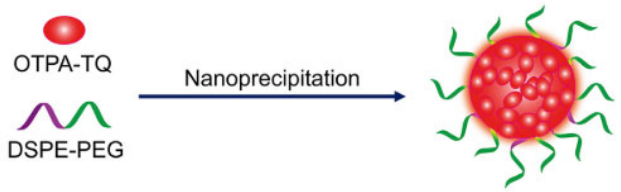


2

The synthesized probes correspond to a minimalist approach of the reported all in one dye



Fluorescence-Photoacoustic-**Raman** Properties in One Fluorophore for Precise Cancer Surgery



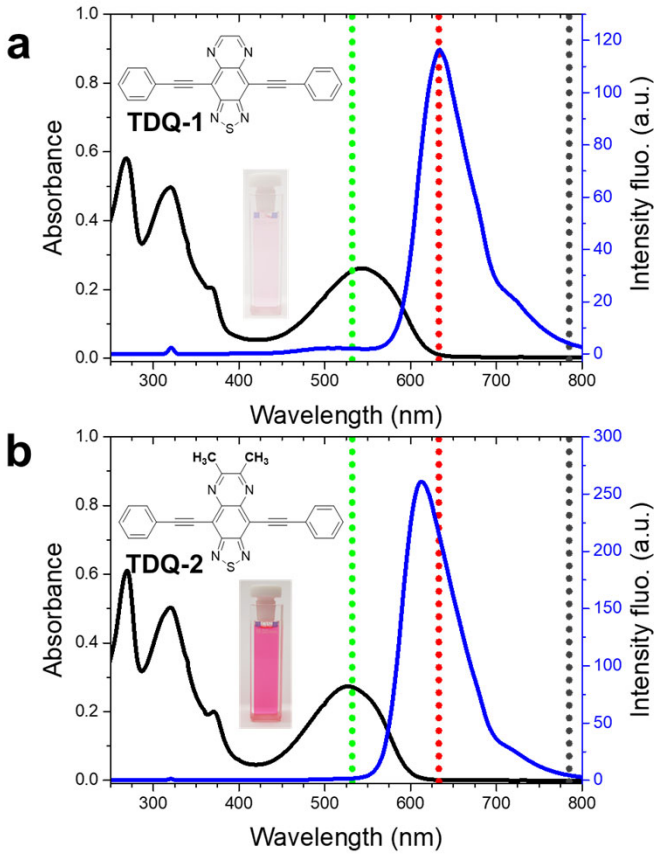
Why have we selected these probes?

Chem **2019**, *5*, 2657

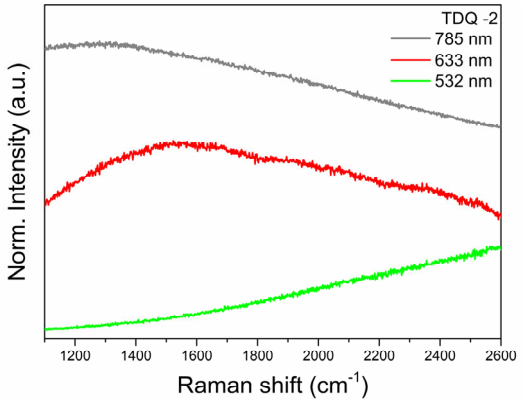
Characterization of the Raman reporter

UCLM

UV-Vis and fluorescence of the probes

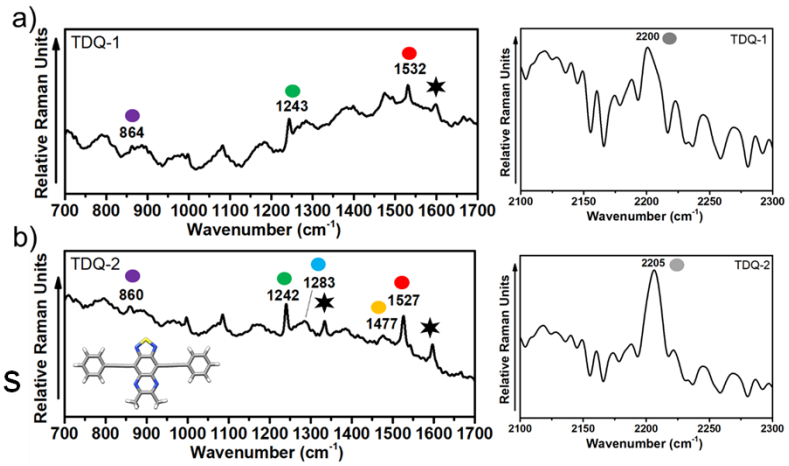


Raman characterization



Impossible to get any signals with these lasers

FT-Raman (U. Málaga)



λ = 1064 nm
3000-4000 scans
Low signal/ratio

ACS Nano, 2023, 15, 2280

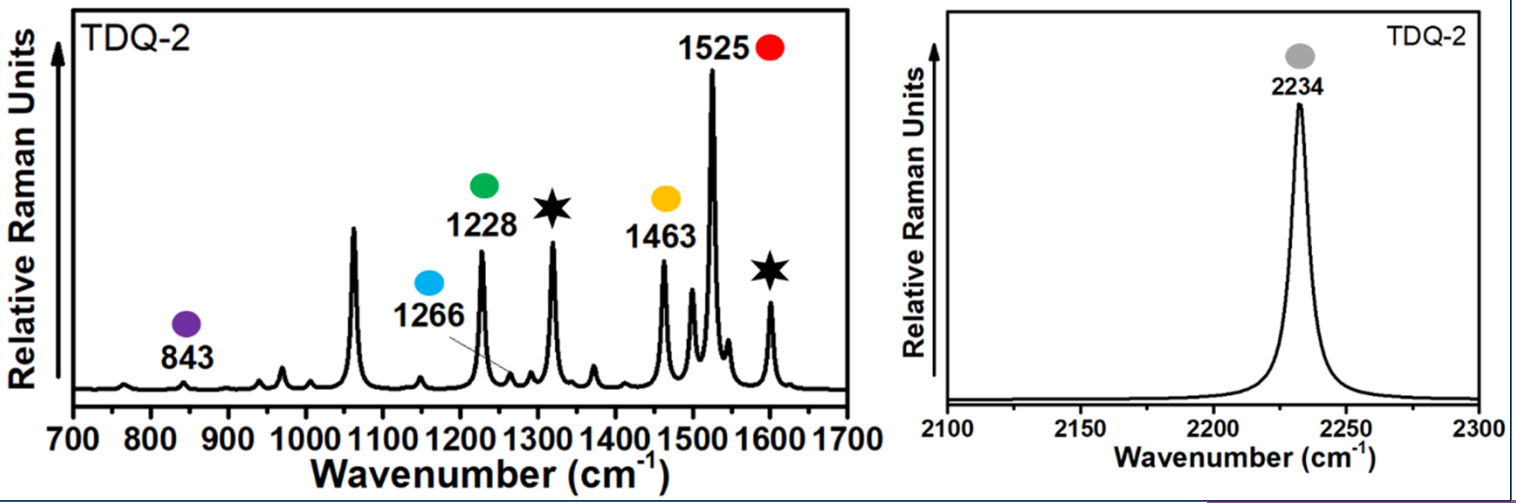
Characterization of the Raman reporter

Computed Raman spectrum helped to assigned the main vibrations

a)

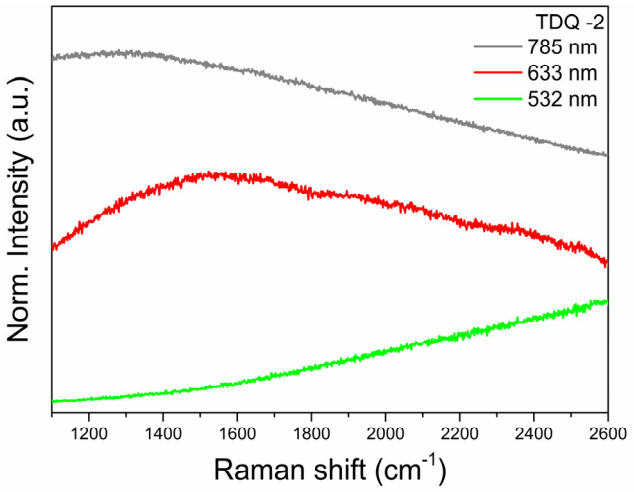
Raman frequency (cm^{-1})	Description
2205 (2234)	C≡C stretching vibration of acetylene groups
1527 (1525)	CC and CN stretching vibration of quinoxilane unit
1477 (1463)	CH bending of external phenyl rings + CC stretching of central TDQ unit
1283 (1266)	CH bending of external phenyl rings + CC stretching vibration of acetylene groups and central TDQ unit
1242 (1228)	CH bending of pyrazine + CC stretching vibration of pyrazine
860 (843)	SN stretching vibration of thiadiazole

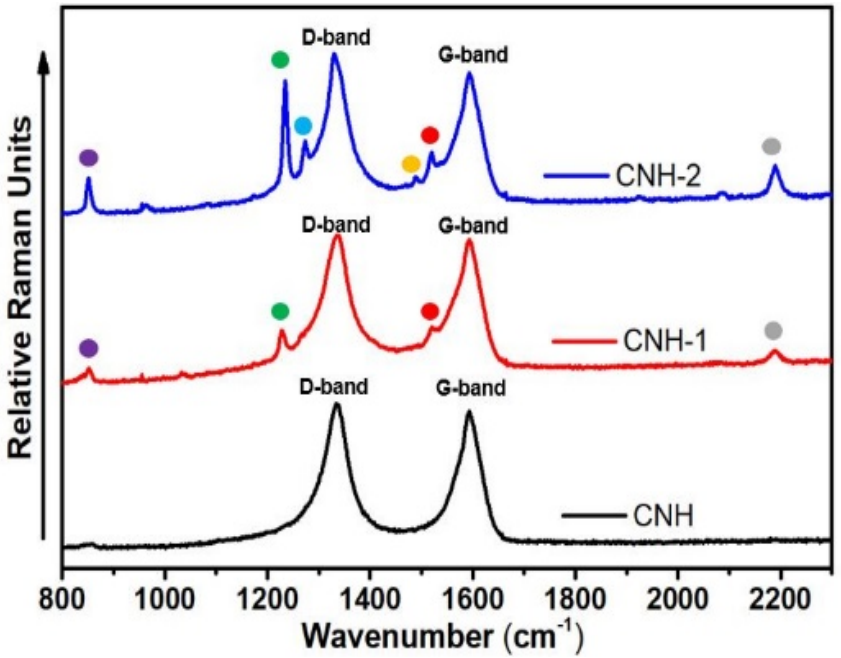
b)

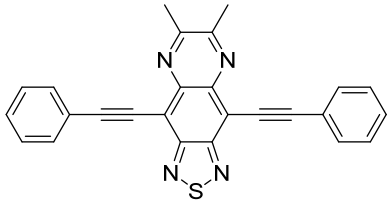


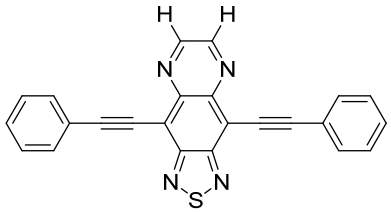
ACS Nano, 2023, 15, 2280

Characterization of the Raman reporter







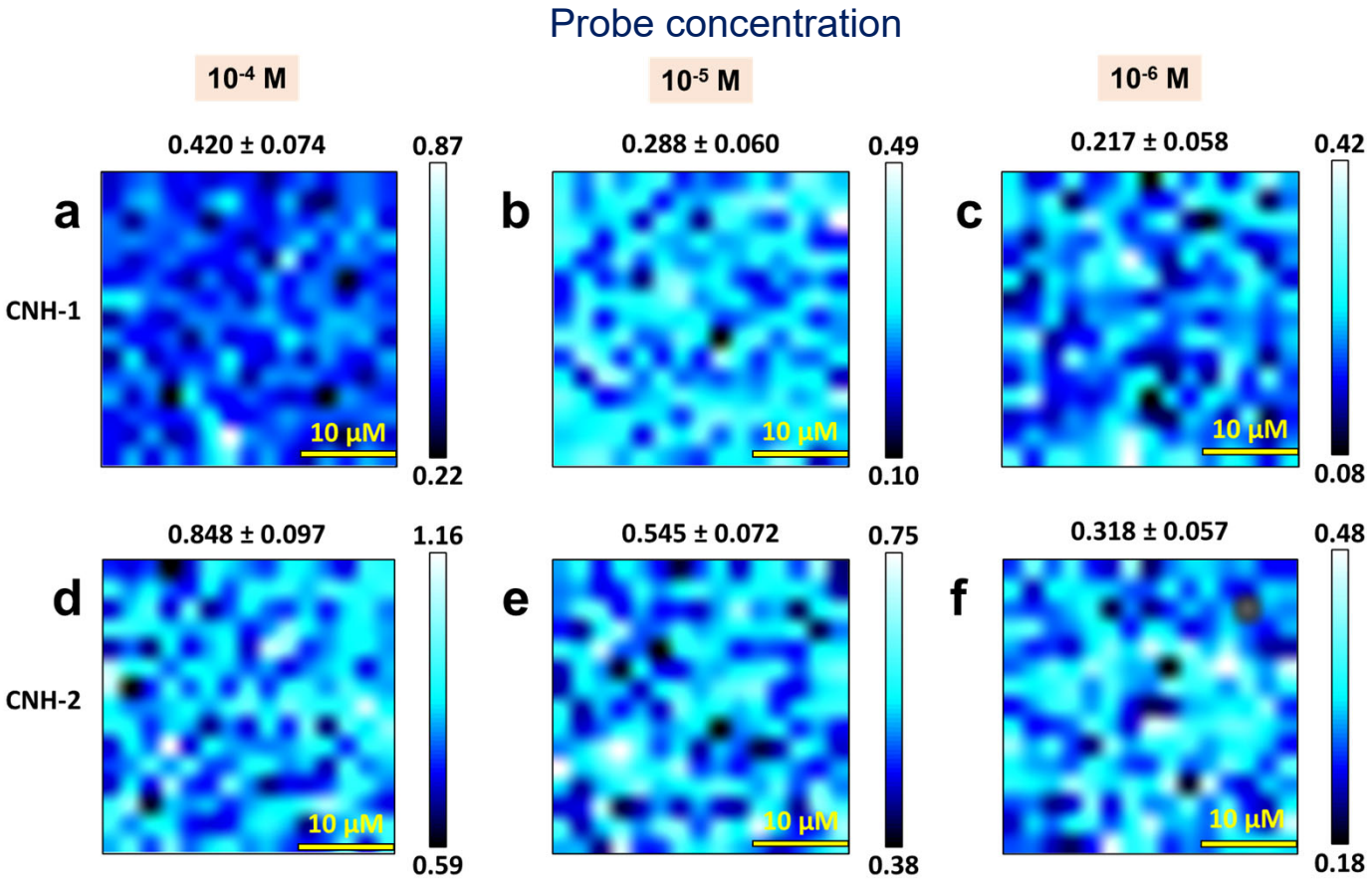


- The interaction of the dyes and CNHs produces a dramatic Raman enhancement
- The enhancement is higher for probe **2** (methyl groups)

We have studied the effect of fluorescence quenching, wavelength and intensity of the lasers

ACS Nano, 2023, 15, 2280

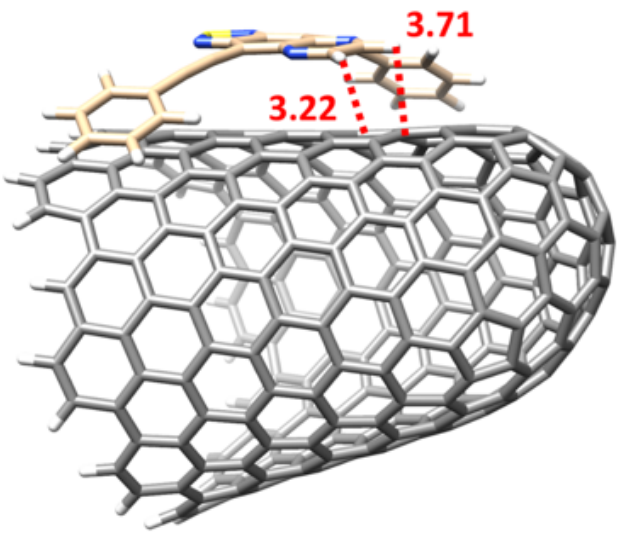
Characterization of the Raman reporter



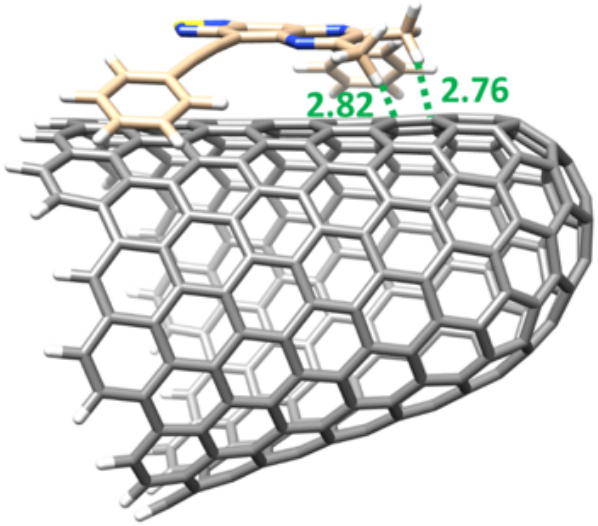
The enhancement decreases with probe concentration.
This suggests single molecule adsorption on the walls of CNHs.

Characterization of the Raman reporter

CNH-1



CNH-2



Eight different positions were studied (the most stable is represented here)

Most importantly:

- The originally flat molecules bend to adapt to the curved structure of CNHs
- There is a strong effect of CH – π interactions.
- Probe 2 has more and stronger interactions with CNHs.

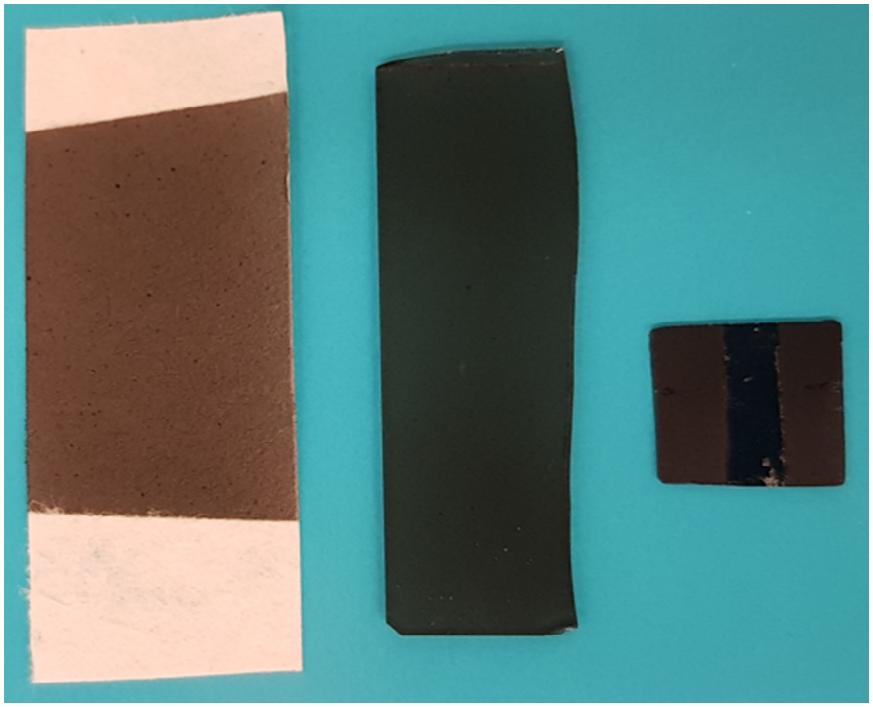
All these could explain the stronger enhancement observed in CNH-2 (with two – CH_3 groups)

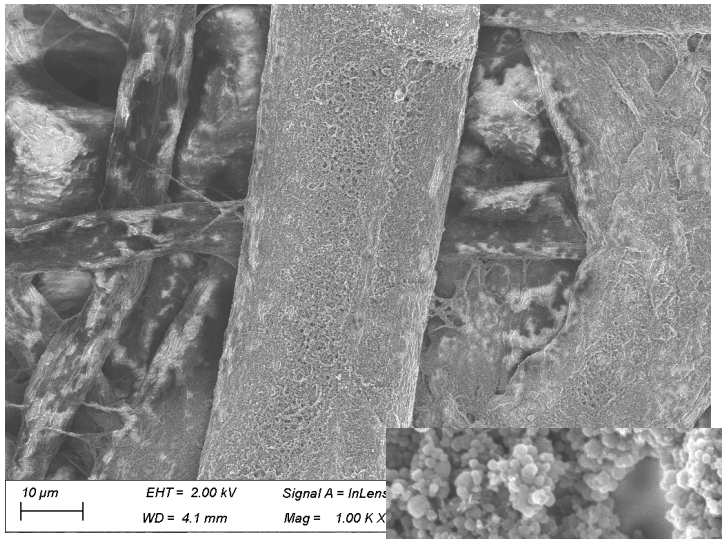
Integration onto surfaces

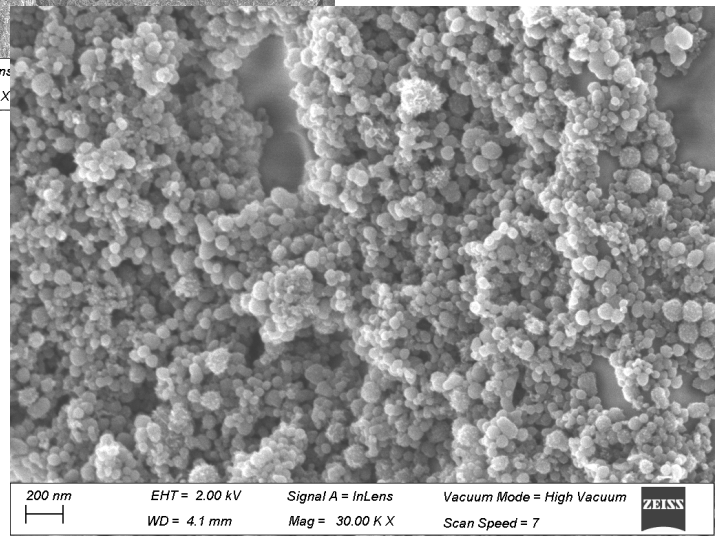
UCLM

CNH-2
pristine CNHs
substrate

Spray-coated films on different substrates



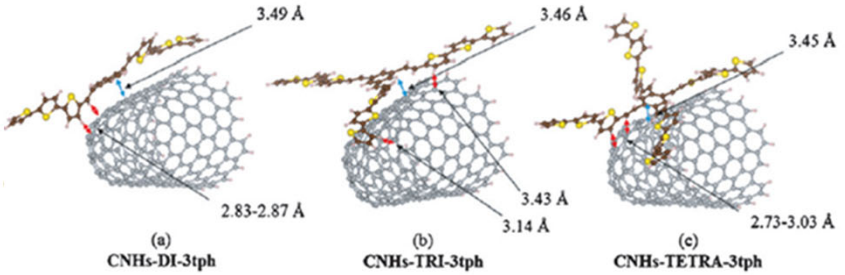




Nanostructures

Design of Assembled Systems Based on Conjugated Polyphenylene Derivatives and Carbon Nanohorns

Daniel Iglesias,[a, b] Javier Guerra,[a, c] M. Victoria Gómez,[a] Antonio M. Rodríguez,[a, Pilar Prieto,[a] Ester Vázquez,[a] and M. Antonia Herrero*[a]



Check for updates

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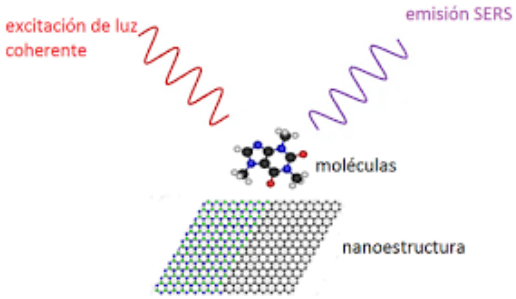
Received 15th May 2020,
Accepted 26th June 2020

DOI: 10.1039/d0cc03496g

rsc.li/chemcomm

Microwave-assisted functionalization of carbon nanohorns with oligothiophene units with SERS activity†

Daniel Iglesias, [a] Javier Guerra, [b] María Isabel Lucío, [c] Rafael C. González-Cano, [d] Juan T. López Navarrete,[d] M. Carmen Ruiz Delgado, [d] Ester Vázquez [ef] and M. Antonia Herrero *[ef]



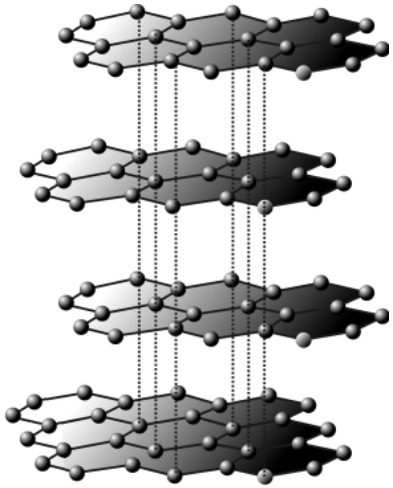
Check for updates

Cite this: *Nanoscale*, 2023, **15**, 12280

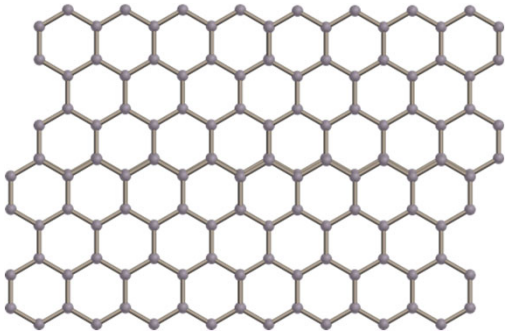
Understanding the Raman enhancement of carbon nanohorns labelled with organic dyes†

Daniel Iglesias, ‡[a,b] Raúl Martín, ‡[a,d] Miguel Á. Álvarez-Sánchez, [a,b] Irene Badía-Domínguez,[c] Ester Vázquez, [a,b] M. Carmen Ruiz Delgado, *[c] Pilar Prieto *[a] and M. Antonia Herrero *[a,b]

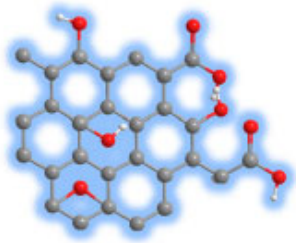
Graphene/Graphene Quantum Dots



Graphite



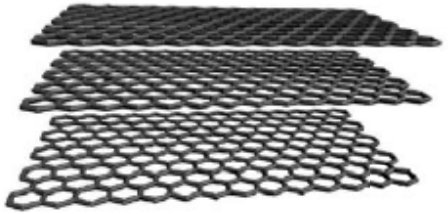
Graphene



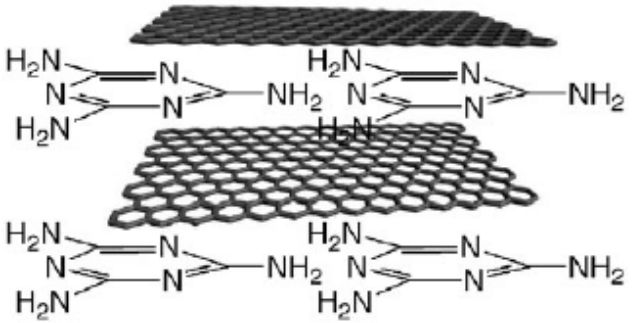
Graphene
Quantum Dots

Green Chemistry

Synthesis of Graphene

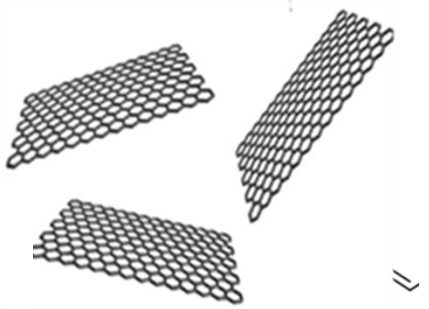


Melamine



Solvent

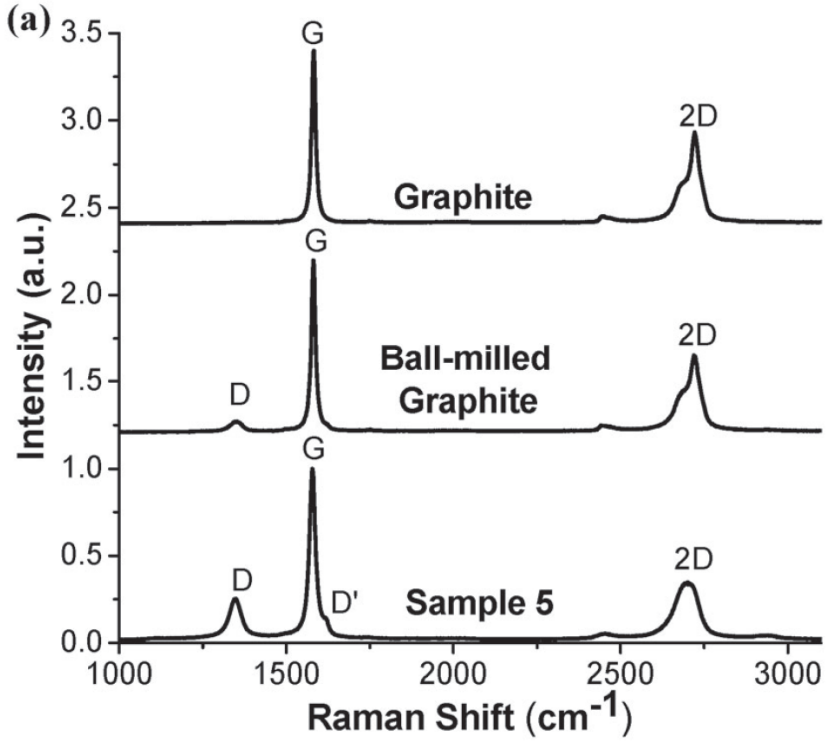
Graphene solutions



Dialysis
edimentation

Chem. Commum, 2011, 47, 10936
Nature Protocols, ***2018,*** *13, 495*

Characterisation of Graphene



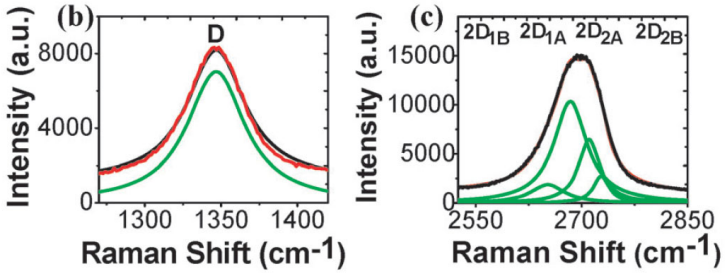
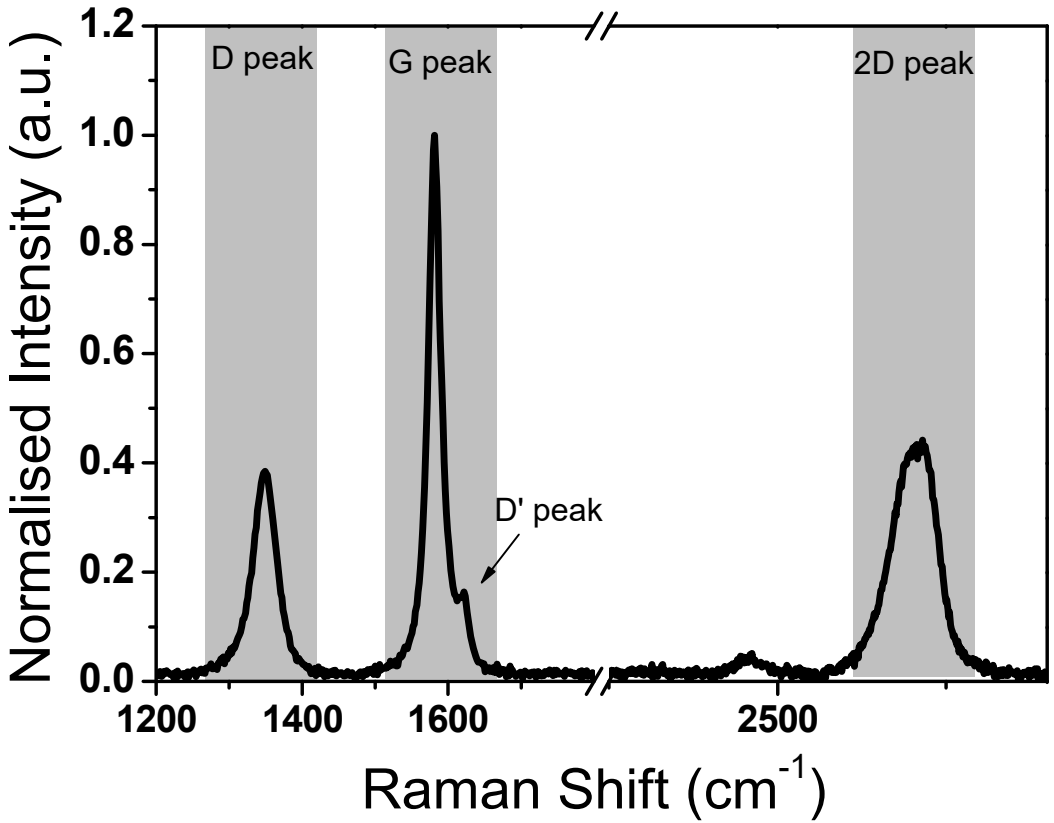


Fig. 3 (a) Comparison of Raman spectra at 514 nm for graphite, ball-milled graphite under the same conditions of sample **5** and sample **5**. (b) The D band in sample **5**, fitted to one component. (c) The four components of the 2D band in sample **5**.

Characterisation of Graphene

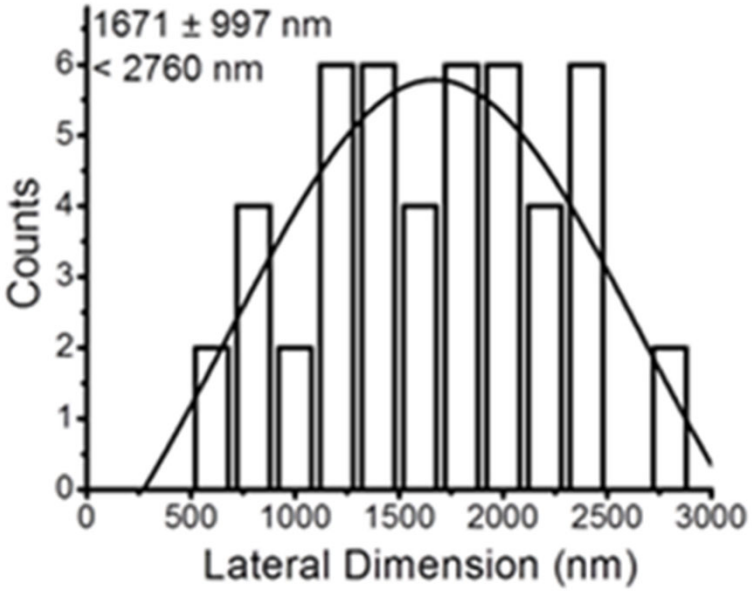
- Raman Spectroscopy

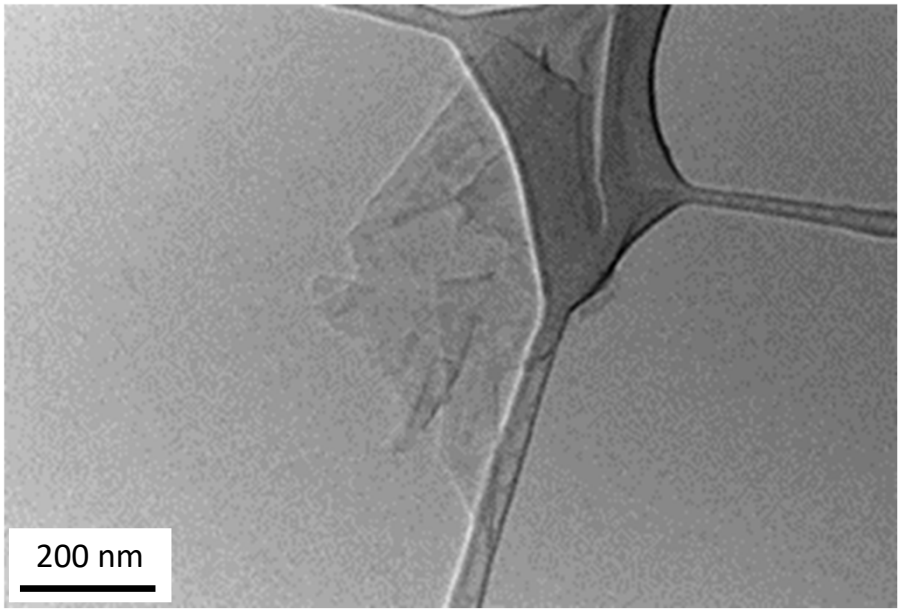


- ✓ FWHM (2D) = 60.6 cm^{-1}
- ✓ I_{2D}/I_G = 0.45
- ✓ 4 layers
- ✓ I_D/I_G = 0.4

Characterisation of Graphene

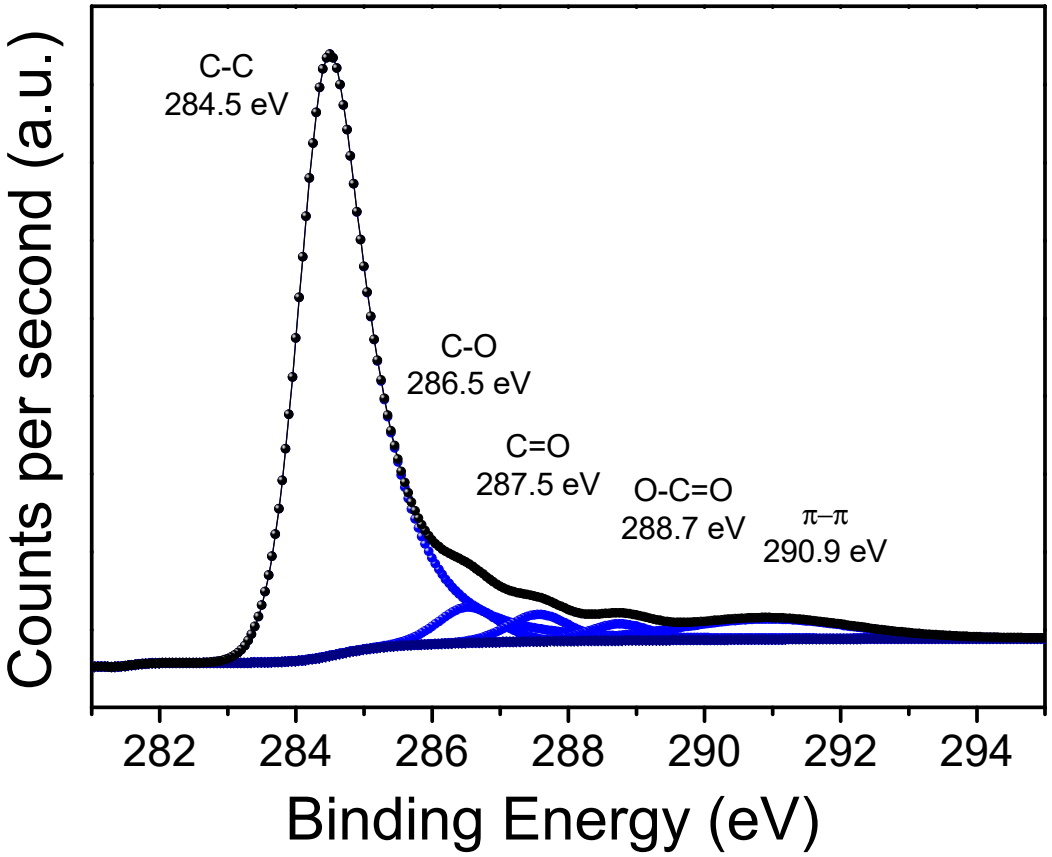
- TEM analysis





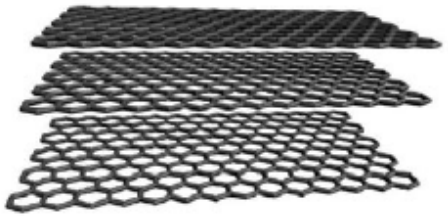
Characterisation of Graphene

➢XPS and Elemental Analysis



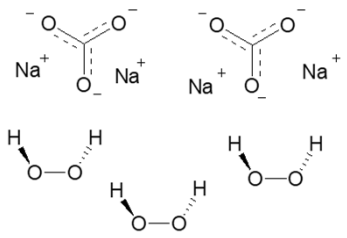
Element	% wt
C	94.93±0.28
H	0.55±0.02
N	0.54±0.02
S	0.33±0.03

Synthesis of Graphene Quantum dots



Graphite

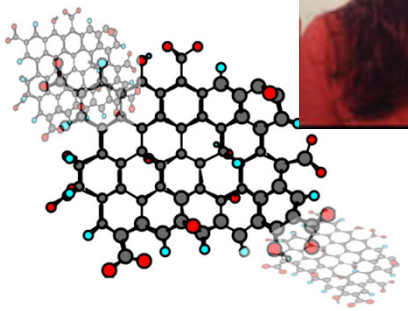
+



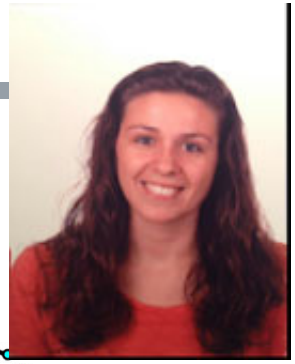
Sodium Percarbonate

Ball-milling

No solvent



Graphene Quantum Dots (GQDs)



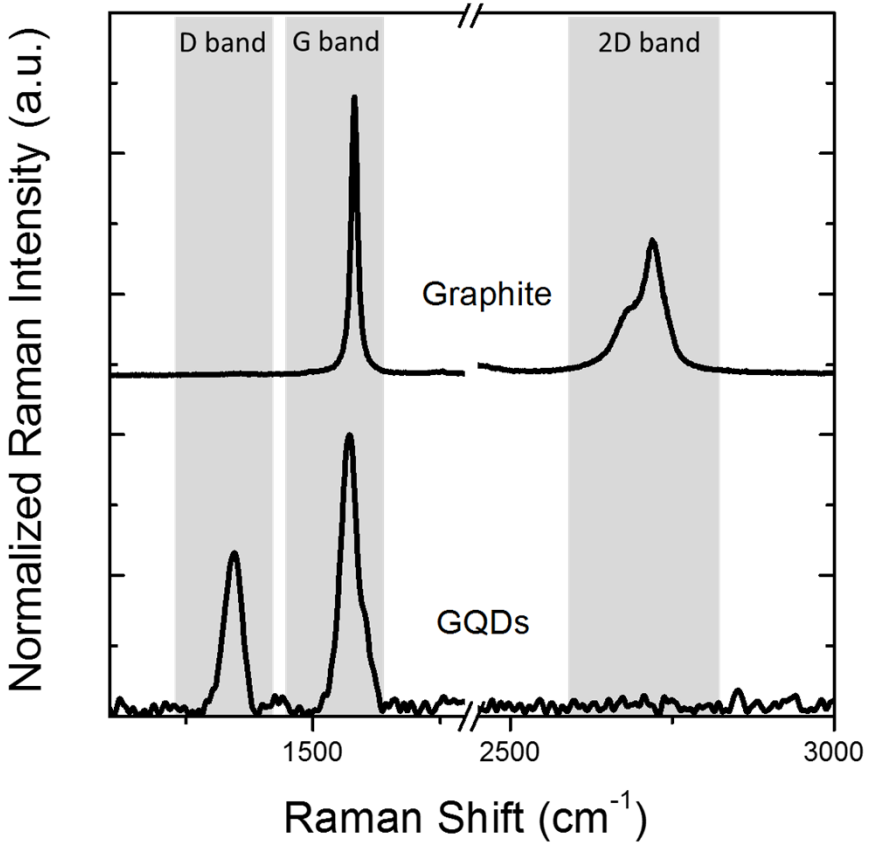
Optimised conditions:

- ✓ 300 mg total mass
- ✓ Graphite/SPC ratio = 2
- ✓ 12h
- ✓ 400 rpm

ACS Applied Mater & Interfaces **2018**, 10, 18192

Characterisation of Graphene Quantum dots

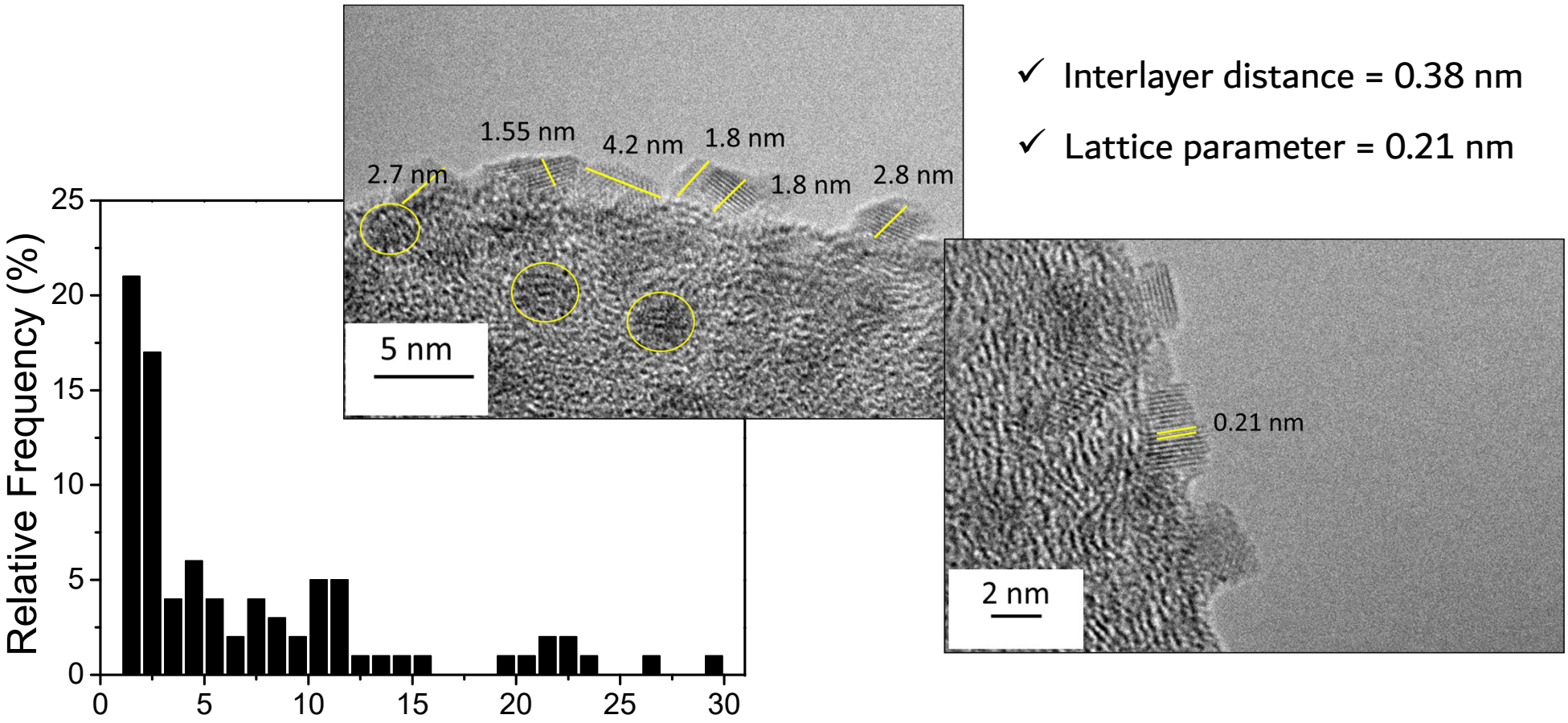
- Raman Spectroscopy



- ✓ No 2D peak
- ✓ $I_D/I_G = 0.6$

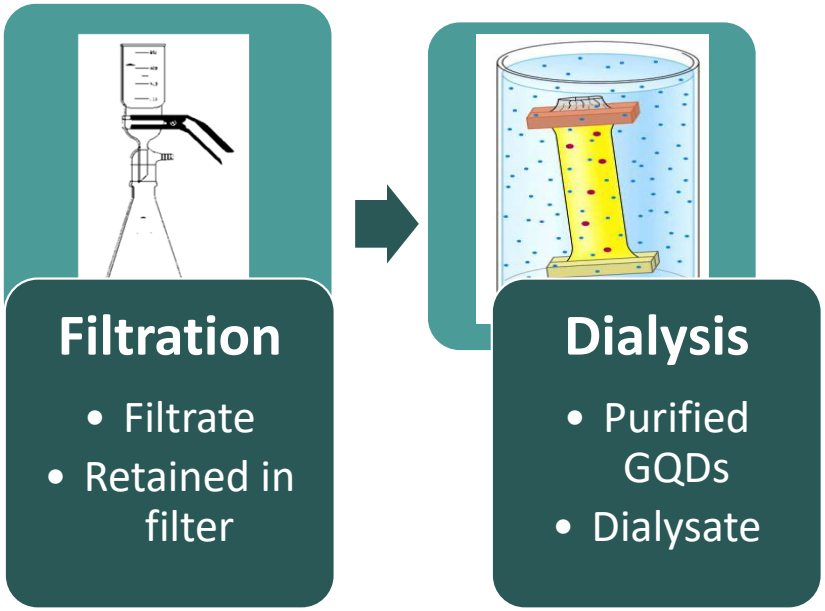
Characterisation of Graphene Quantum dots

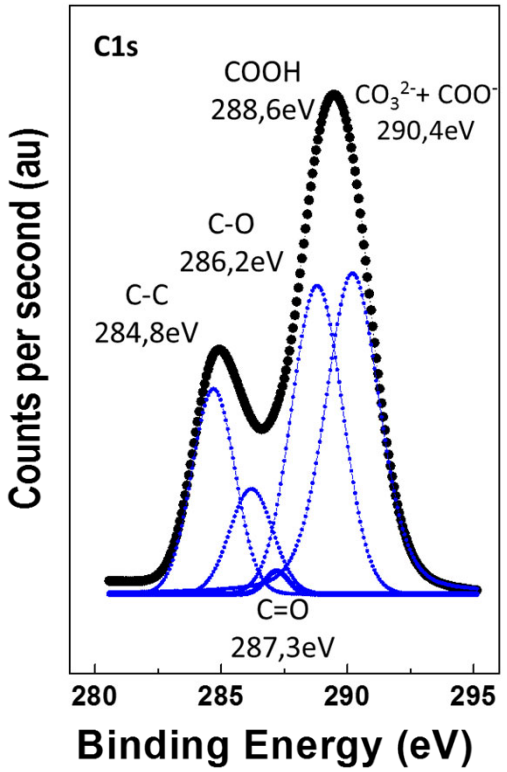
➢TEM

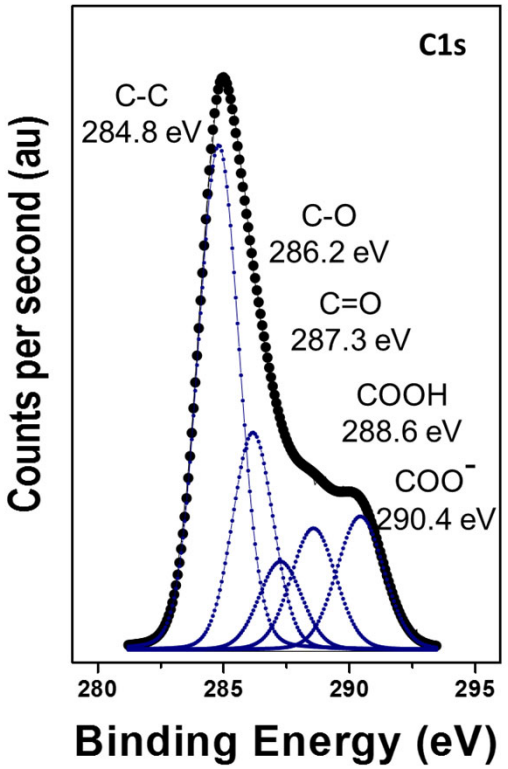


- ✓ Interlayer distance = 0.38 nm
- ✓ Lattice parameter = 0.21 nm

Purification of Graphene Quantum dots

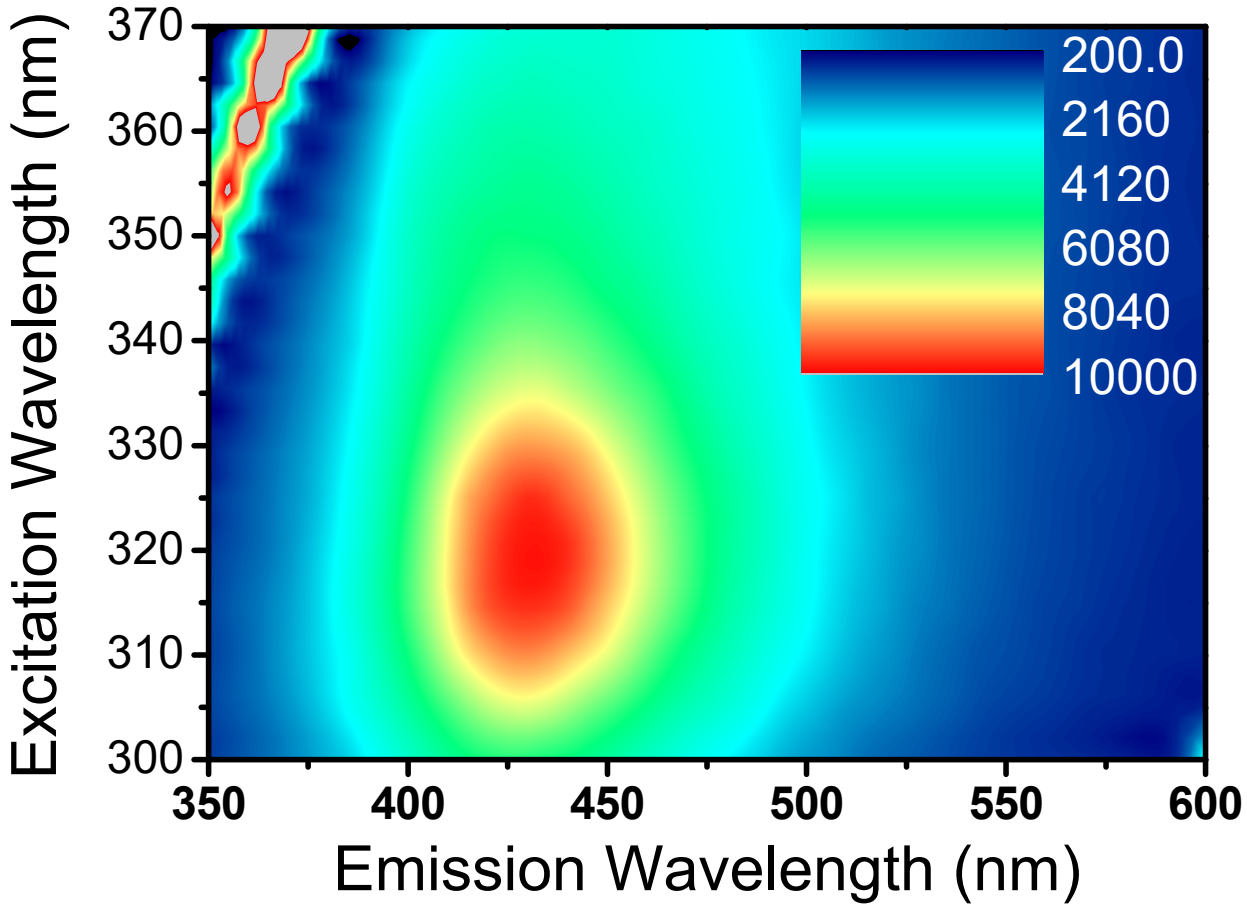






Filtration + Dialysis ⟶ Purified GQDs

Characterisation of Graphene Quantum dots



- ✓ λ_{exc} = 315 nm
- ✓ λ_{em} = 430 nm

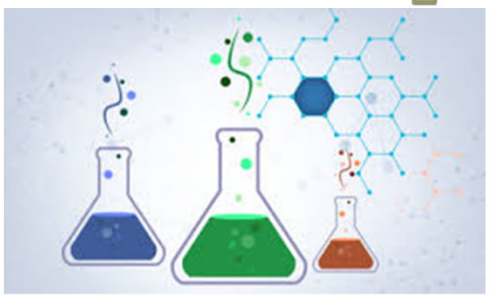
Independent emission from the excitation wavelength

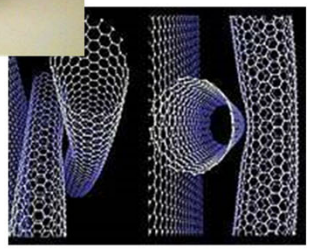
Water dispersable / soluble carbon nanomaterials

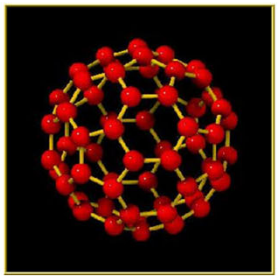
León *et al.*, Chem Commun **2011**, 47, 10936
González-Dominguez *et al.*, Nat Protoc **2018,** 13, 495

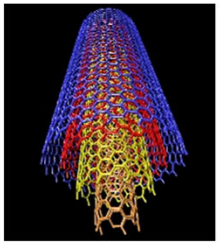
ACS Appl. Mater. Interfaces, **2018**, 10, 18192

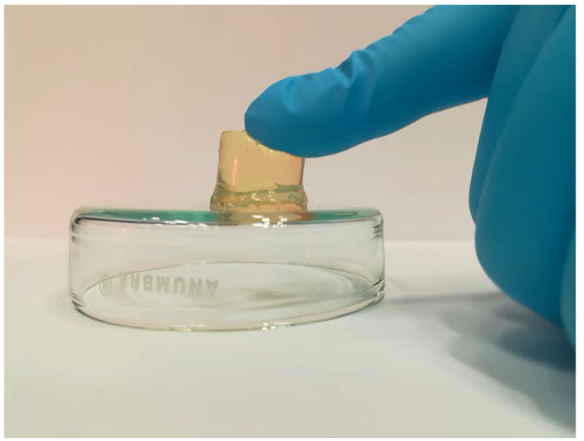
2000 2002 2006 2007 2008 2011 2025



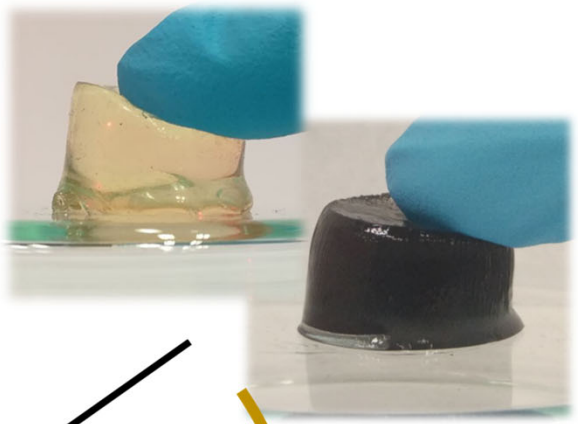


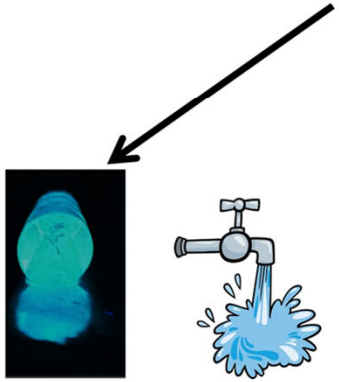


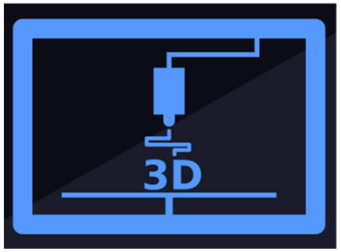




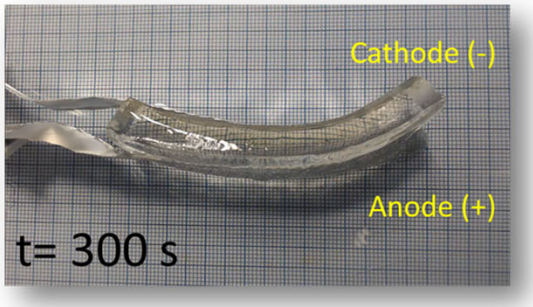

Hidrogel Híbrido
con Nanomateriales
Robótica
blanda
Sensores
Cultivos
celulares





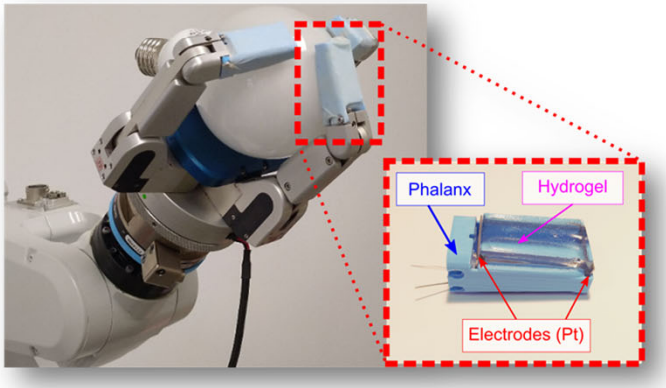


Work in progress



Actuator

Publication in preparation

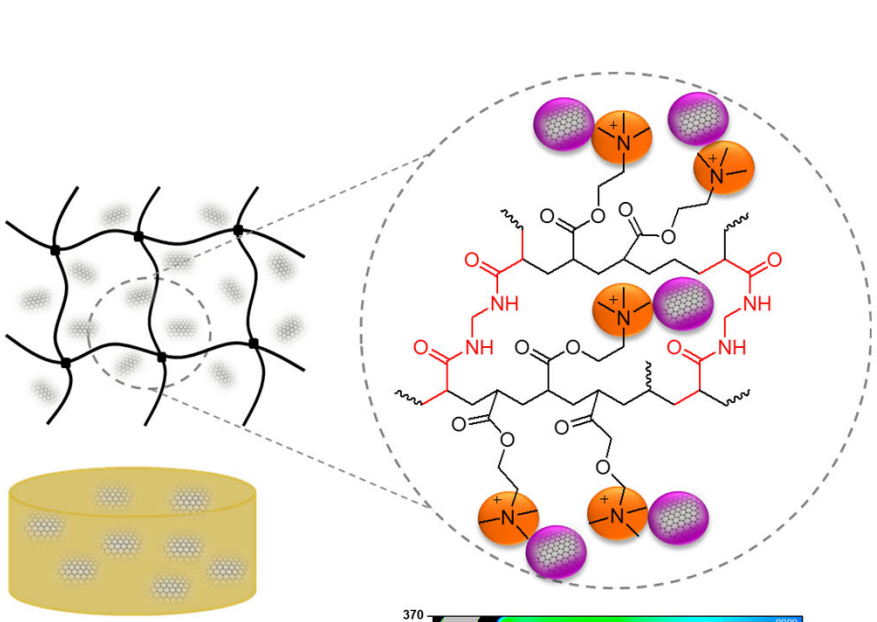


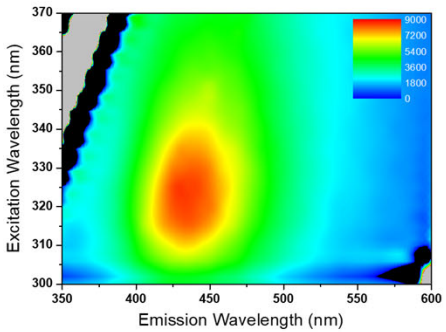
Fingertip

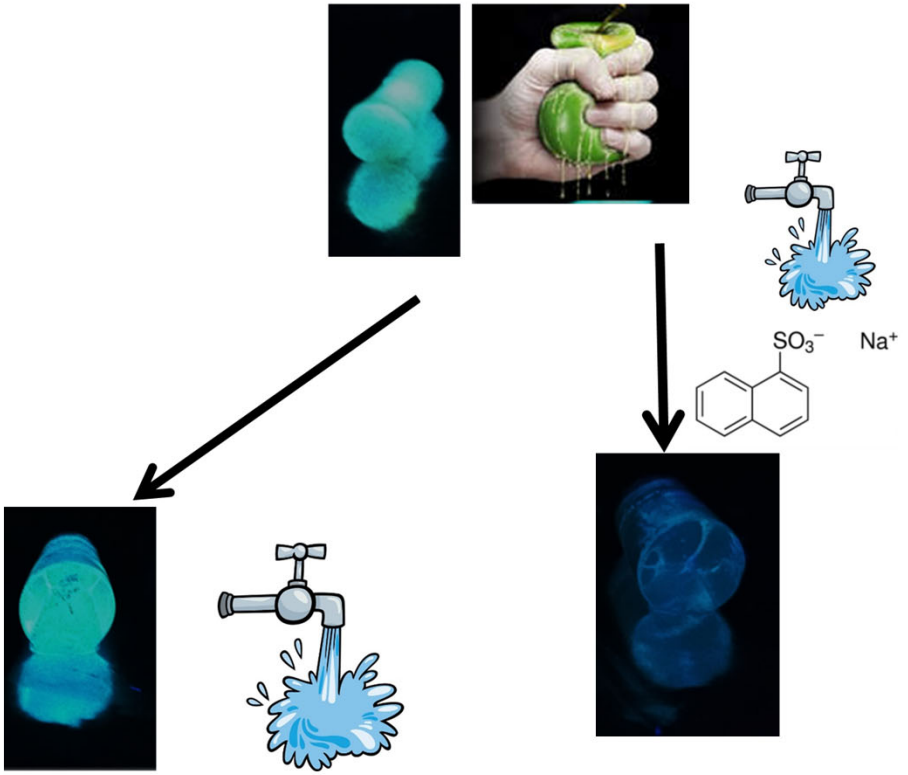
ICRA **2019**, 5126

Graphene Quantum Dot–Aerogel: From Nanoscopic to Macroscopic Fluorescent Materials. Sensing Polyaromatic Compounds in Water

ACS Appl. Mater. Interfaces 2018, 10, 18192–18201





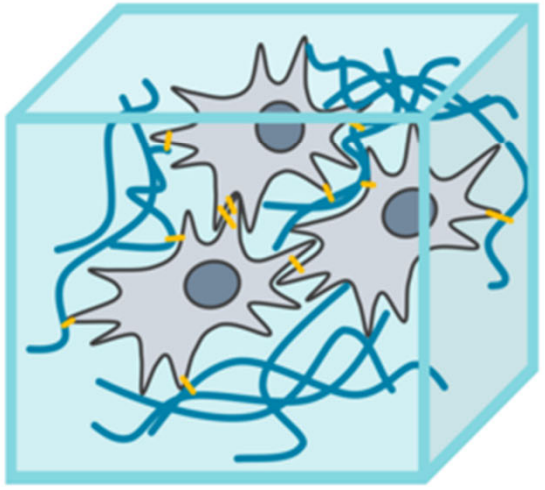


Cite this: *Nanoscale*, 2023, **15**, 14238

Mimicking the extracellular matrix by incorporating functionalized graphene into hybrid hydrogels†

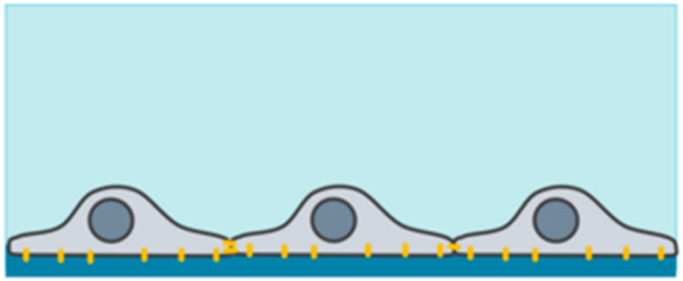
3D

Imitan mejor la matriz extracelular



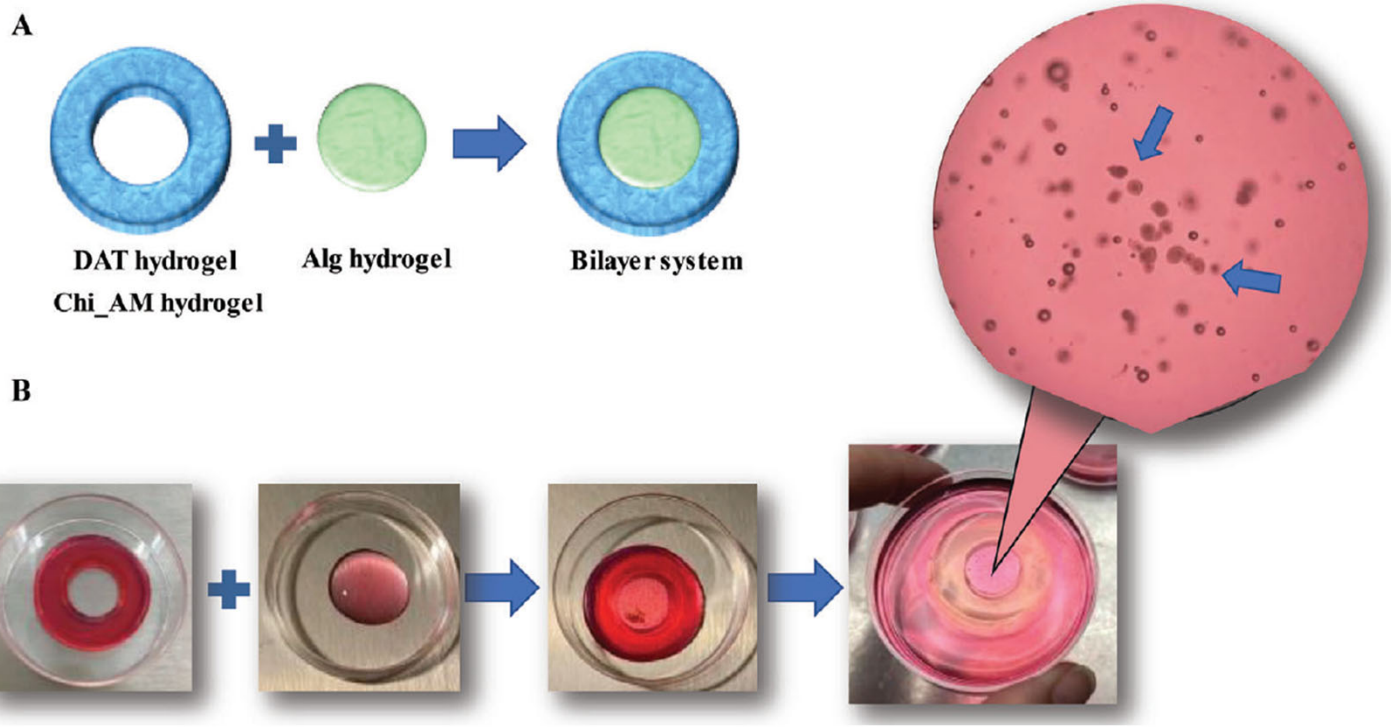
2D

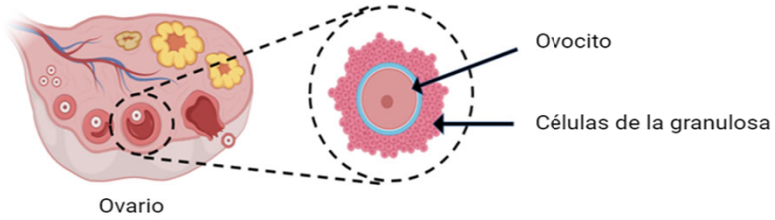
No representativos del entorno celular *in vivo*

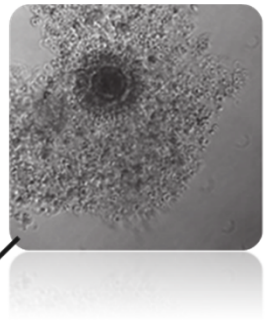


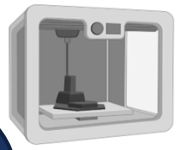
A Biomimetic Follicle-Based Design for Engineering Reproductive Technologies

Adv. Funct. Mater. **2024**, *34*, 2310787

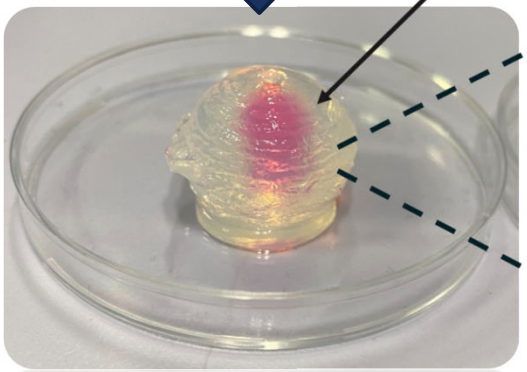


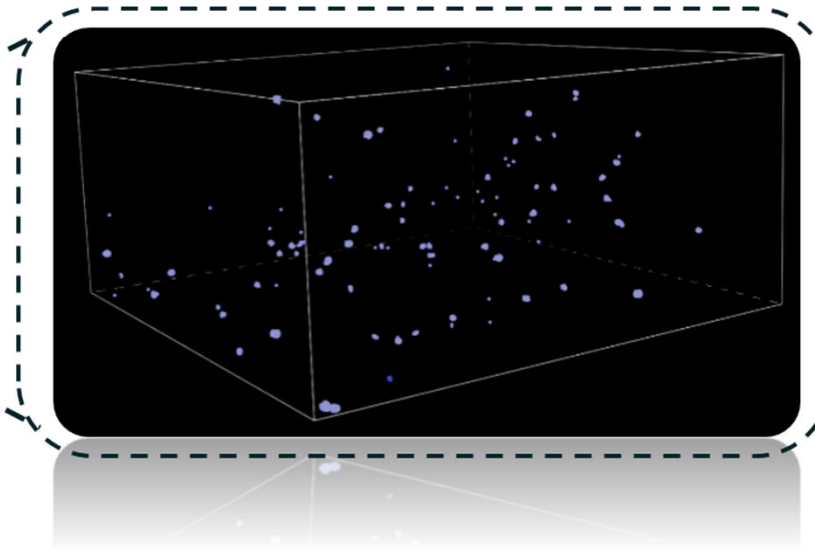






3D printer

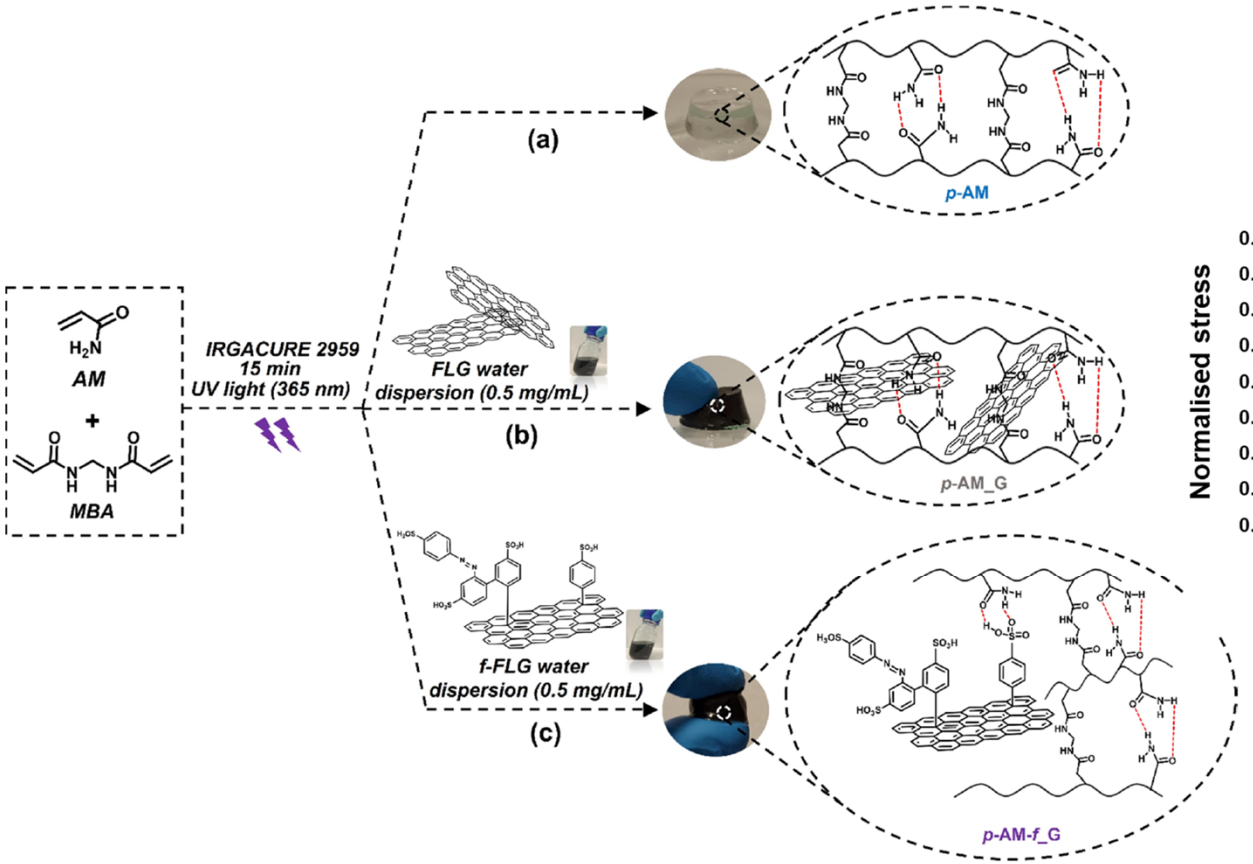


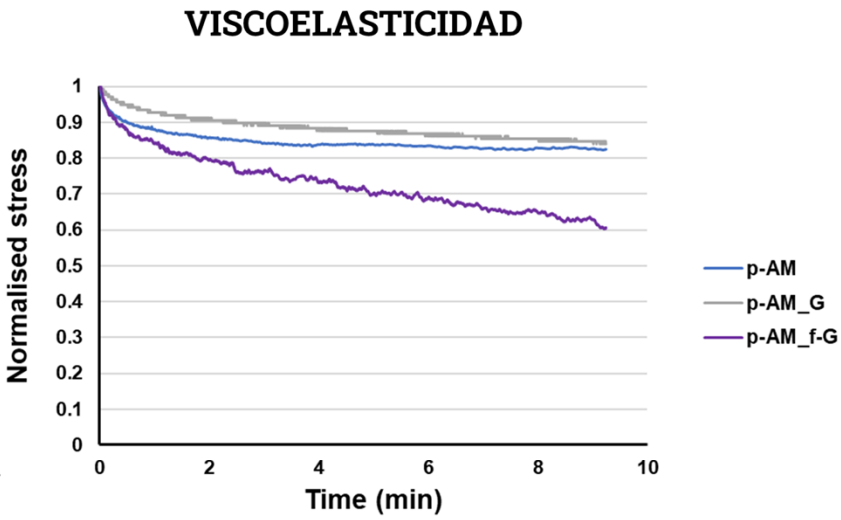


Check for updates

Cite this: *Nanoscale*, 2023, **15**, 14238

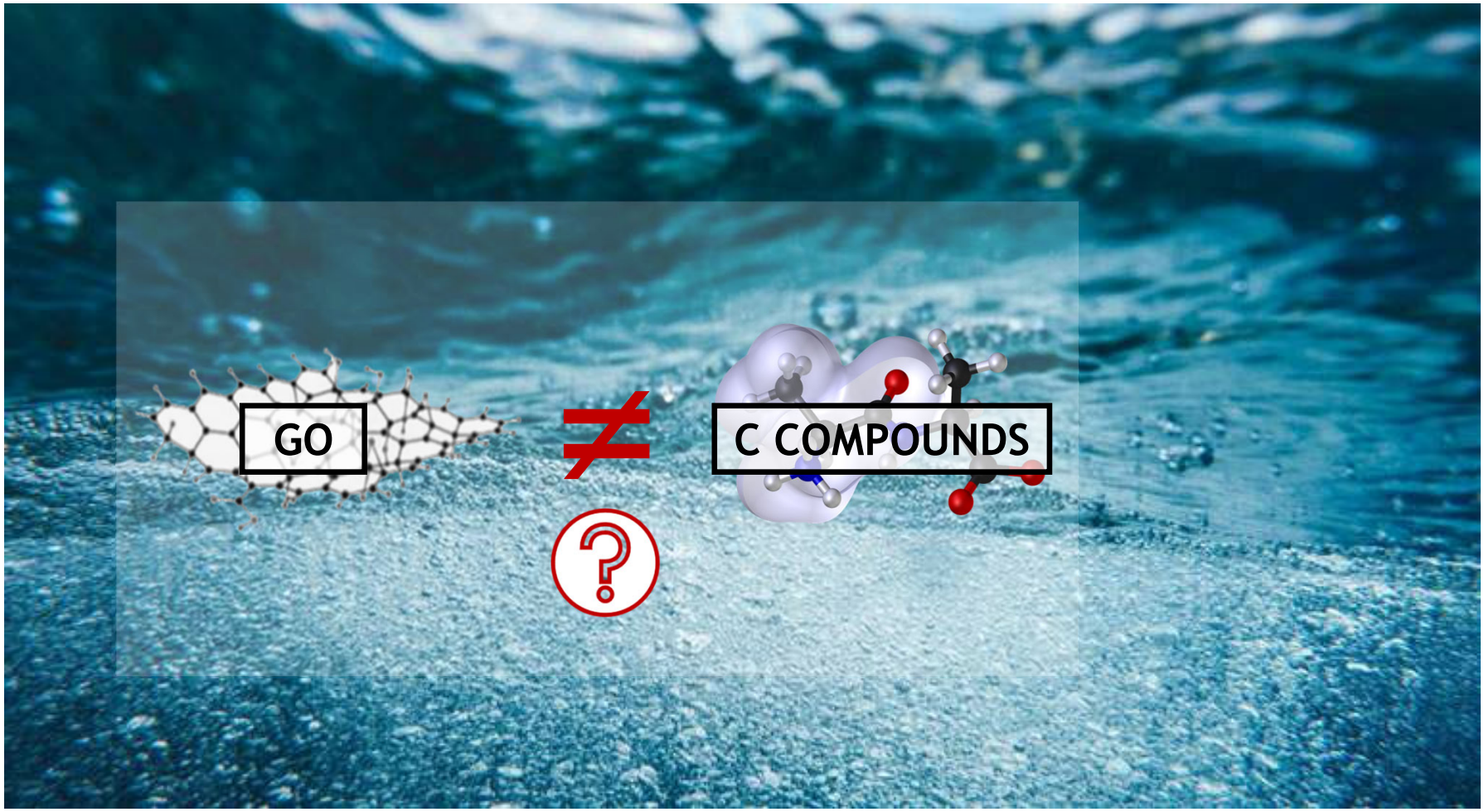
Mimicking the extracellular matrix by incorporating functionalized graphene into hybrid hydrogels†



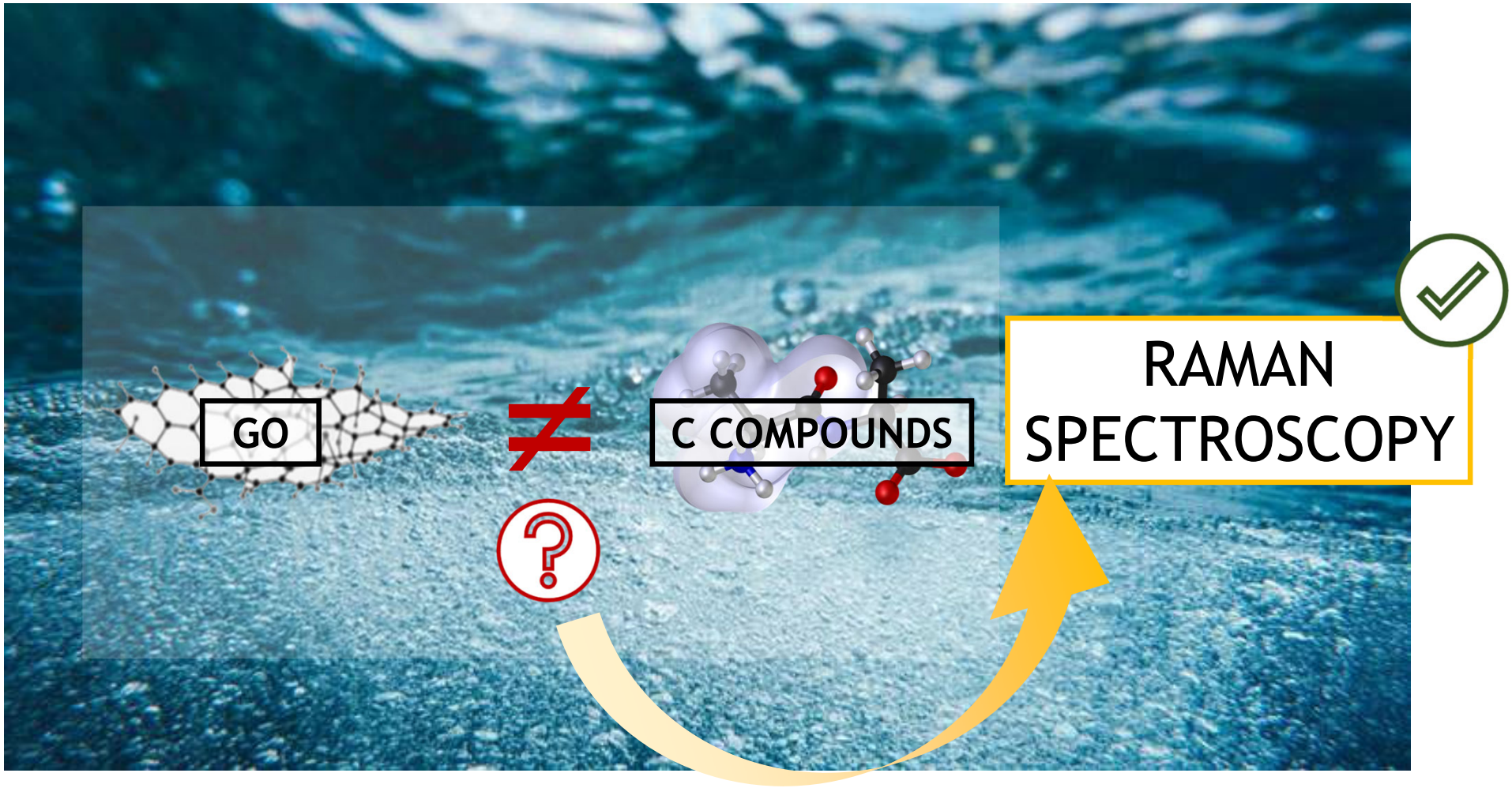


OBJECTIVE

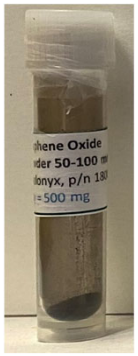
Develop a sensitive and simple method to quantify at trace levels of GO in aqueous samples.

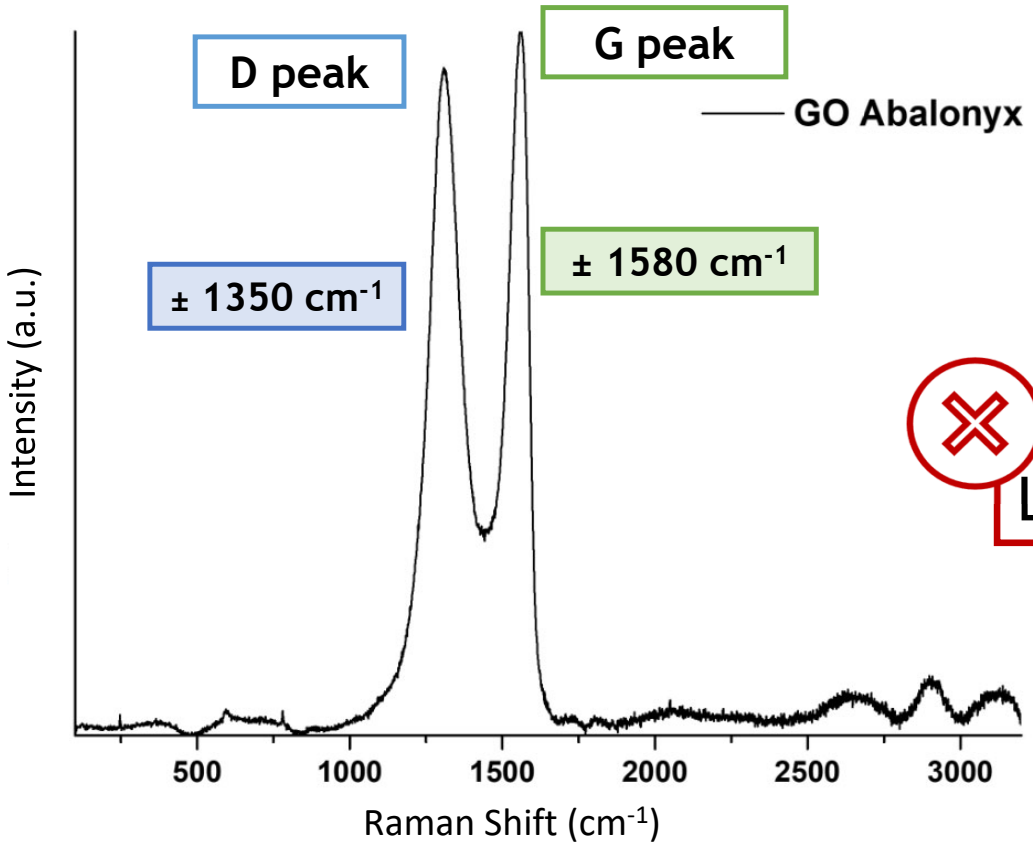

GO
≠
C COMPOUNDS
?

Method to quantify GO



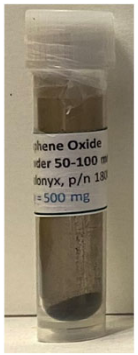
Raman Spectroscopy GO

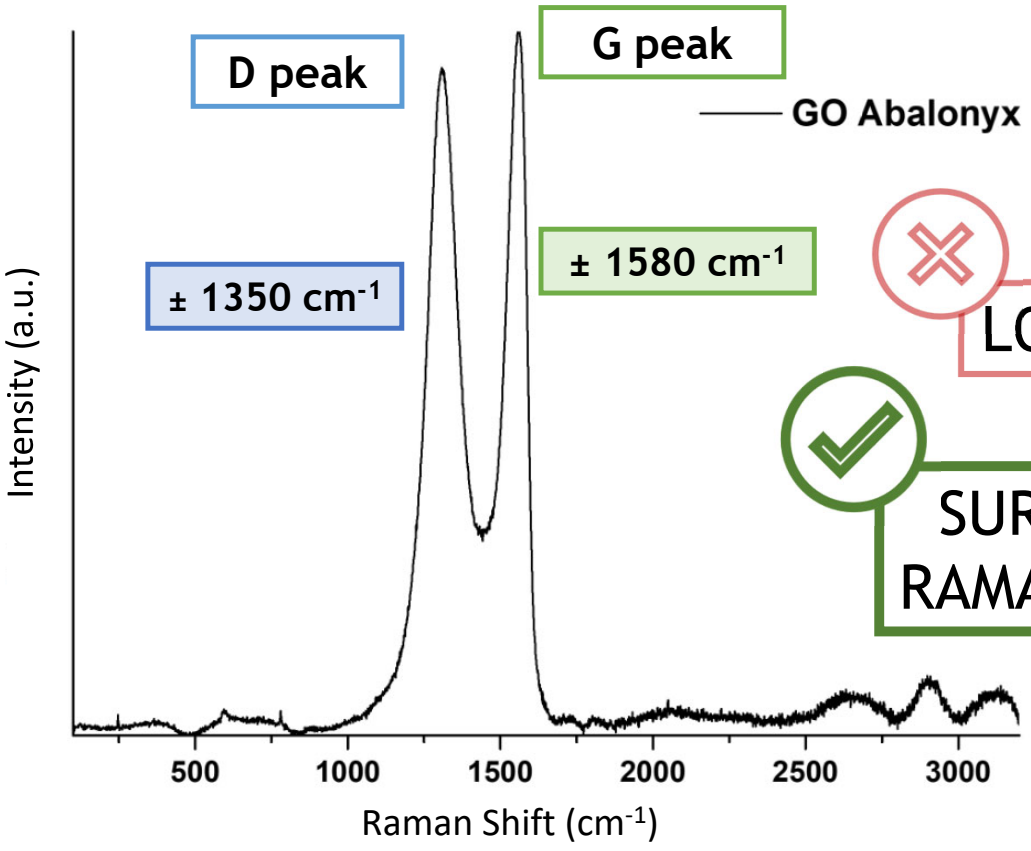




LOW SENSITIVITY

Raman Spectroscopy GO

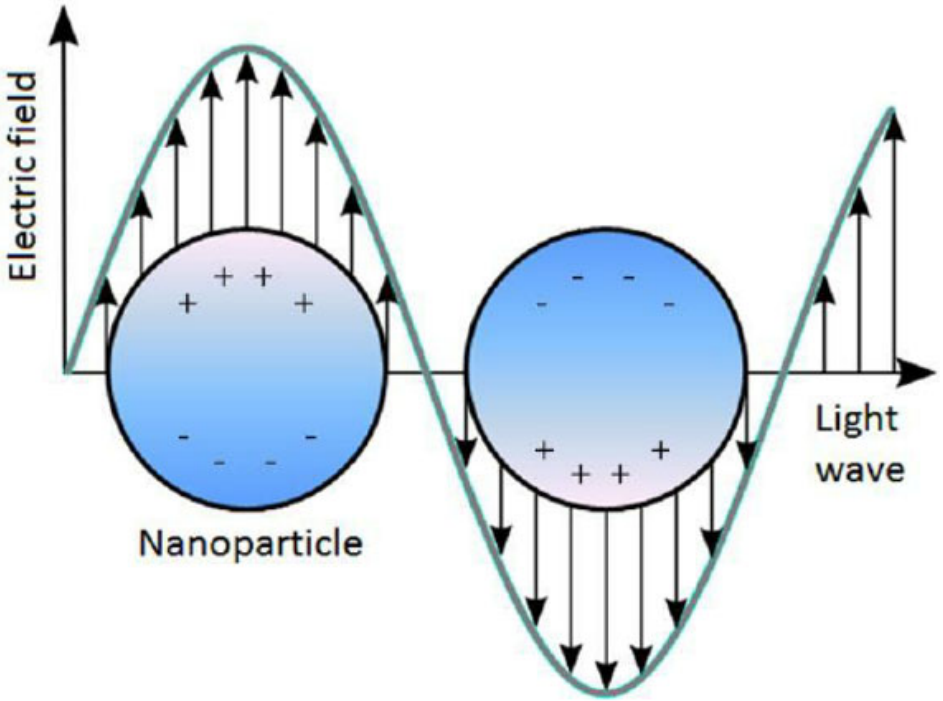


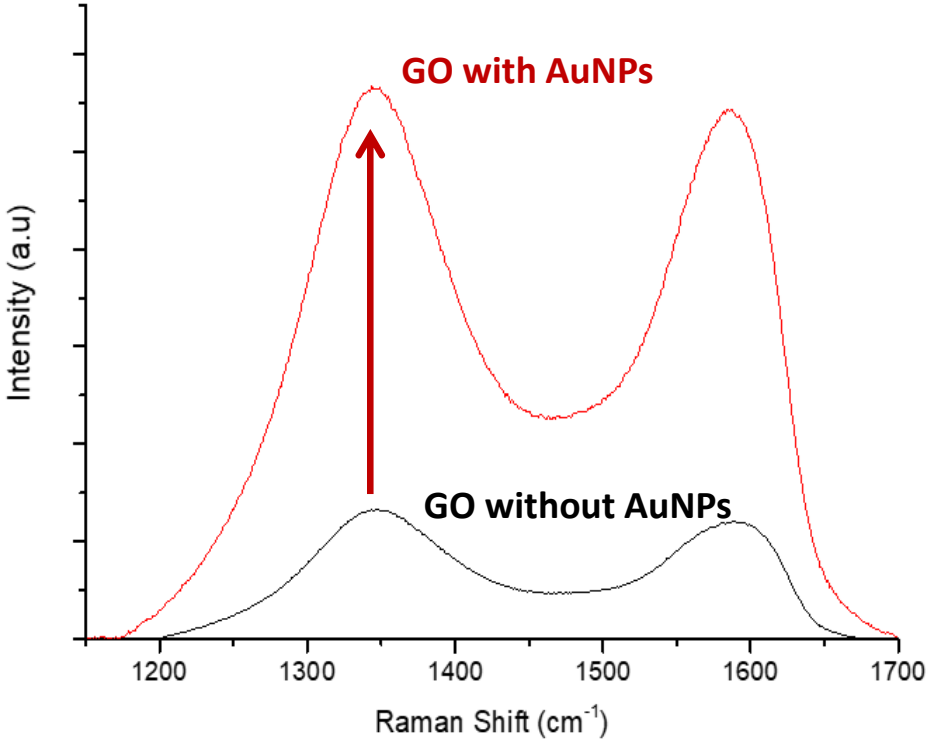


LOW SENSITIVITY

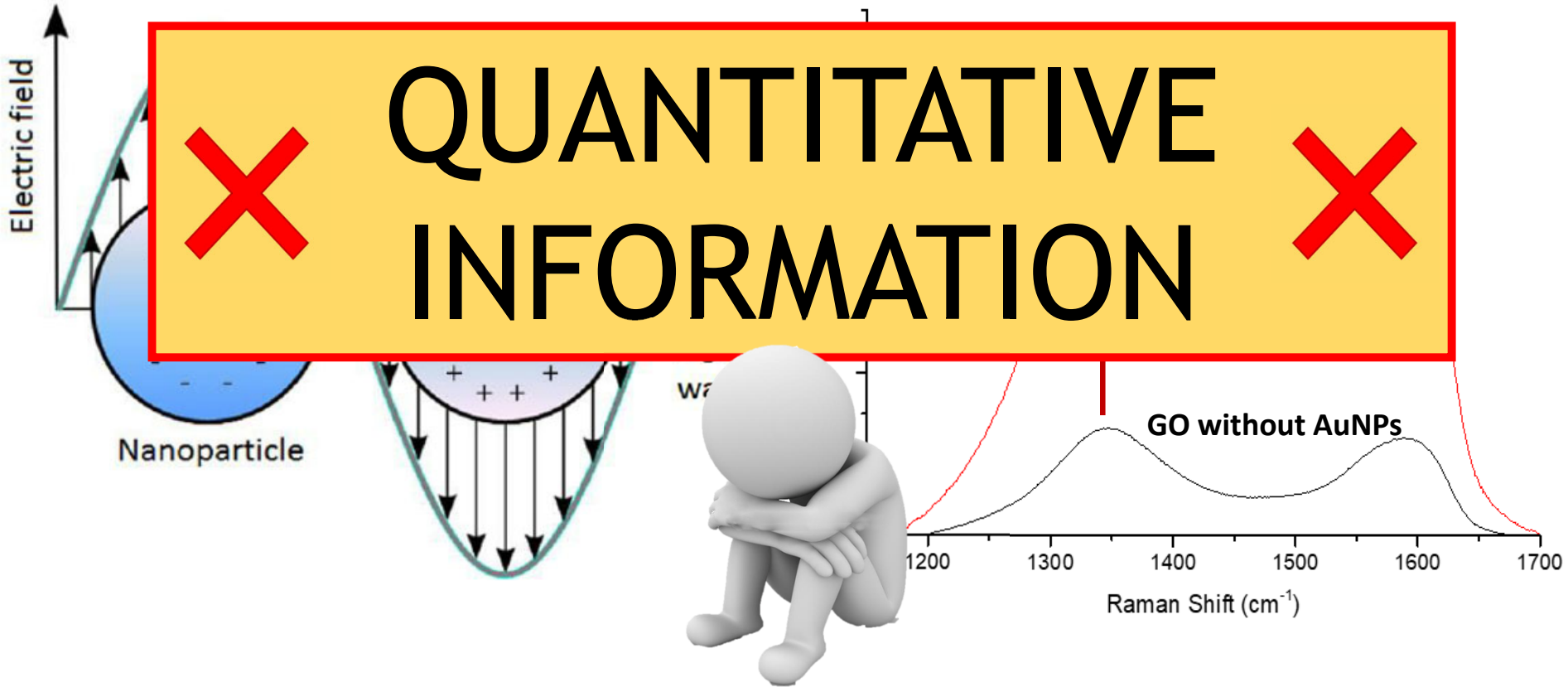
SURFACE-ENHANCED RAMAN SPECTROSCOPY

Surface-enhanced Raman Spectroscopy





Surface-enhanced Raman Spectroscopy



QUANTITATIVE INFORMATION

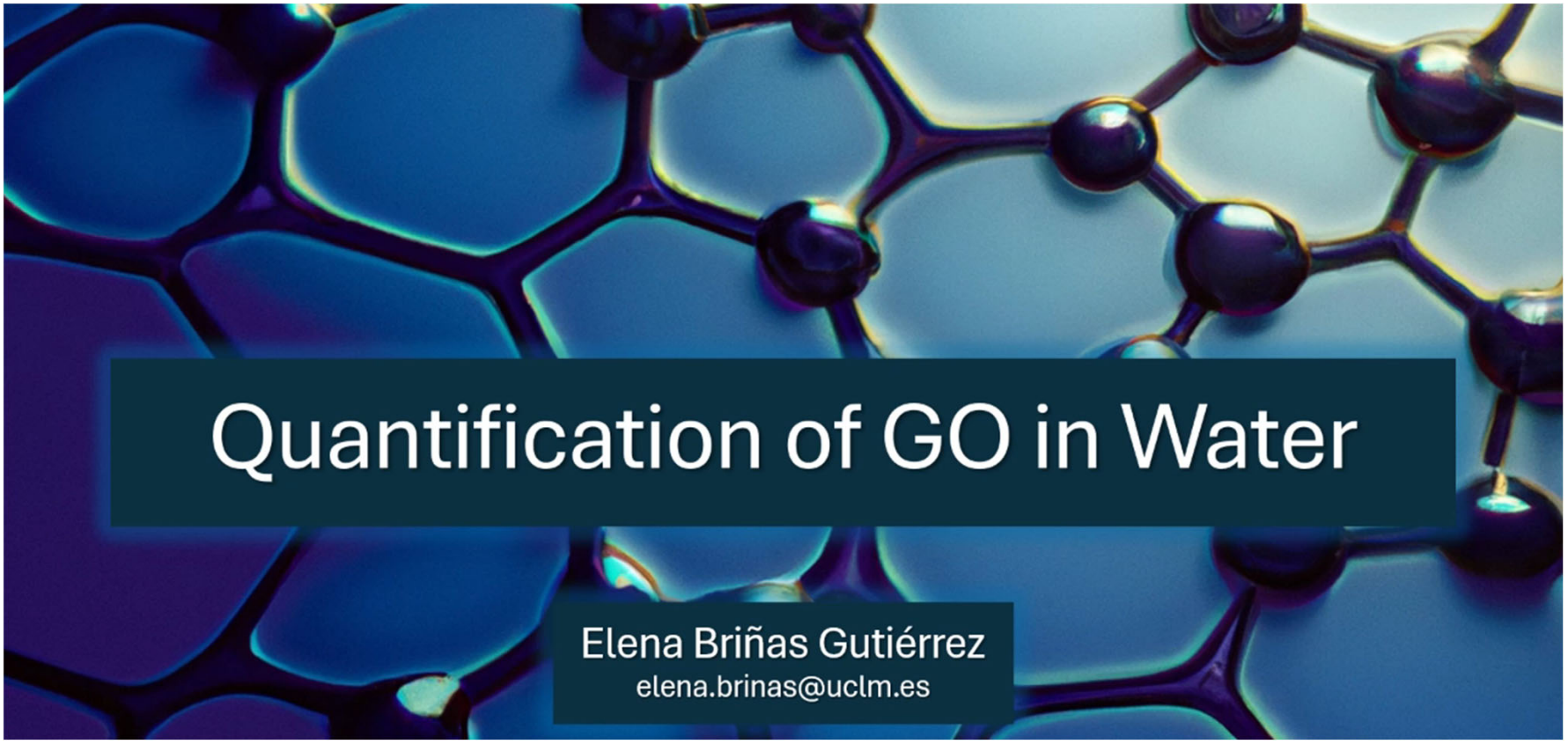
Surface-enhanced Raman Spectroscopy

OPTIMIZATION OF METHOD

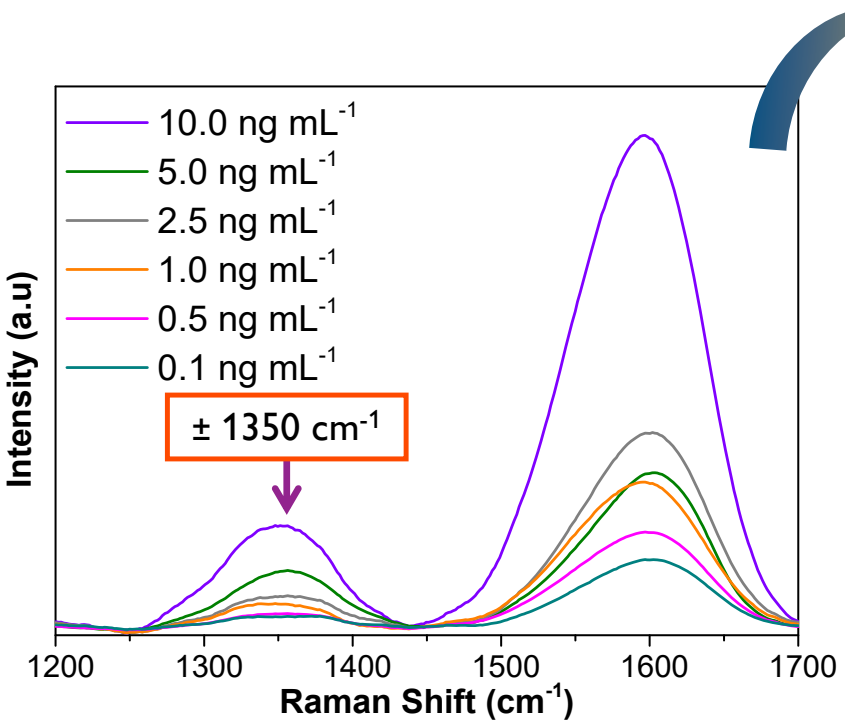
RELIABILITY TESTS

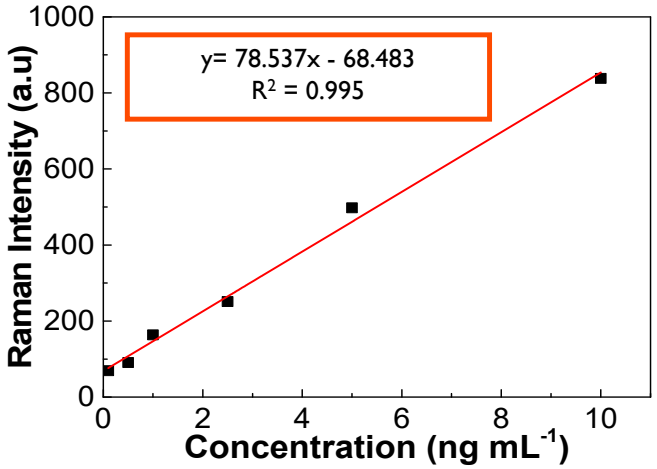
ANALYTICAL VALIDATION

Surface-enhanced Raman Spectroscopy



Quantification of GO





ENVIRONMENTAL Science & Technology

pubs.acs.org/est Article

SERS-Based Methodology for the Quantification of Ultratrace Graphene Oxide in Water Samples

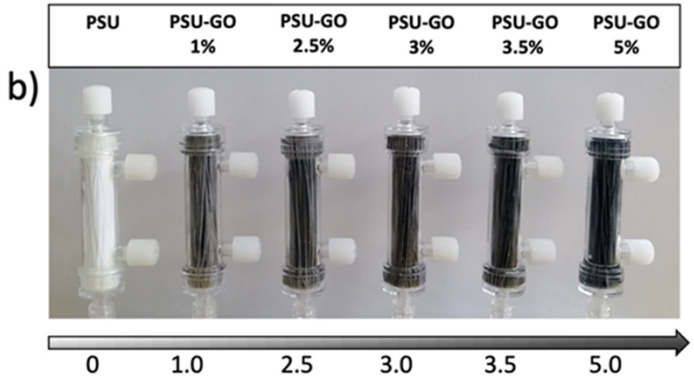
Elena Briñas,[⊥] Viviana Jehová González,[⊥] María Antonia Herrero,* Mohammed Zougagh, Ángel Ríos, and Ester Vázquez*

Cite This: *Environ. Sci. Technol.* 2022, 56, 9527−9535 Read Online

Quantification of GO

Graphene oxide-polysulfone hollow fibers membranes with synergic ultrafiltration and adsorption for enhanced drinking water treatment

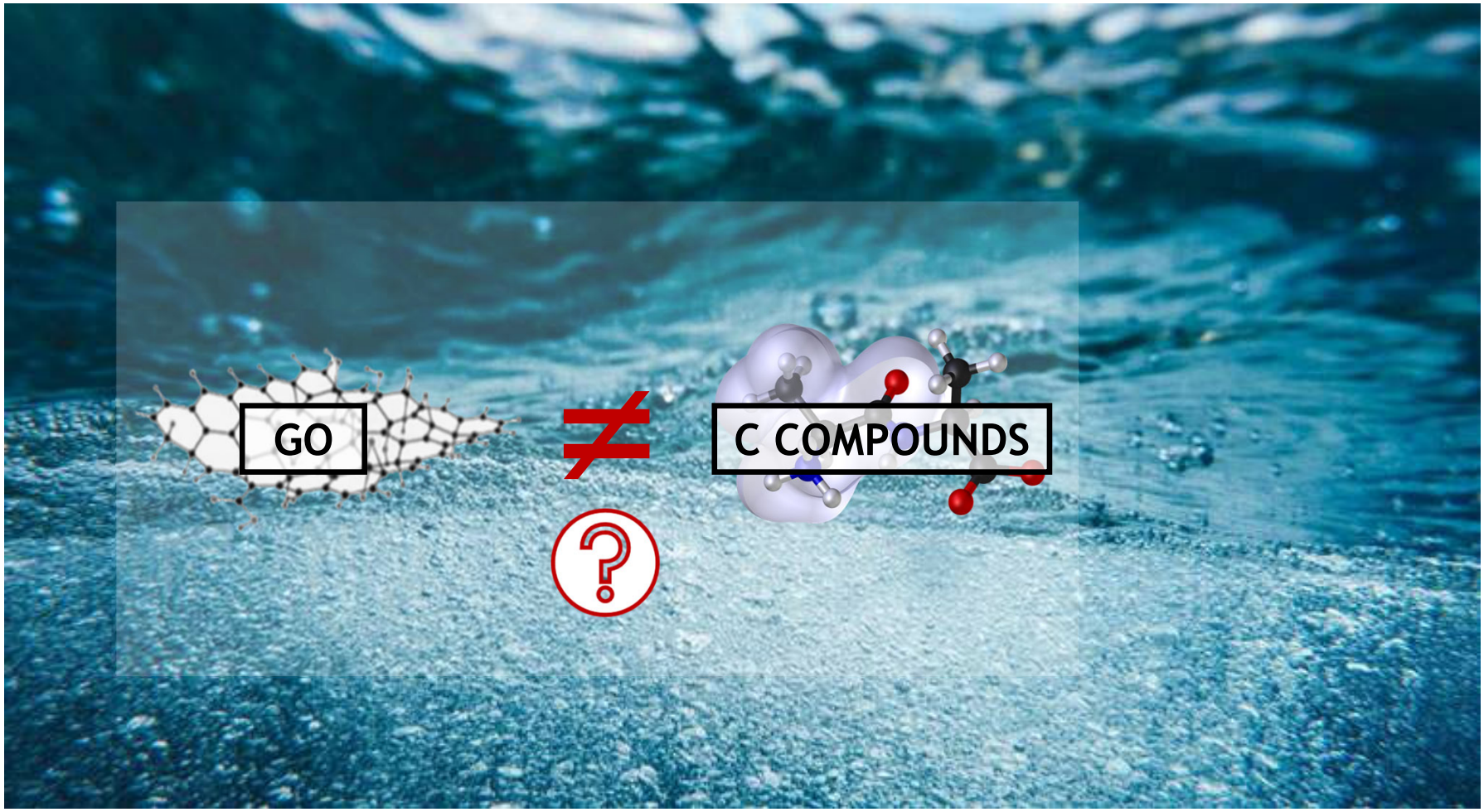
Journal of Membrane Science 658 (2022) 120707



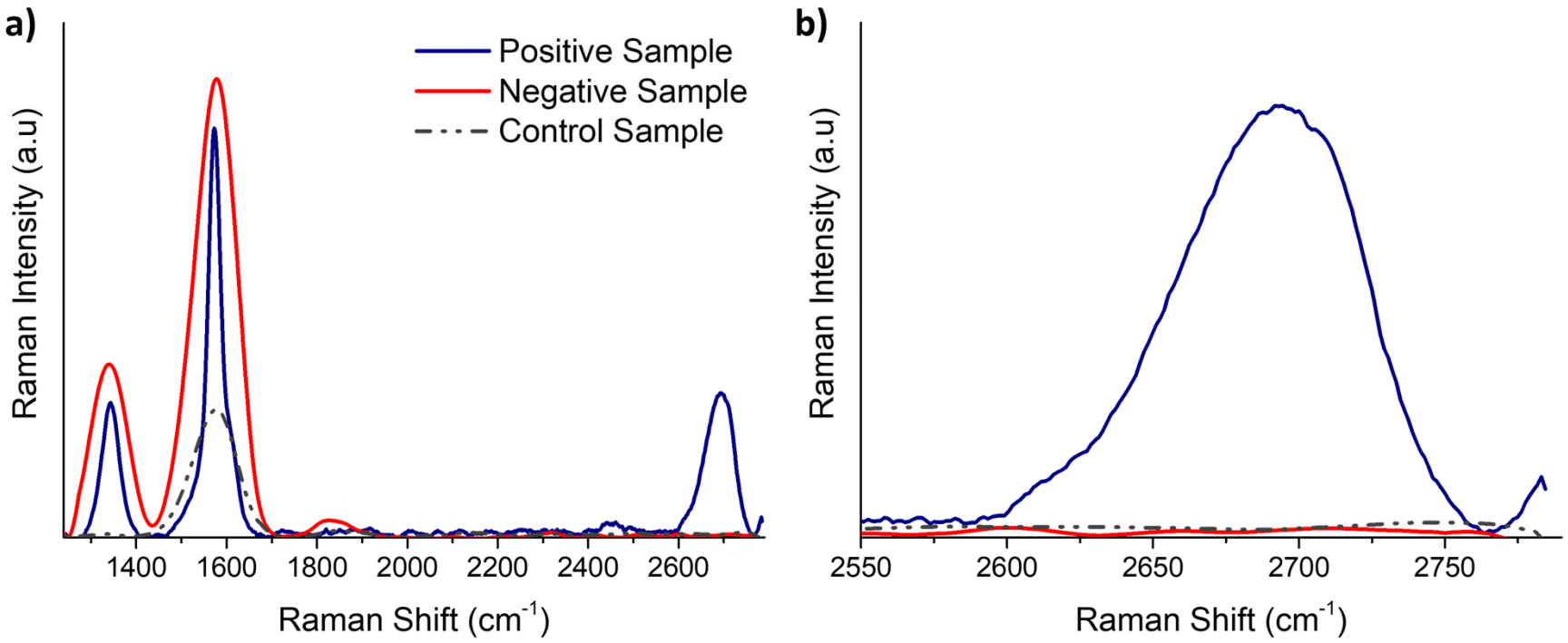
Check for updates

Cite this: *Environ. Sci.: Water Res. Technol.*, 2024, **10**, 1097

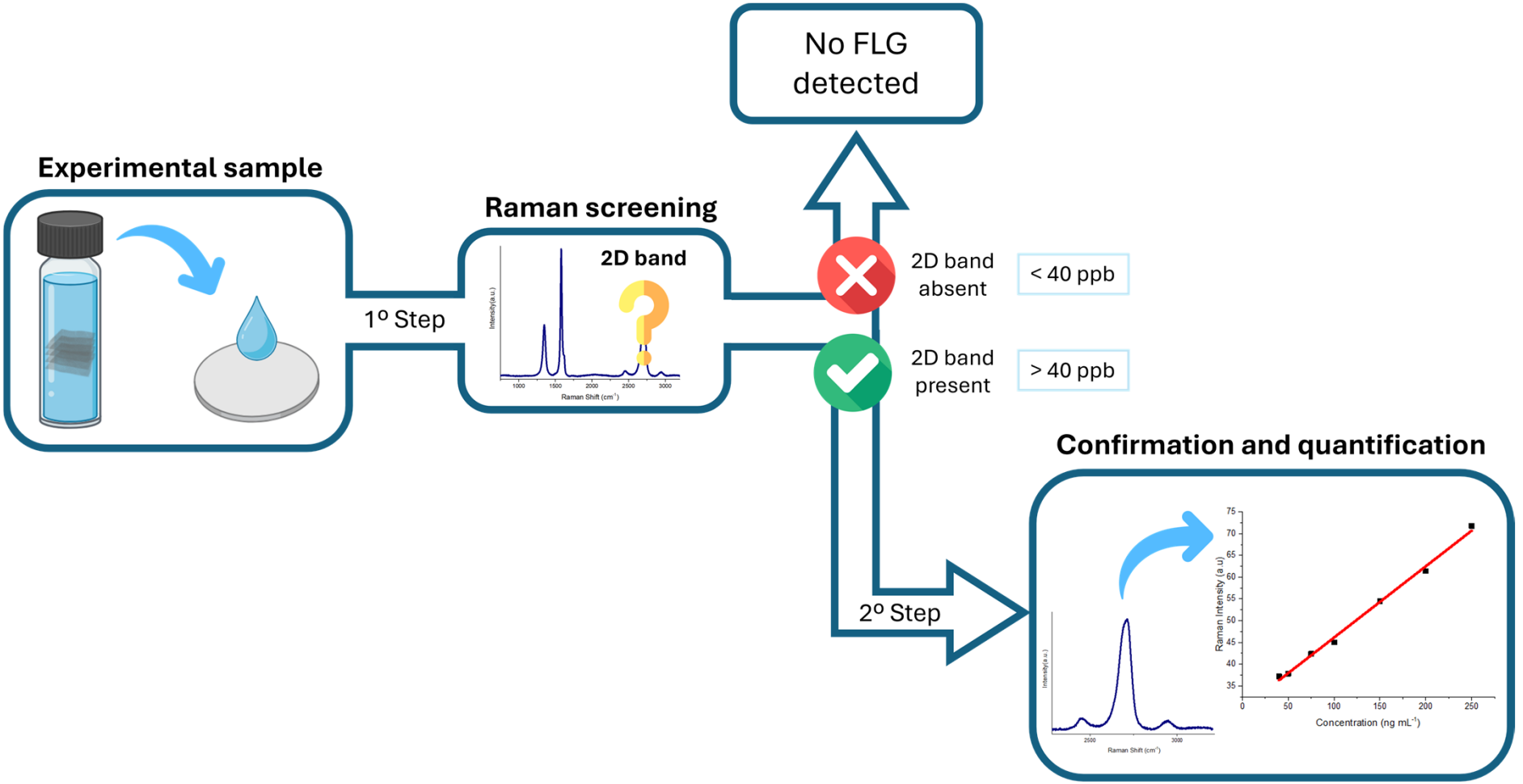
Upcycling of plastic membrane industrial scraps and reuse as sorbent for emerging contaminants in water†


GO
≠
C COMPOUNDS
?

Quantification of FLG

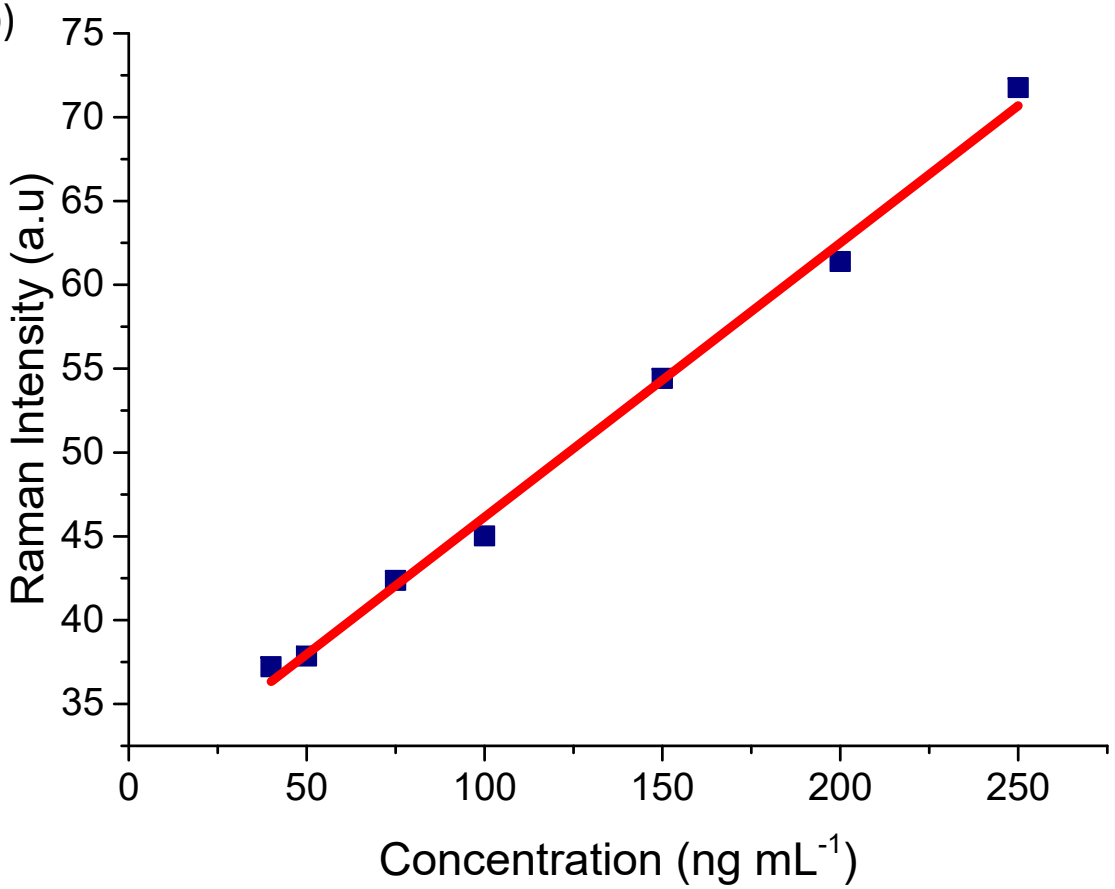


Quantification of FLG



Quantification of FLG

b)



ANALYTICAL FEATURES

Parameter	Value
Linear range (ng mL^{-1})	0.00 -250.00
R^2	0.995
LOD[a] (ng mL^{-1})	17.56
RSD intrasubstrate (%)	5.26
RSD intersubstrate (%)	9.74

Quantification of FLG

RECOVERY STUDIES OF FLG IN DEIONIZED WATER SAMPLES

SAMPLES	Added (ng mL^{-1})	Found (ng mL^{-1})	Recovery (%)	RSD (%)
FLG only	60	61.06	101.77	8.91
	130	123.56	95.04	3.45
	220	222.99	101.36	3.39
FLG and GO (total 500 ng mL^{-1})	100	103.82	103.82	8.87
	150	155.51	103.67	2.05

Quantification of FLG

Negative Samples

	Carbon Nanomaterials Added		1st step – Raman screening			2nd step – Confirmation and quantification metho		
	FLG (ng mL^{-1})	GO (ng mL^{-1})	2D band Raman intensity (a.u)	Result	Decision	Found concentration (ng mL^{-1})	Recovery (%)	RSD (%)
S1	-	0.25	8.56 ± 0.28	No	End	-	-	-
S2	-	3.50	7.89 ± 0.18	No	End	-	-	-
S3	-	7.50	5.92 ± 0.80	No	End	-	-	-
S4	10.00	400.00	6.46 ± 0.52	No	End	-	-	-

No FLG detected

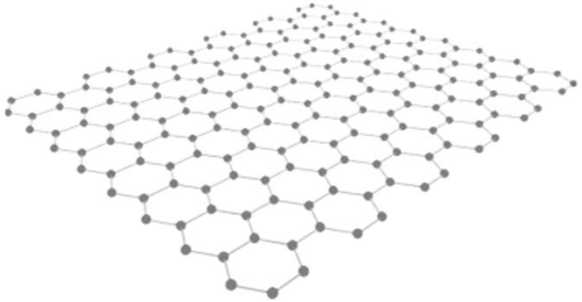
Quantification of FLG

Positive Samples

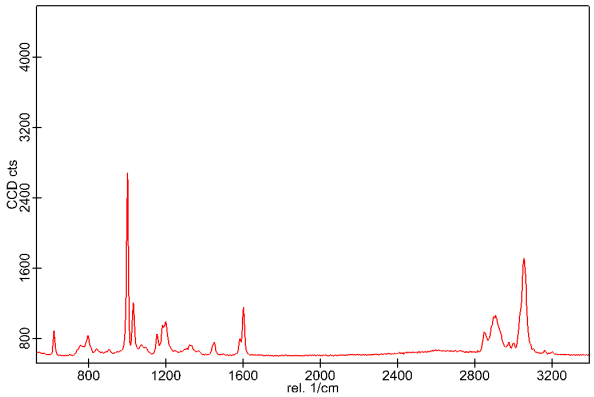
	Carbon Nanomaterials Added		1st step – Raman screening			2nd step – Confirmation and quantification metho		
	FLG ($ng\ mL^{-1}$)	GO ($ng\ mL^{-1}$)	2D band Raman intensity (a.u)	Result	Decision	Found concentration ($ng\ mL^{-1}$)	Recovery (%)	RSD (%)
S5	50.00	100.00	37.70 ± 0.70	Yes	Confirm by Step 2	48.39	**96.77**	8.82
S6	90.00	300.00	44.41 ± 0.96	Yes	Confirm by Step 2	89.39	**99.32**	6.55
S7	140.00	400.00	52.24 ± 1.21	Yes	Confirm by Step 2	137.28	**98.05**	5.40
S8	60.00	-	40.01 ± 0.43	Yes	Confirm by Step 2	62.50	**104.17**	4.23
S9	130.00	-	50.66 ± 1.47	Yes	Confirm by Step 2	127.60	**98.15**	7.06
S10	220.00	-	65.30 ± 1.81	Yes	Confirm by Step 2	217.07	**98.67**	5.09

Detection of Nanoplastics/SERS

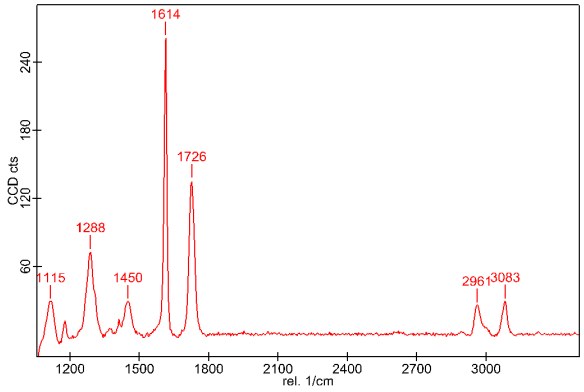
Detection of Nanoplastics/SERS



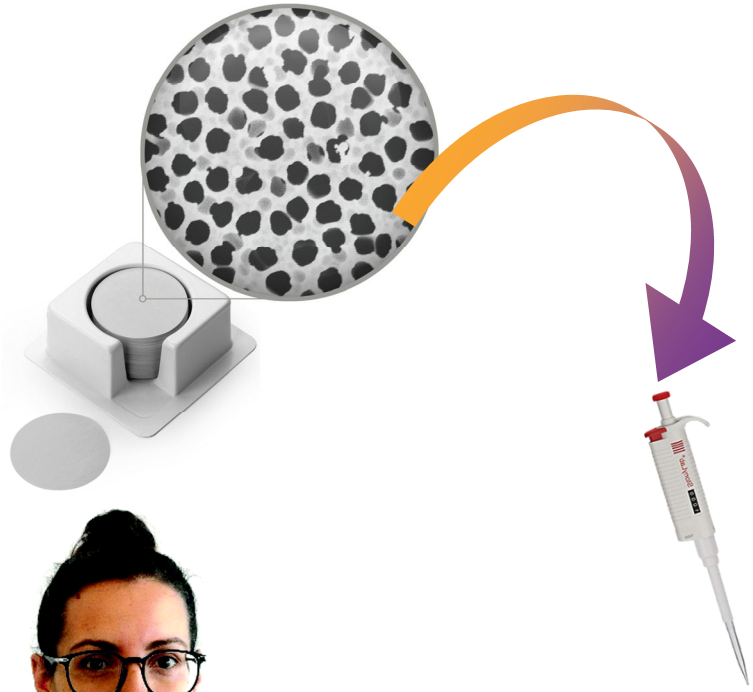
PS (Polystyrene)



PET (Polyethylene Terephthalate)



Detection of Nanoplastics/SERS



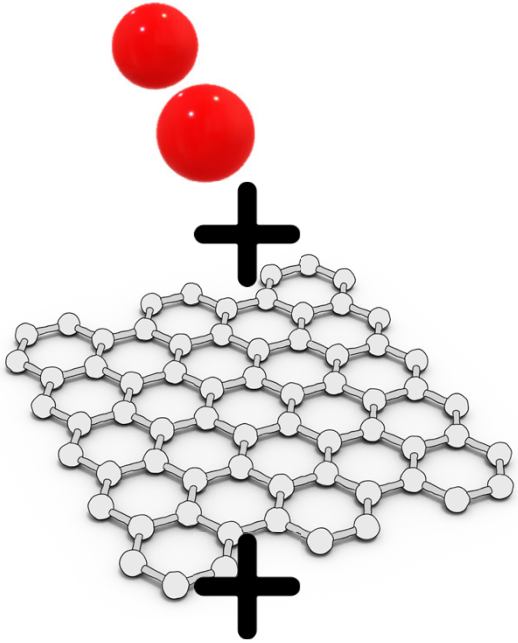
PS // PET

2 µl

FLG

0.1 mg/mL

2 µl



DROP CASTING

Patricia Taladriz-Blanco
Universidad de A Coruña

Detection of Nanoplastics/SERS

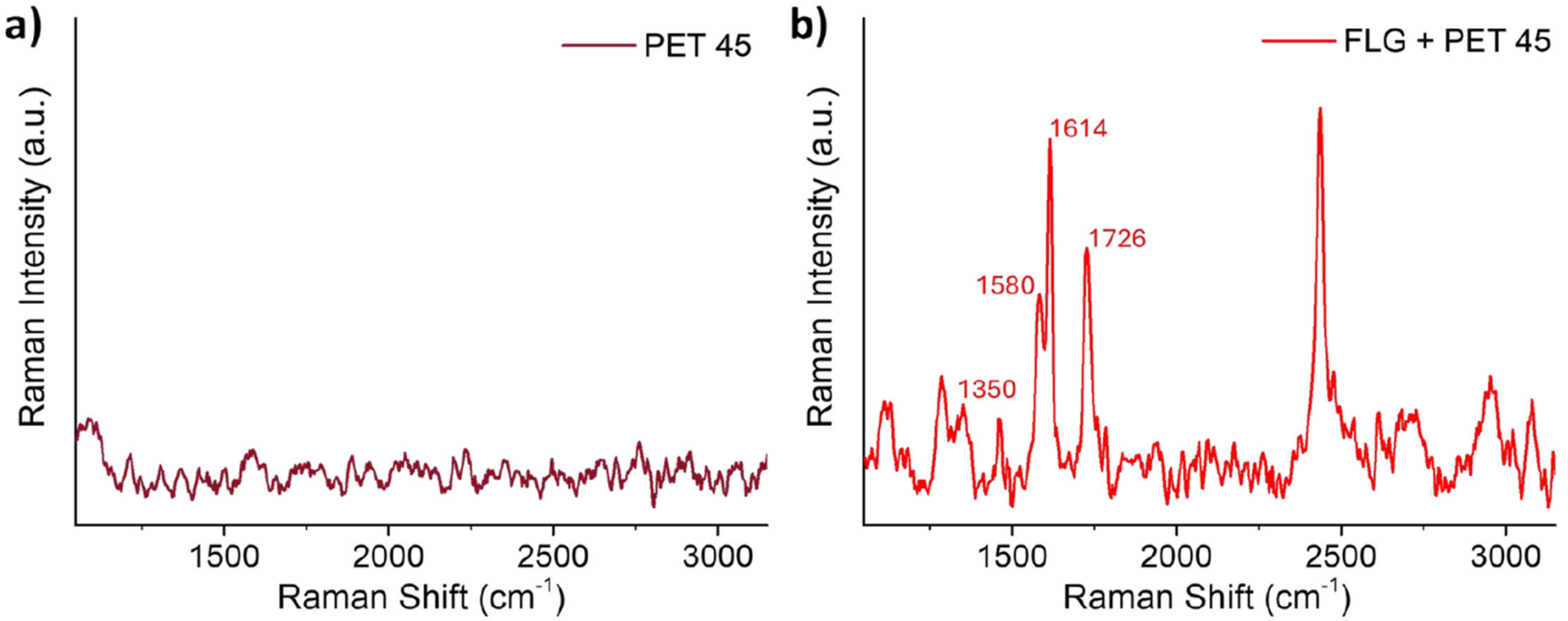


Figure 3.12. Raman spectra of PET 45 at 3.58 μg mL^{-1} acquired (a) without FLG (control) and (b) on FLG-based GERS substrate.

Detection of Nanoplastics/SERS

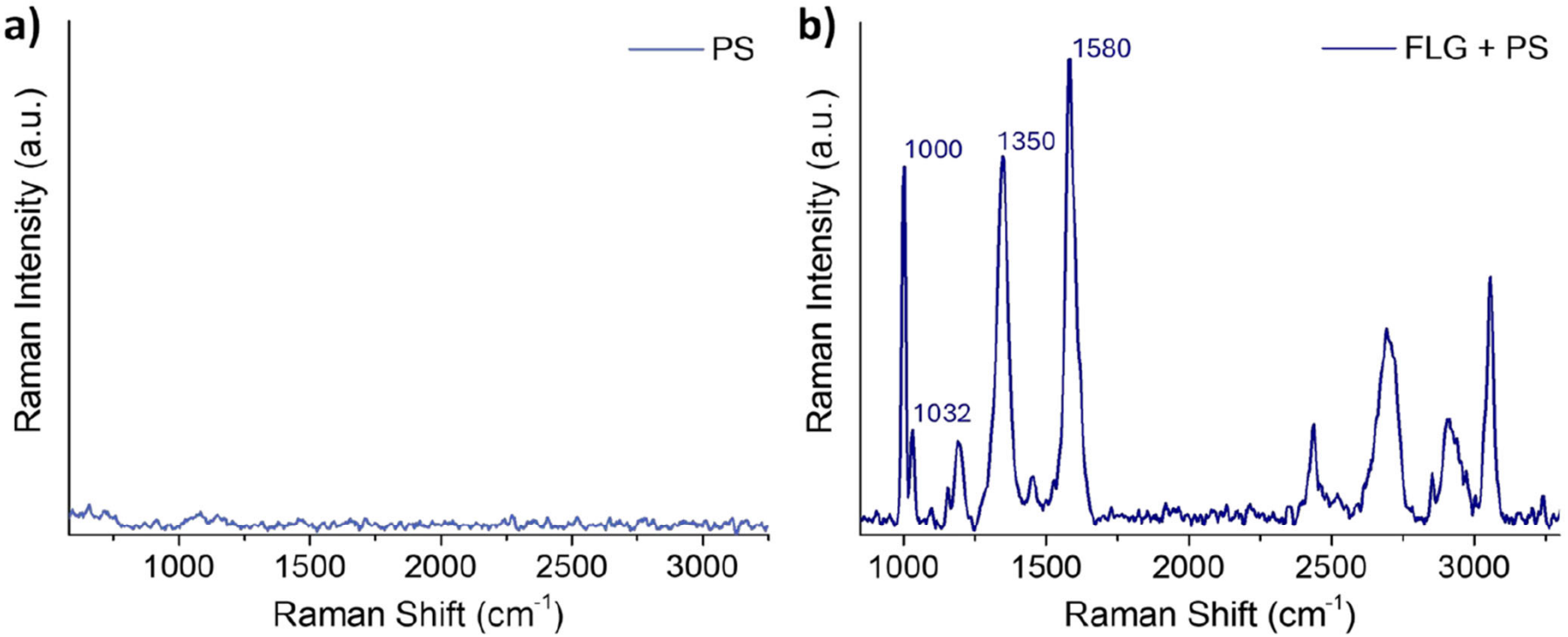
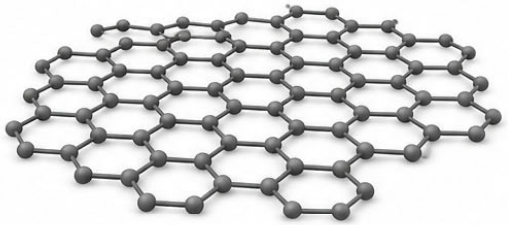
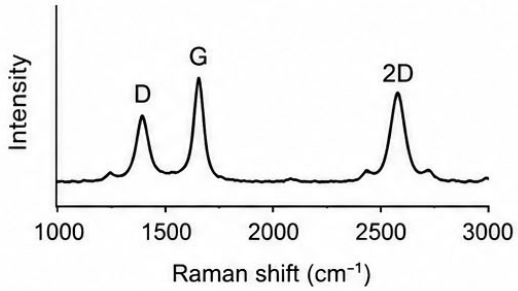


Figure 3.9. Raman spectra of PS at 53 μg mL^{-1} acquired (a) without FLG (control) and (b) on FLG-based GERS substrate.

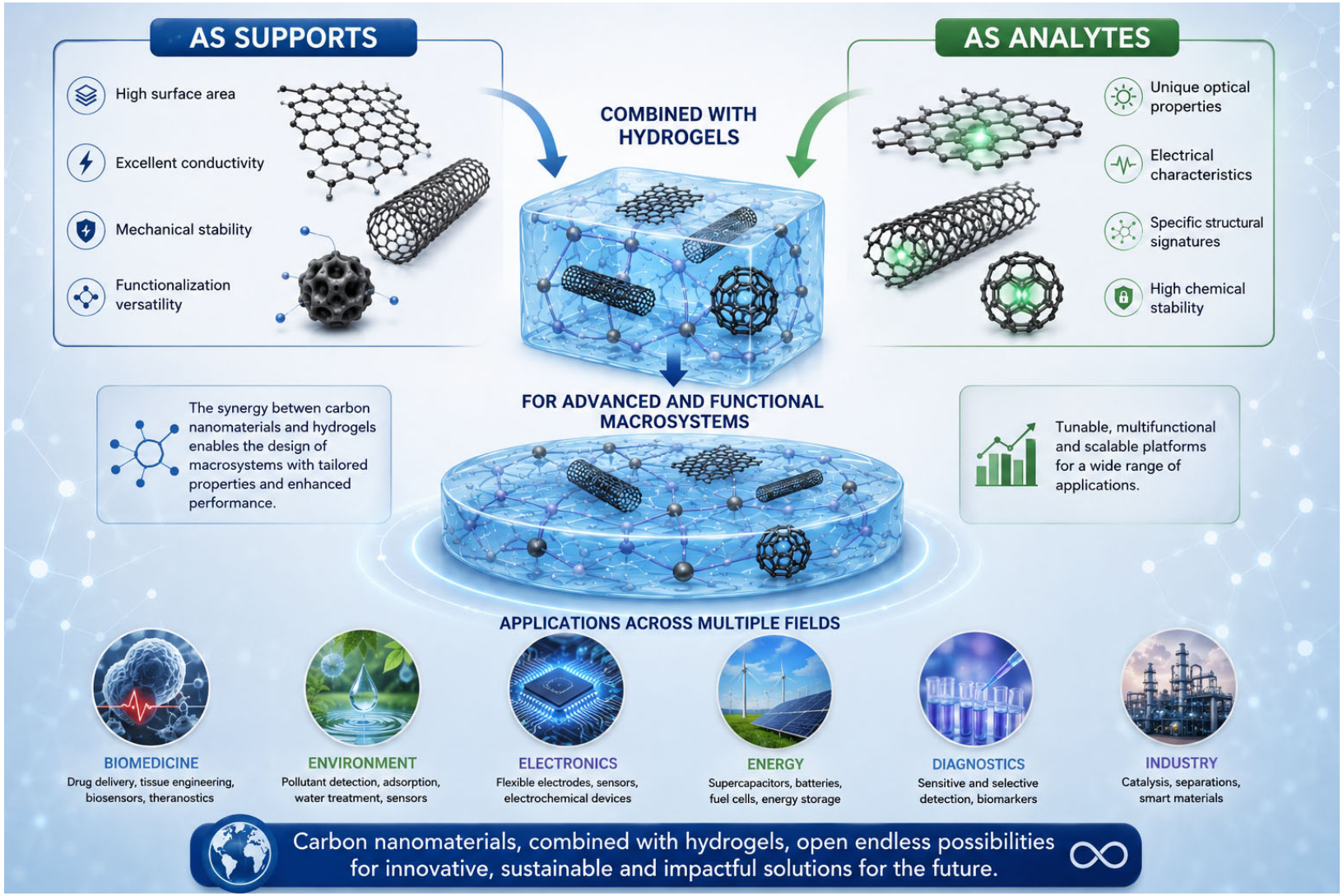
1. Graphene as analyte

Target of analysis





From analy
to analytical


AS SUPPORTS
High surface area
Excellent conductivity
Mechanical stability
Functionalization versatility
COMBINED WITH HYDROGELS
AS ANALYTES
Unique optical properties
Electrical characteristics
Specific structural signatures
High chemical stability
The synergy betwen carbon nanomaterials and hydrogels enables the design of macrosystems with tailored properties and enhanced performance.
FOR ADVANCED AND FUNCTIONAL MACROSYSTEMS
Tunable, multifunctional and scalable platforms for a wide range of applications.
APPLICATIONS ACROSS MULTIPLE FIELDS
BIOMEDICINE
Drug delivery, tissue engineering, biosensors, theranostics
ENVIRONMENT
Pollutant detection, adsorption, water treatment, sensors
ELECTRONICS
Flexible electrodes, sensors, electrochemical devices
ENERGY
Supercapacitors, batteries, fuel cells, energy storage
DIAGNOSTICS
Sensitive and selective detection, biomarkers
INDUSTRY
Catalysis, separations, smart materials
Carbon nanomaterials, combined with hydrogels, open endless possibilities for innovative, sustainable and impactful solutions for the future.

¡Gracias!

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