

Studies of curcuminoids on two/three-terminal devices and surfaces



2023

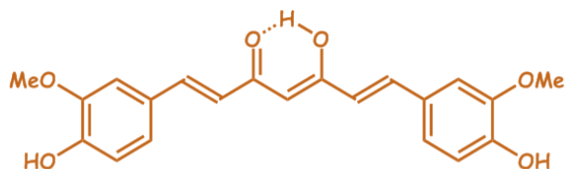
**FUN
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ICREA Professor Núria Aliaga-Alcalde
Insitute of Materials Science of Barcelona (ICMAB-CSIC)

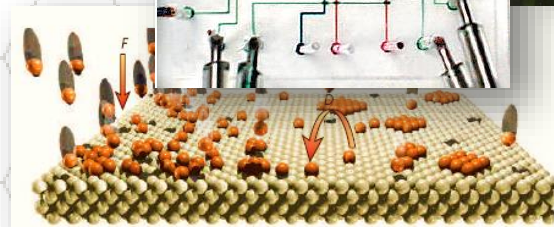
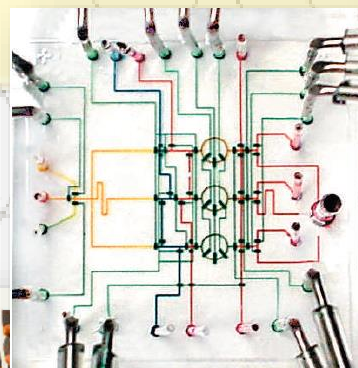
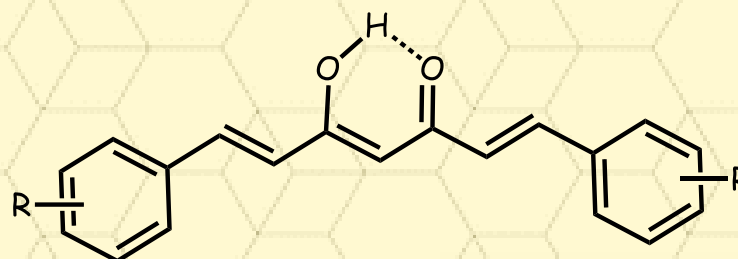
8th of May 2023

Curcuminoids (CCMoids)

CCM



Nanoscience/Nanotechnology



Symmetric CCMoids

Diarylheptanoid skeleton
β-diketone moiety
Aromatic rings
Additional groups

Synthetic procedure: Pabon's method

Single pot reaction
Straightforward purification
High yields

CCMoids Properties

Linear conjugated systems
Coordination units / heteroditopic linkers
Dyes
Fluorophore and solvatochromic molecules
Antiinflammatory and antioxidant agents

H. J. J. Pabon, *Recueil des Travaux Chimiques des Pays-Bas*, 1964, 83, 379

Our CCMoids

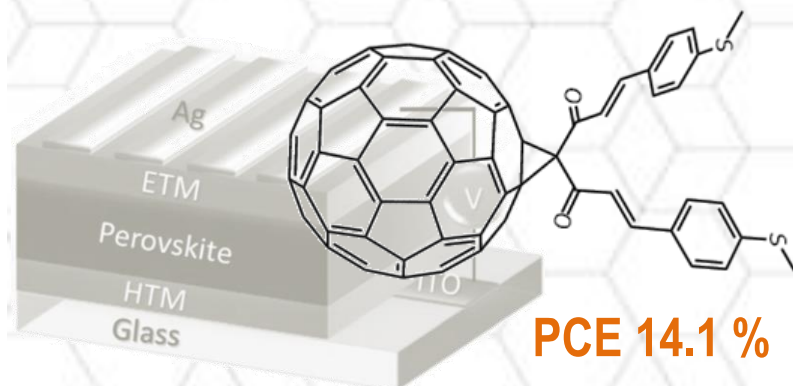
Organic solar cells

MOFs

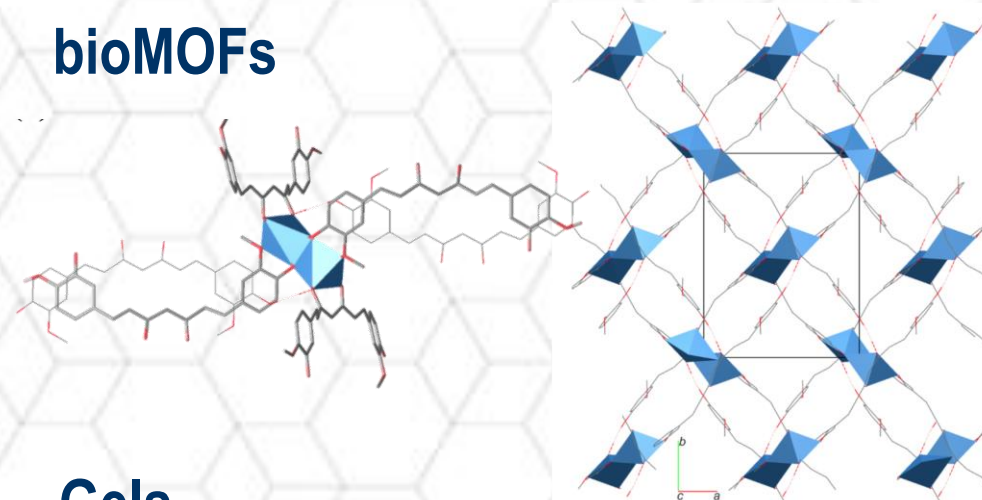
Single-molecule magnets (SMMs)

Gels

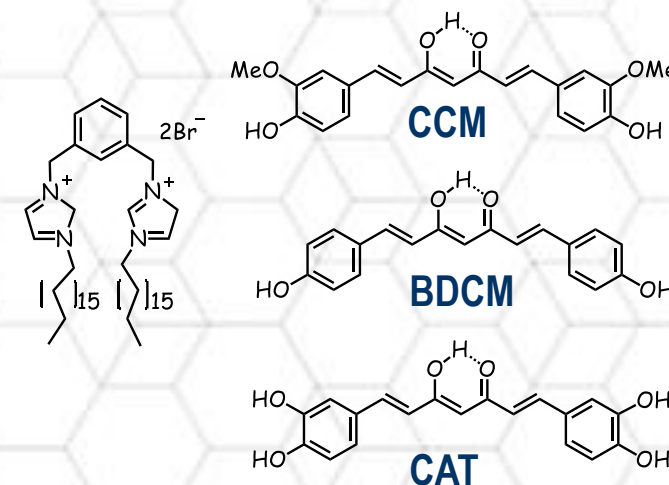
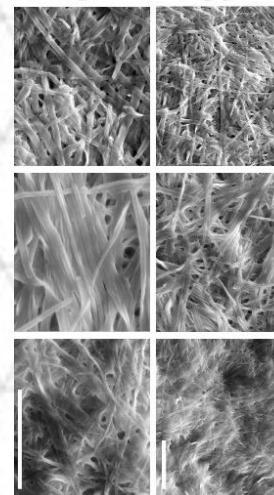
Perovskite Solar Cells



bioMOFs

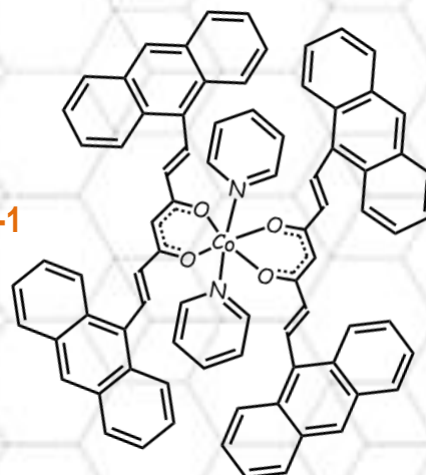


Gels



SMMs

D = -74 cm⁻¹



Collaborators:

Prof. Luis Echegoyen

Prof. Eliseo Ruiz

Dr. Concepción Domingo

Dr. José P. Giner

Dr. Maria Lluïsa Perez-Garcia

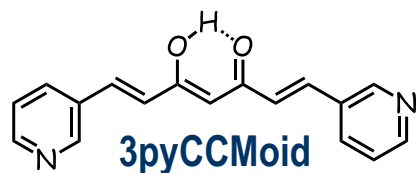
E. Castro *et al.* *RSC Advance* **2018**, 8, 41692; N. Portoles-Gil *et al.* *ACS Sustainable Chemistry & Engineering*, **2018**, 6, 12309

L. Rodríguez-Cid *et al.* **2020**, *Crystal Growth & Design*, 20, 6555; R. Díaz-Torres *et al.* *Chemical Science*, **2016**, 7, 2793

D. Limón *et al.* *ACS Applied Nano Materials* **2022**, an-2022-01482m.R1

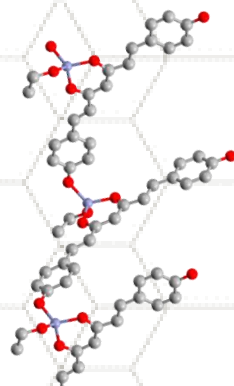
Our CCMoids

Coordination Polymers (CPs)

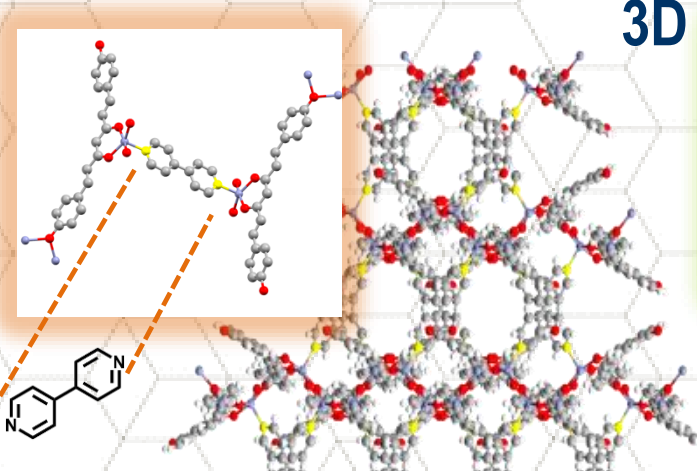


CCMoids as linkers

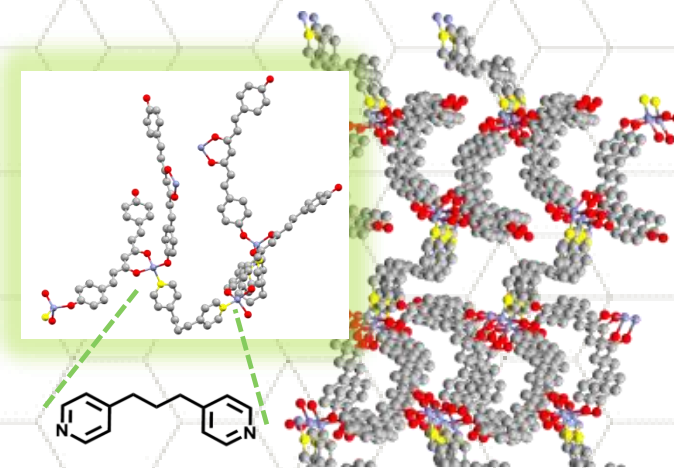
1D



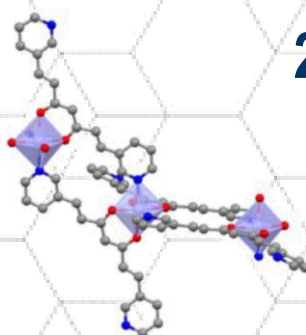
3D



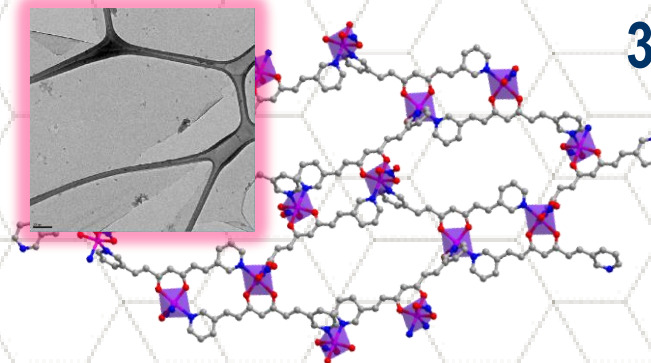
3D



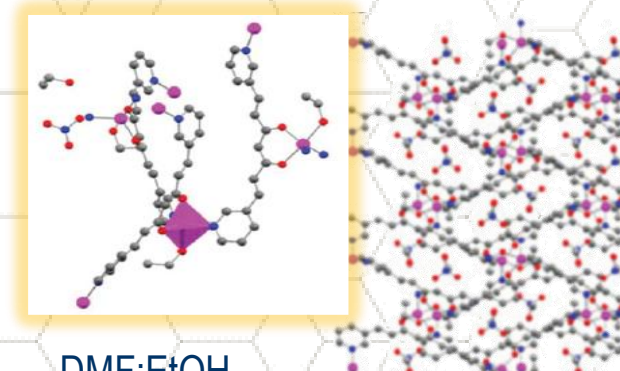
1D



2D



3D



DMF:MeOH
Solvothermal (80 °, 72 h)

DMA:EtOH
Solvothermal (80 °, 72 h)

DMF:EtOH
Layering (RT, 2 weeks)

L. Rodríguez *et al.* *Crystal Growth and Design*, **2020**, 20, 6555; L. Rodríguez *et al.* *Dalton Transactions*, **2021**, 50, 7056.

Collaborators:

Dr. Concepción Domingo

Dr. J. G. Planas

Dr. Mònica Soler

Dr. E. Carolina Sañudo

Dr. D. Choquesillo-Lazarte

FunNanoSurf:

Dr. Laura Rodríguez-Cid

Joseline Iribarra-Araya

CCMoids on substrates

- 1- CCMoids immobilized on glass - sensors**
- 2- Microelectronics**
 - Molecular deposition on three-terminal devices
- 3- Single electron transport**
 - Break-junction (graphene-based nanojunctions)

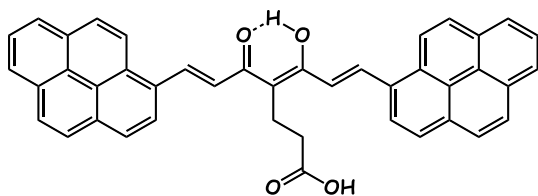
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CCMoids on glass

Micro-contact printing (μ CP)
PDMS stamp
Functionalized Surface

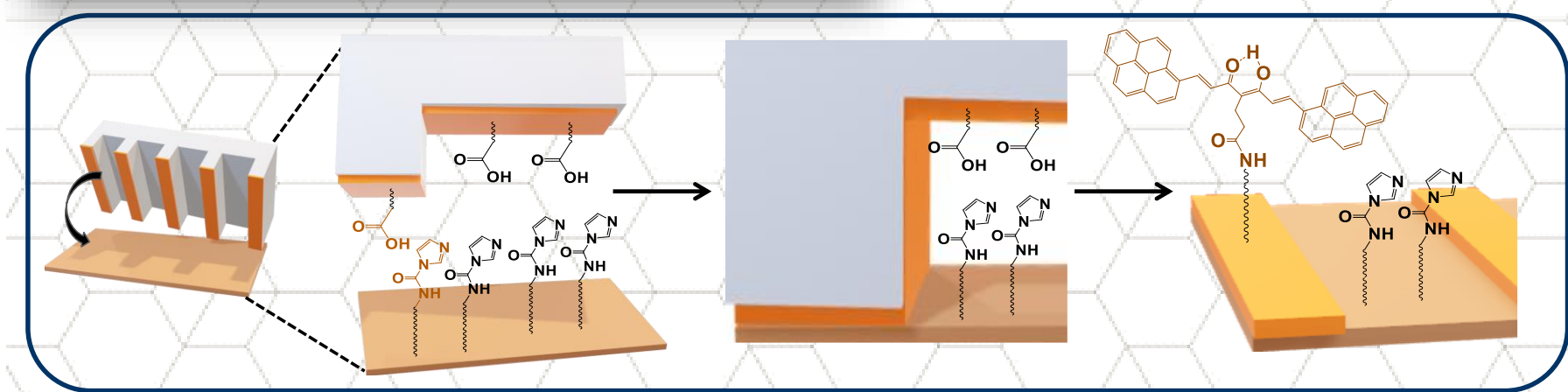
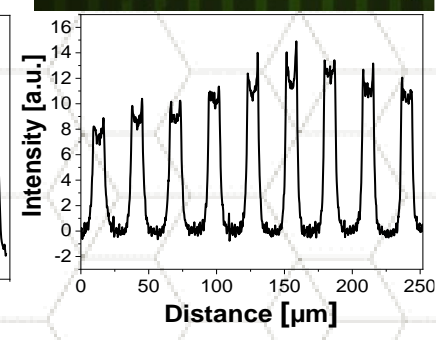
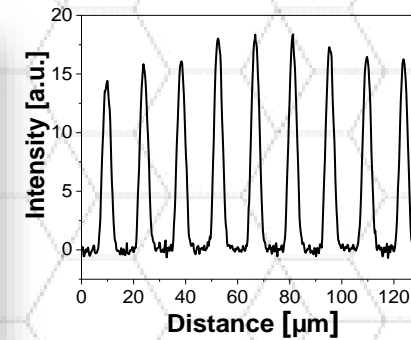
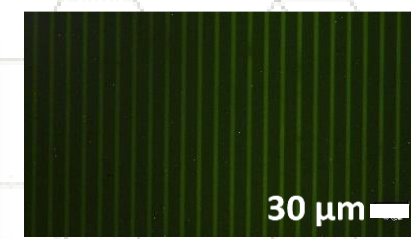
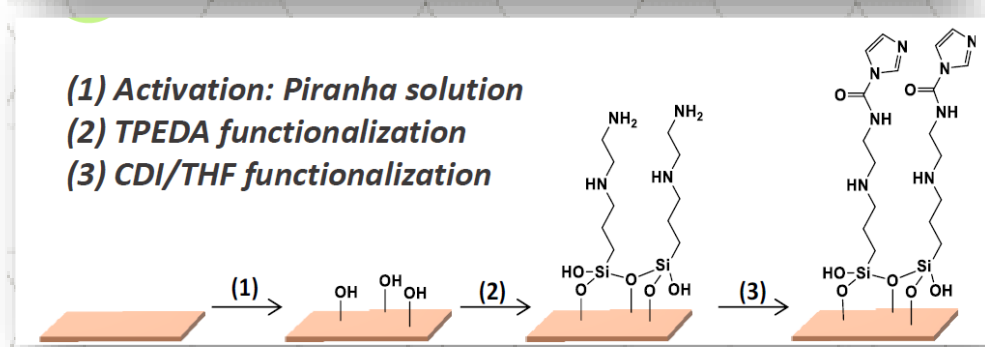
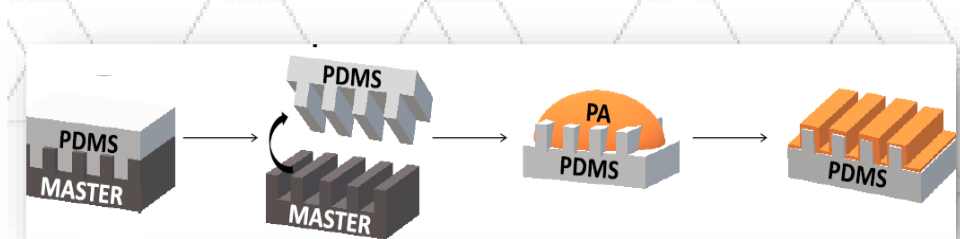
CCMoid molecule



PA-CCMoid

Lines of 10 and 5 μ m
Fluorescence microscopy
Green emission

FunNanoSurf:
Dr. Arántzazu González-Campo
Raquel Gimeno-Muñoz



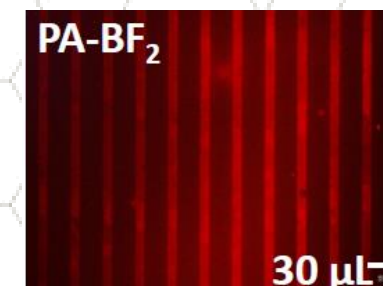
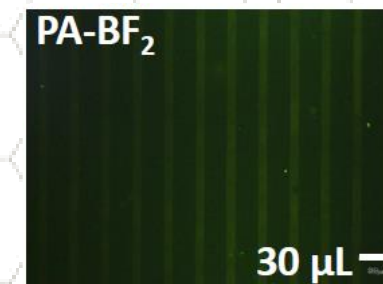
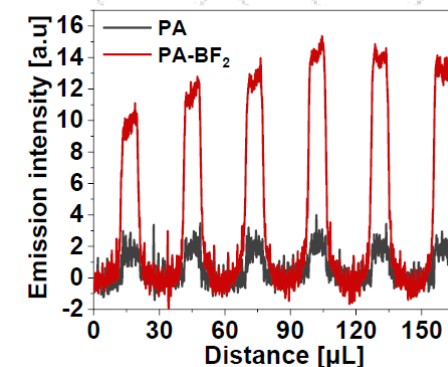
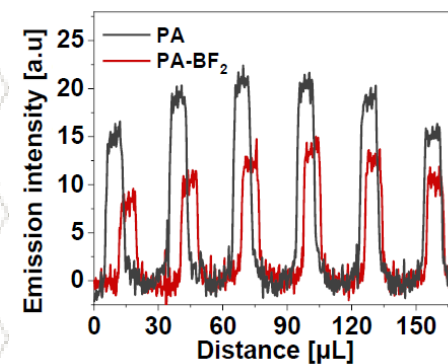
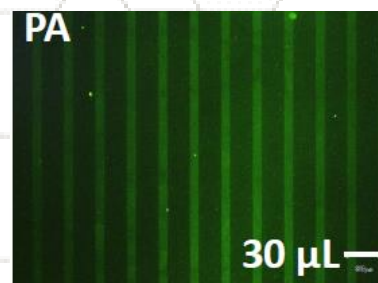
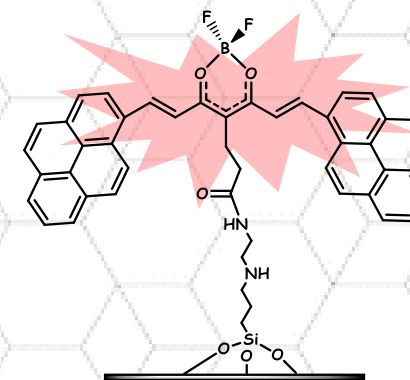
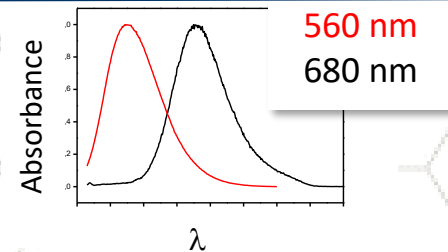
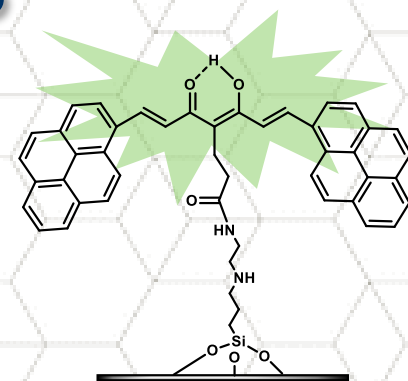
Manuscript under preparation

CCMoids on glass

Sensors

Coordination with $-\text{BF}_2$
red emission

PA-CCMoid



Manuscript under preparation

FunNanoSurf:
Dr. Arántzazu González-Campo
Raquel Gimeno-Muñoz

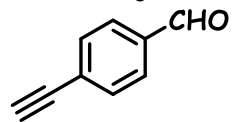
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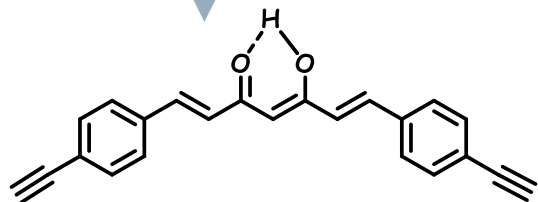
AlkCCMoid (1)



- 1) B_2O_3 , AcOEt
- 2) $B(BuO)_3$, AcOEt



- 3) n-BuNH₂
- 4) Aqueous HCl sol.



HOMO-LUMO gap = 2.4 eV
Sublimation at 160 °C /(1 mbar)

1-MP (MeCN)

1-SC
(EtOAc/Hexanes)

Supramolecular packing

SiO₂

Graphene

1-SUB

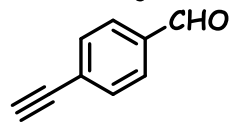
Au **ES202230143**

Daniel Riba-López *et al.* iScience, 2022, 105686

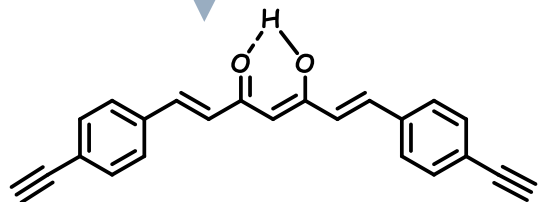
AlkCCMoid (1)



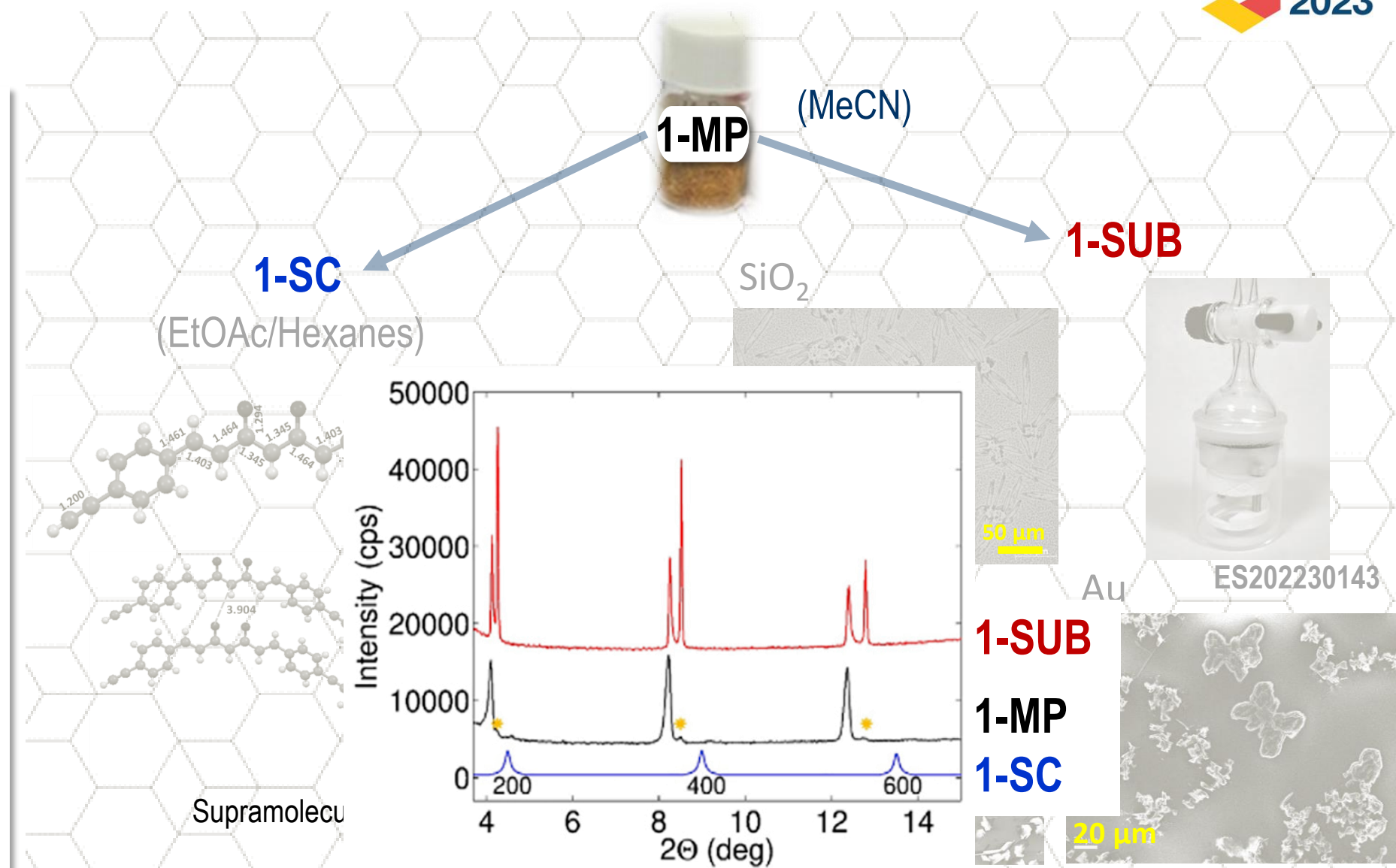
- 1) B₂O₃, AcOEt
- 2) B(BuO)₃, AcOEt



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- 4) Aqueous HCl sol.

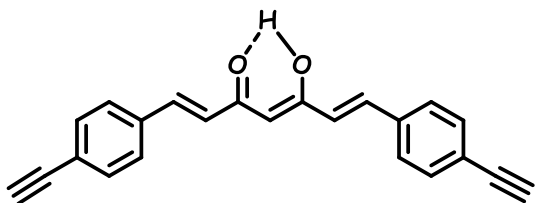


HOMO-LUMO gap = 2.4 eV
Sublimation at 160 °C /(1 mbar)

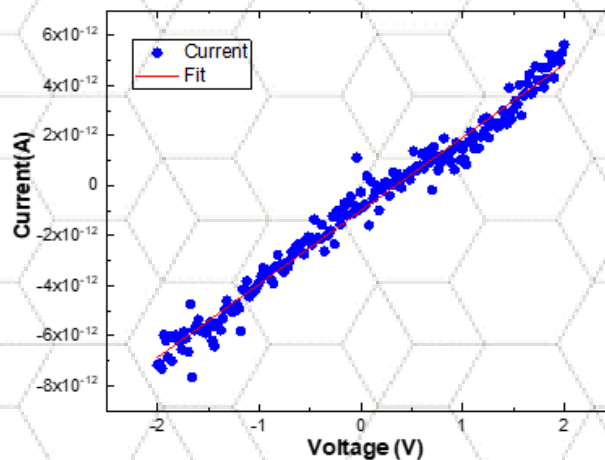
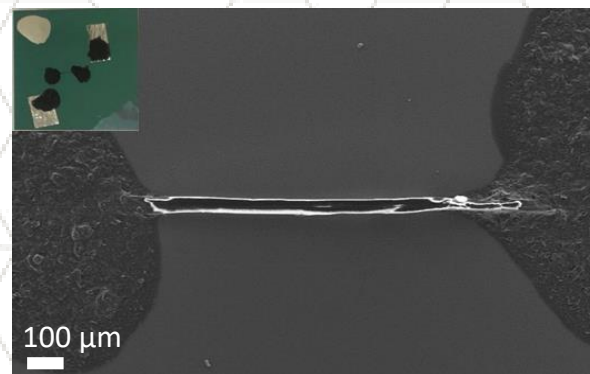


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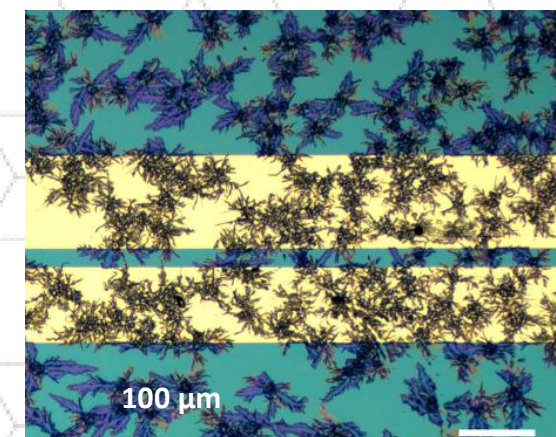
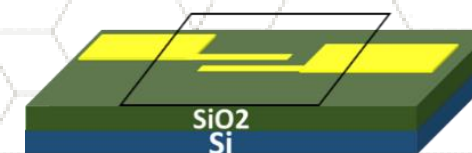
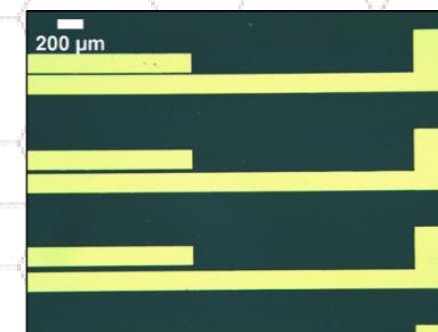


1-MP



$$\sigma > 8.5 \times 10^{-10} \text{ S}\cdot\text{cm} \quad (\text{vacuum})$$

1-SUB



$$\sigma > 2.7 \times 10^{-7} \text{ S}\cdot\text{cm} \quad (\text{Ambient conditions})$$

Collaborators:

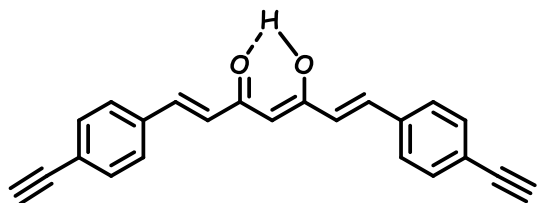
Prof. Eliseo Ruiz
Dr. Raphael Pfattner
Dr. Esther Barrera
Dr. Roc Matheu
Dr. E. Carolina Sañudo

FunNanoSurf:

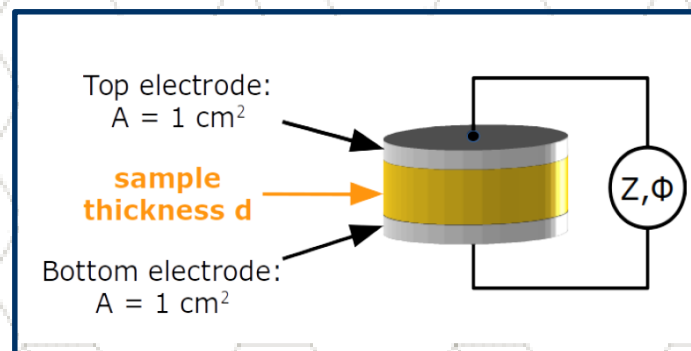
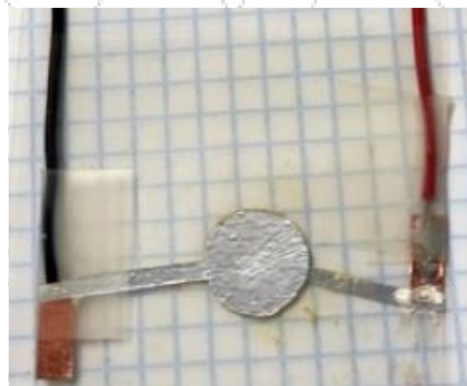
Dr. Daniel Herrera
Dr. Rossella Zaffino
Dr. Daniel Riba-López

Daniel Riba-López *et al.* iScience, 2022, 105686

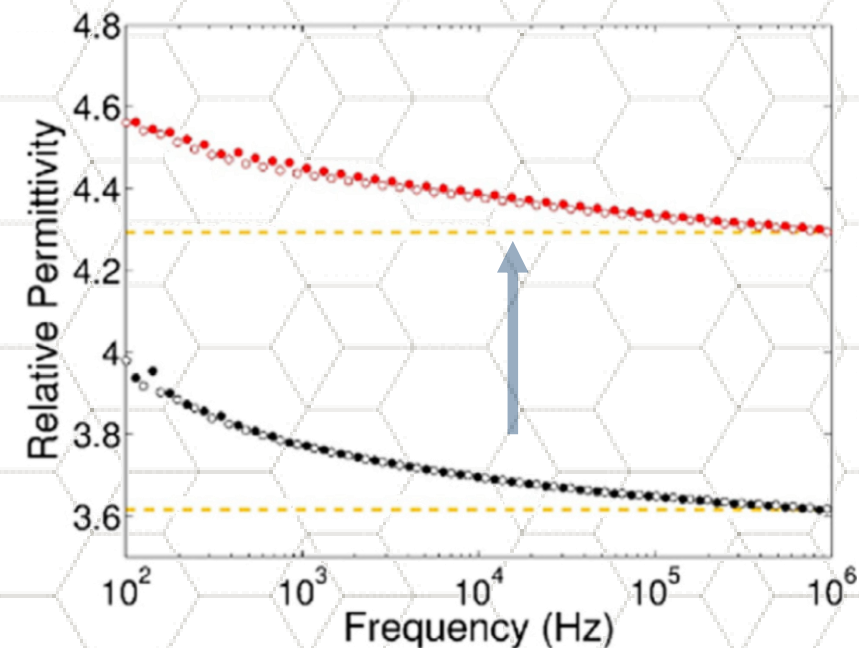
AlkCCMoid (1)



1-MP



$$\epsilon_r = \frac{1}{\epsilon_0} \frac{C d}{A}$$



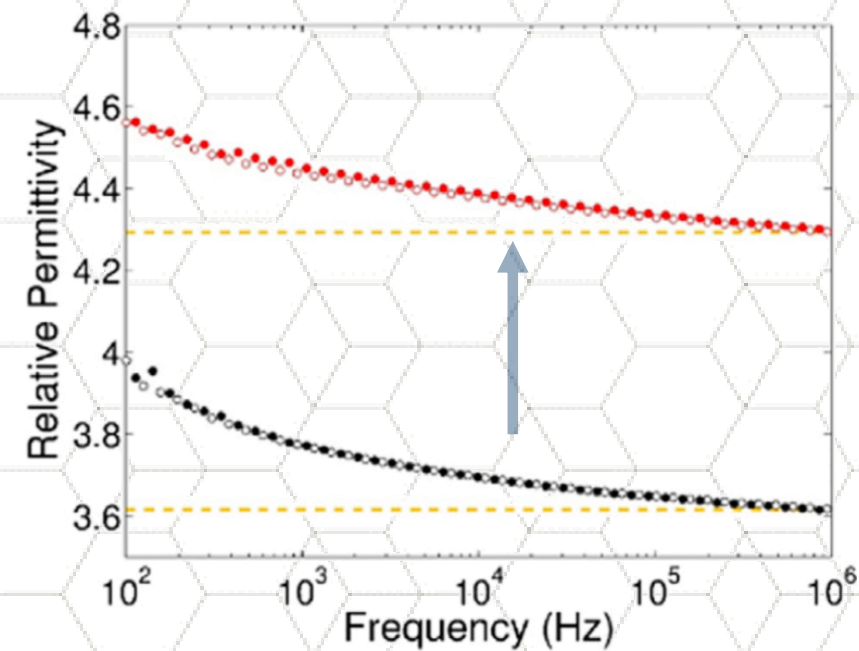
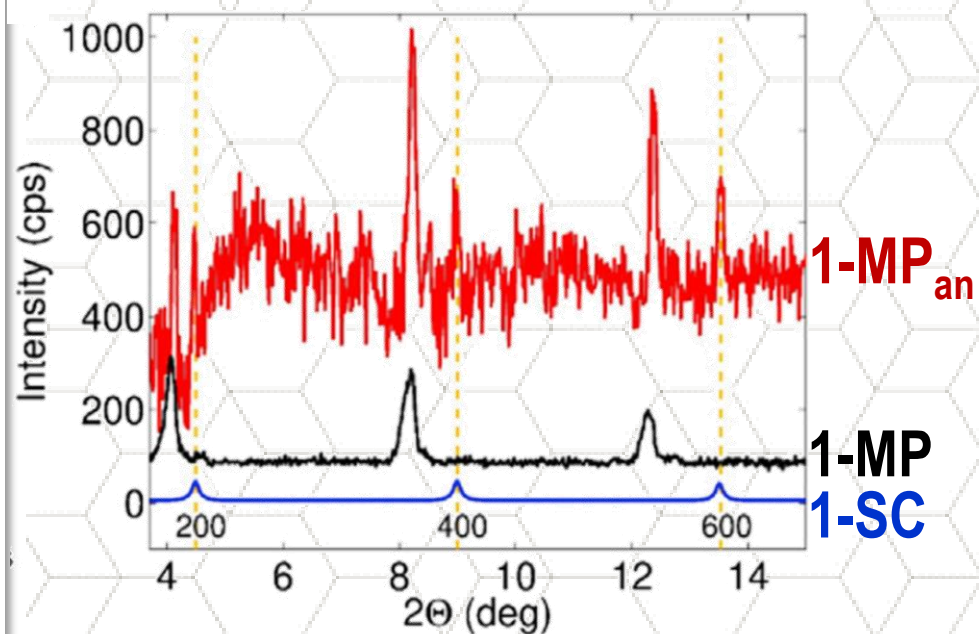
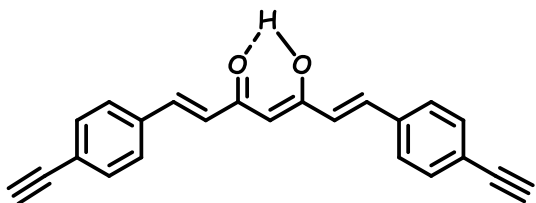
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FunNanoSurf:

Dr. Daniel Herrera
Dr. Rossella Zaffino
Dr. Daniel Riba-López

AlkCCMoid (1)



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Dr. Daniel Herrera
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Dr. Daniel Riba-López

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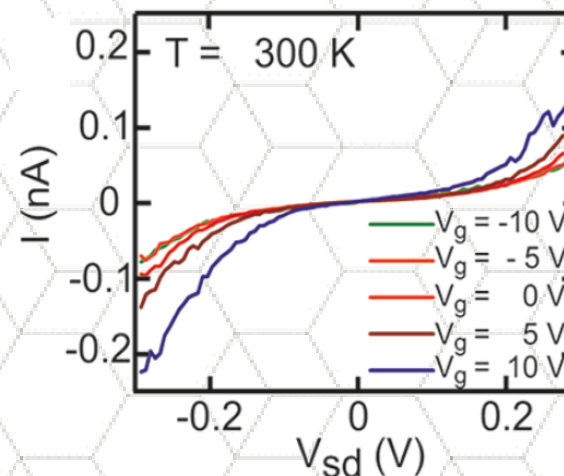
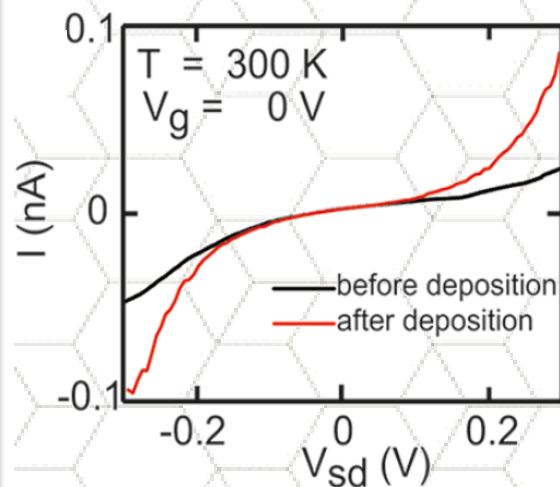
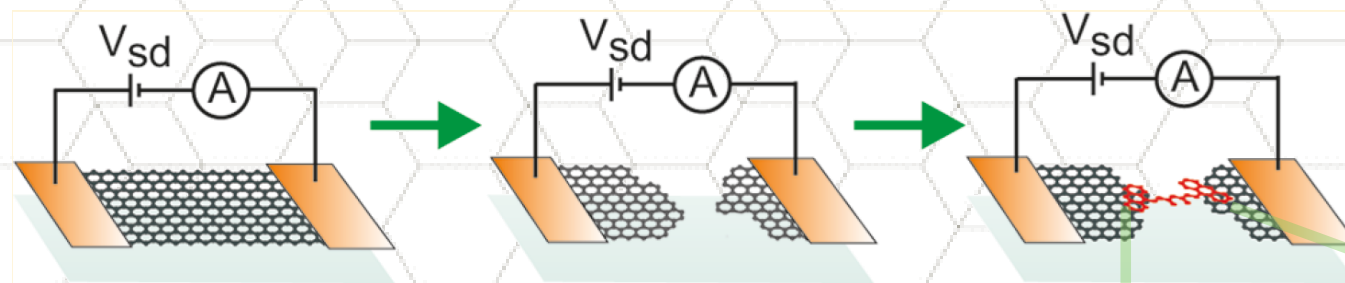
Hybrid graphene-based devices - CCMoids

Few-layers graphene (FLG) nanogap formed by **feedback controlled electroburning**

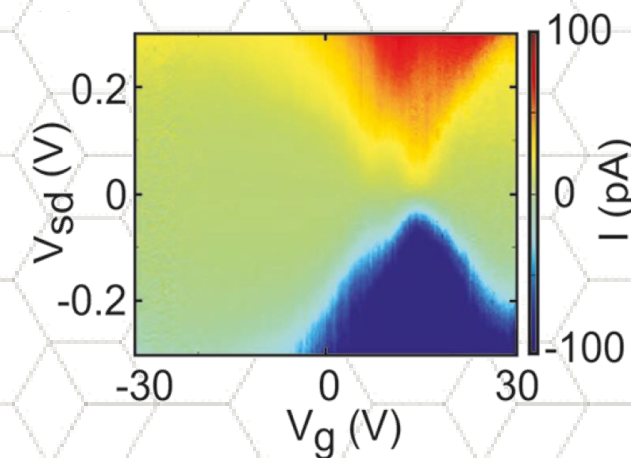
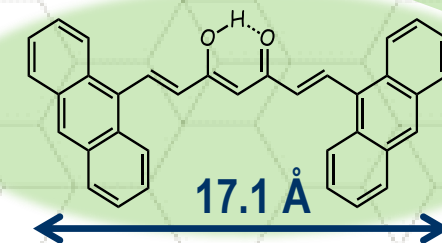
ligand: 9Accm
length: 17.1 Å

Room Temperature experiments

Collaborators:
Prof. J. S. Herre van der Zant
Dr. Ferry Prins



9Accm



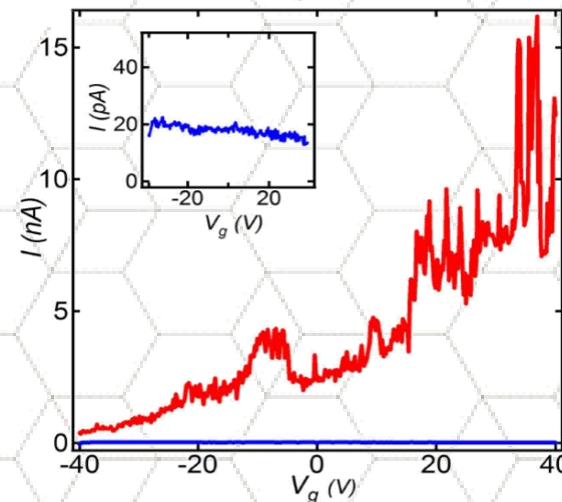
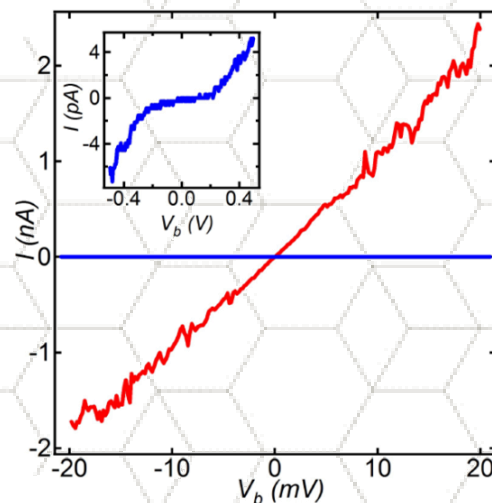
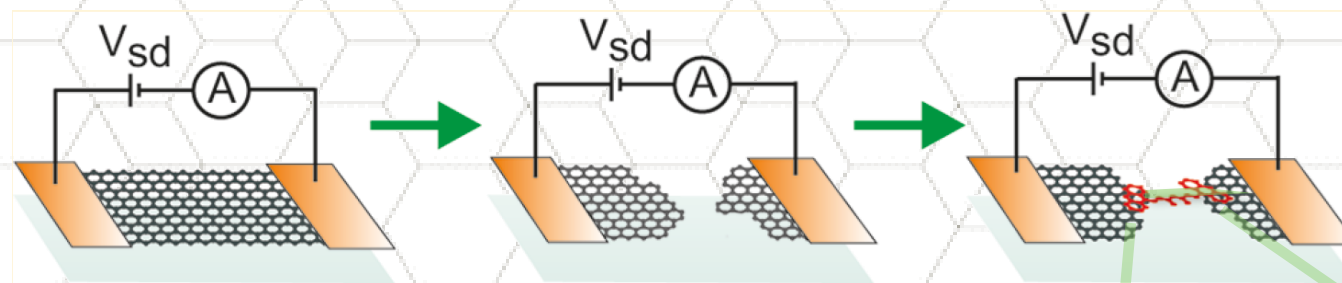
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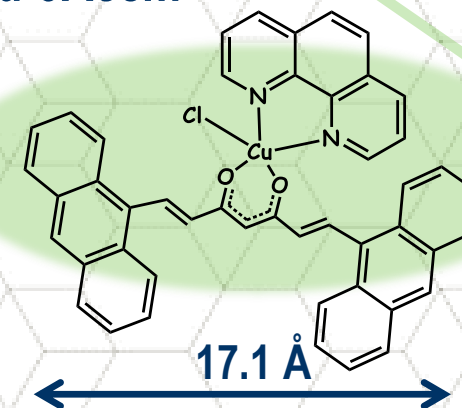
ligand: 9Accm
length: 17.1 Å

Low Temperature
experiments

Collaborators:
Prof. J. S. Herre van der Zant
Dr. Enrique Burzurí



Cu-9Accm



Hybrid graphene-based devices - CCMoids

Few-layers graphene (FLG)
nanogap formed by **feedback
controlled electroburning**

ligand: 9ALCccmoid
length: 21.5 Å

Collaborators:

Prof. J. S. Herre van der Zant

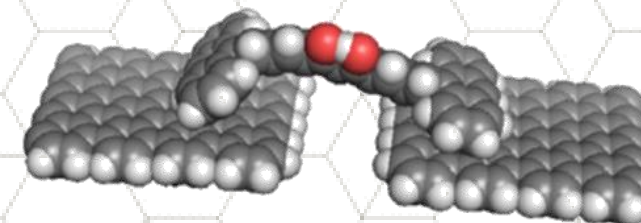
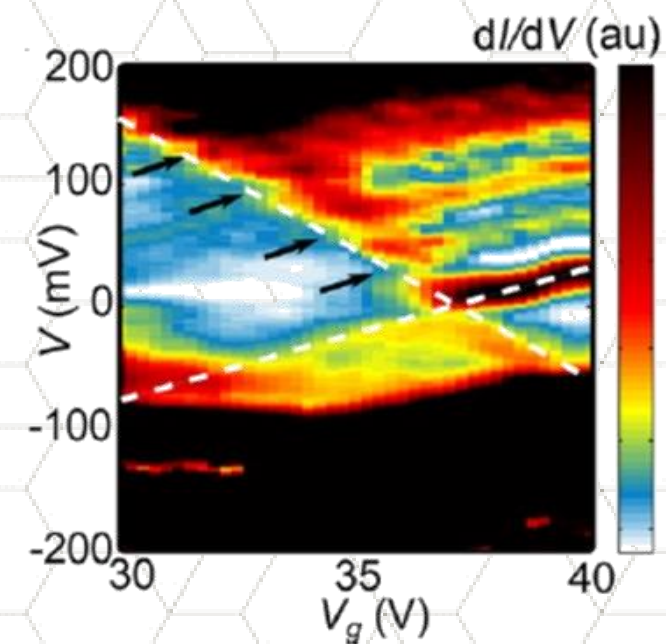
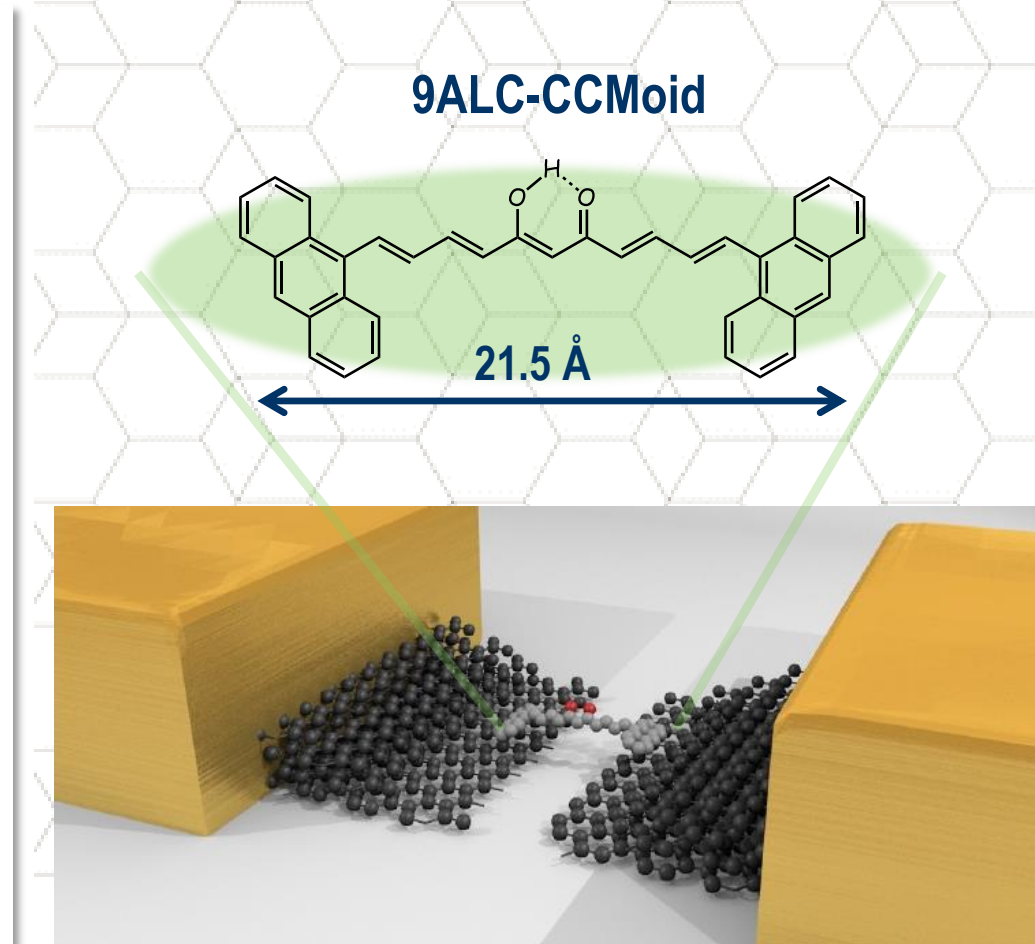
Prof. Eliseo Ruiz

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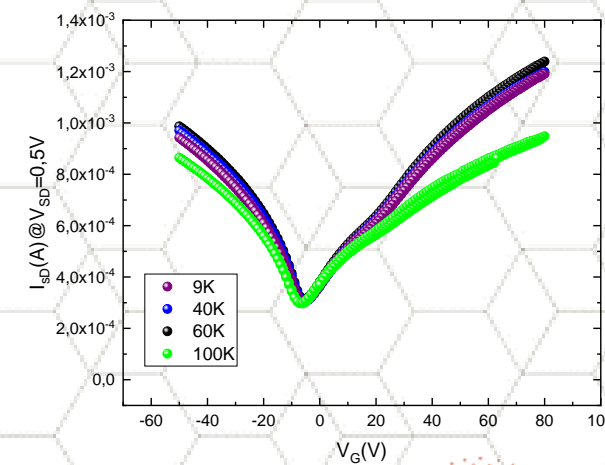
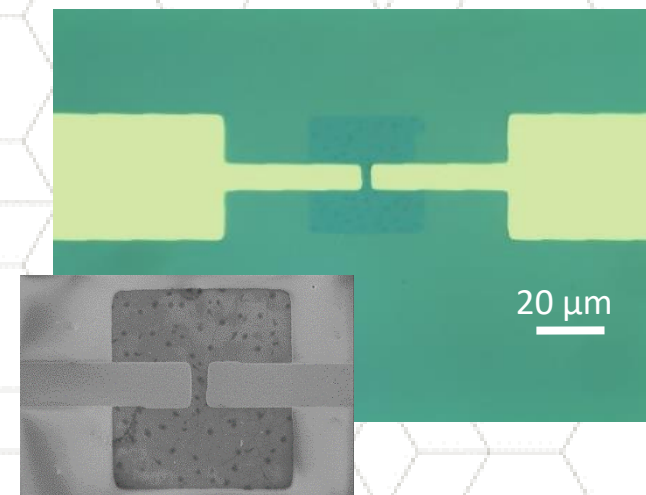
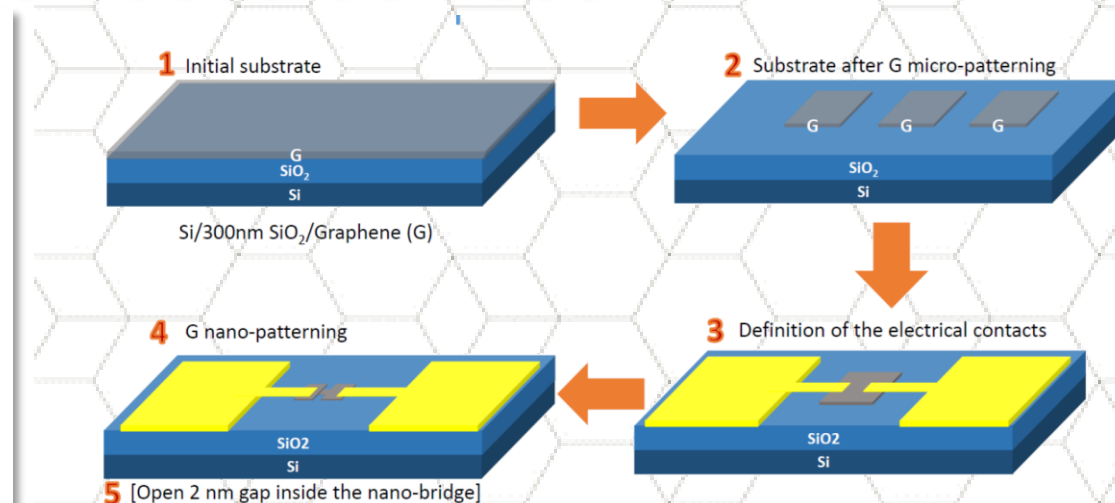
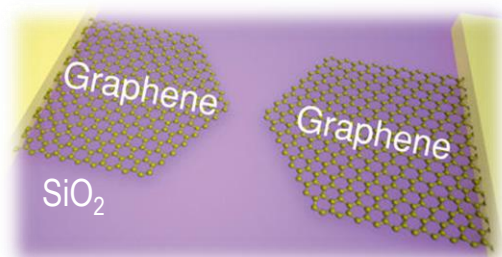
Dr. Raúl Díaz-Torres

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Hybrid graphene-based devices

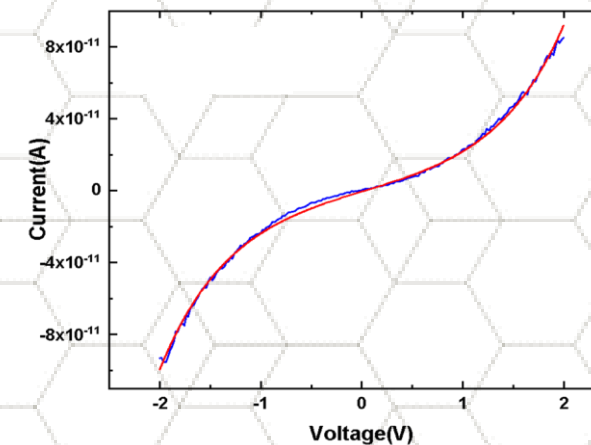
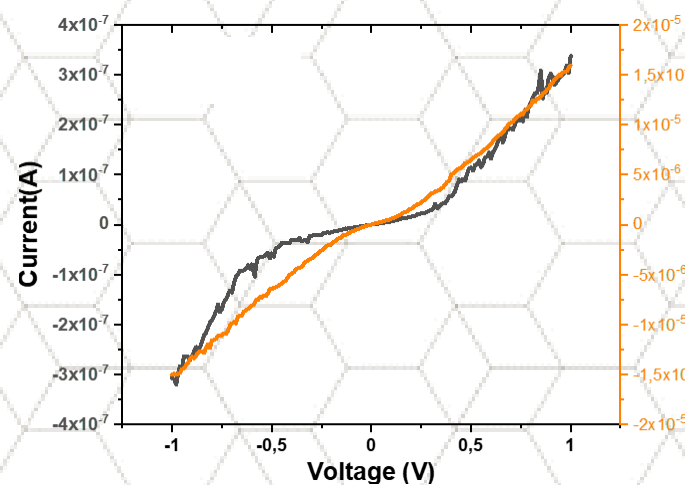
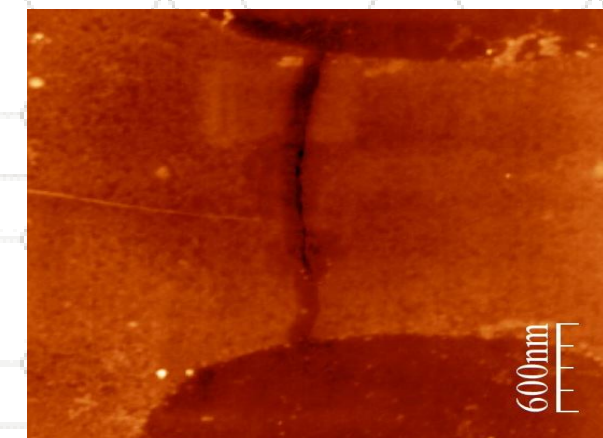
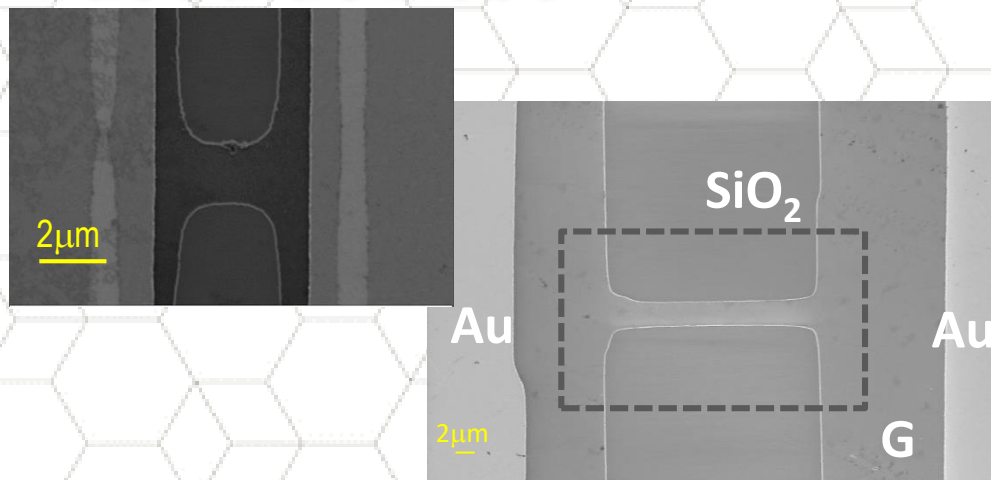
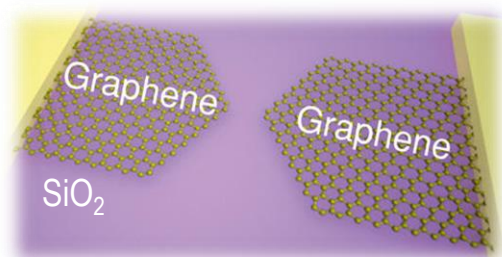
Single-layer graphene (SLG) nanogap formed by feedback controlled electroburning



Collaborators:
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FunNanoSurf
Dr. Rossella Zaffino

Hybrid graphene-based devices

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Work not published

Collaborators:

Prof. J. S. Herre van der Zant

Prof. Eliseo Ruiz

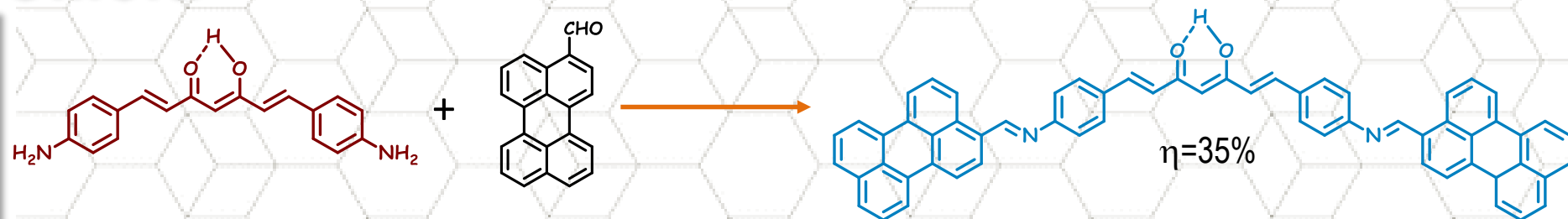
Dr. Raphael Pfattner

FunNanoSurf

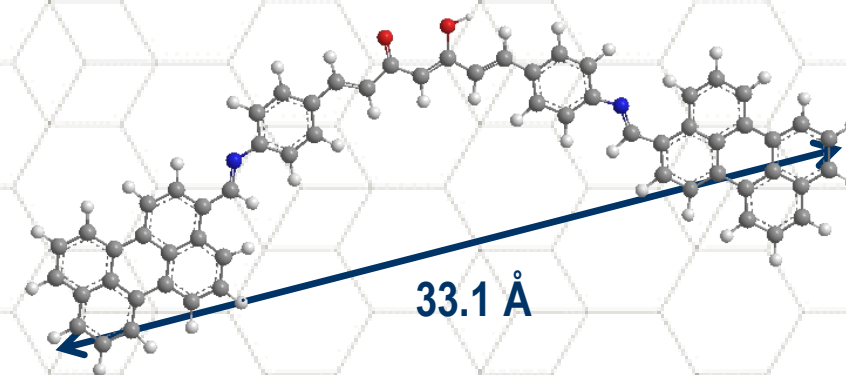
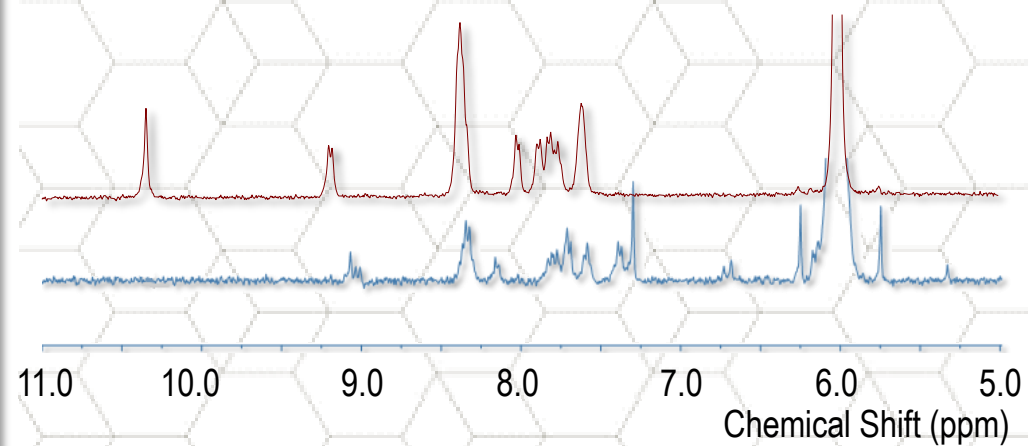
Dr. Rossella Zaffino

Pyrene-amide CCMoid

Synthesis of new PAHs using a CCMoid that can be extended taking advantage of the terminal groups



^1H NMR of 6 and 7 (360 MHz, Tetrachloroethane- d_2) *



Optimized structure

Collaborators:

Prof. Eliseo Ruiz

FunNanoSurf

Teresa Cardona-Lamarca

Dr. Daniel Herrera

Dr. Rossella Zaffino

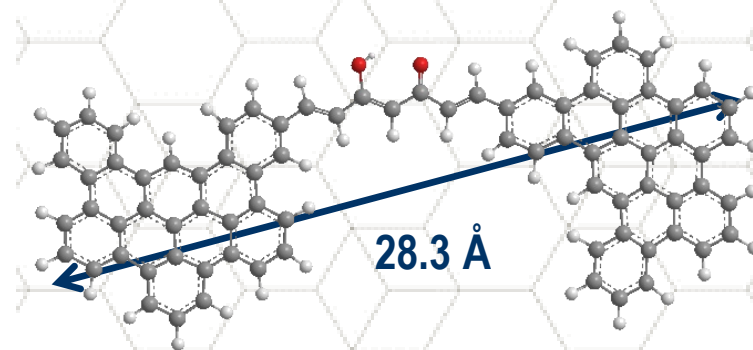
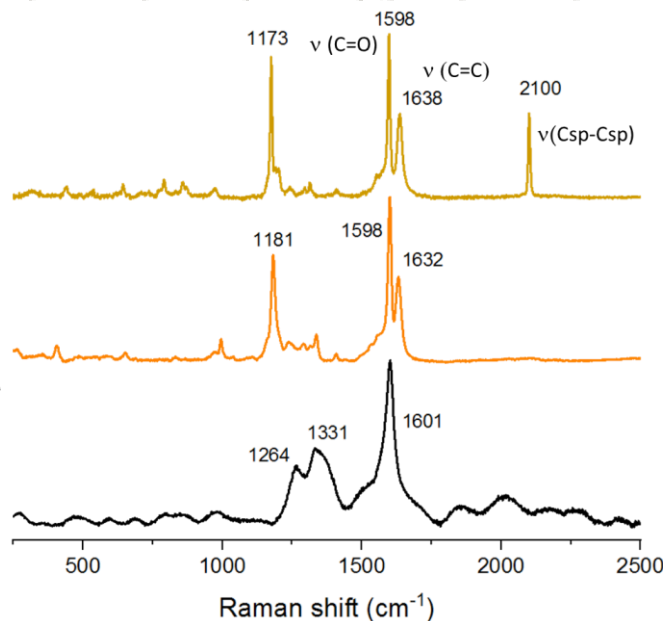
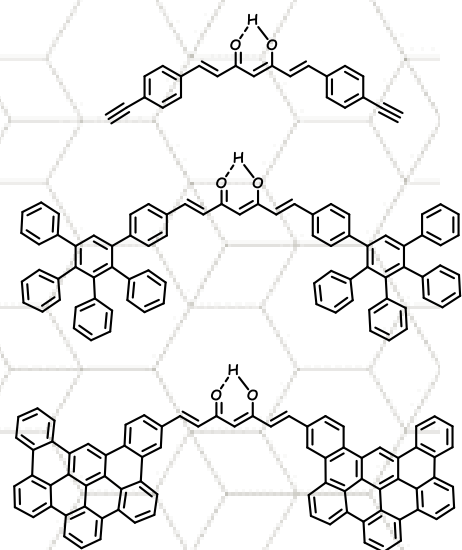
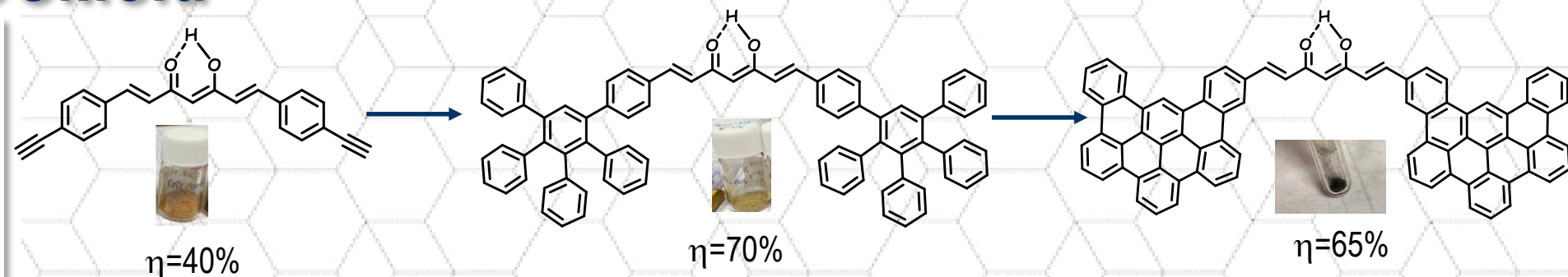
FUN
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Work not published

Graphene-like CCMoid

Additional reactions taking advantage on the terminal groups of the CCMoid molecules

Creation of large PAHs containing CCMoid skeleton and nanographene sides



Optimized structure

Collaborators:

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Prof. Eliseo Ruiz

FunNanoSurf

Dr. Daniel Herrera

Dr. Rossella Zaffino

Dr. Daniel Riba-López

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THANK YOU FOR YOUR KIND ATTENTION