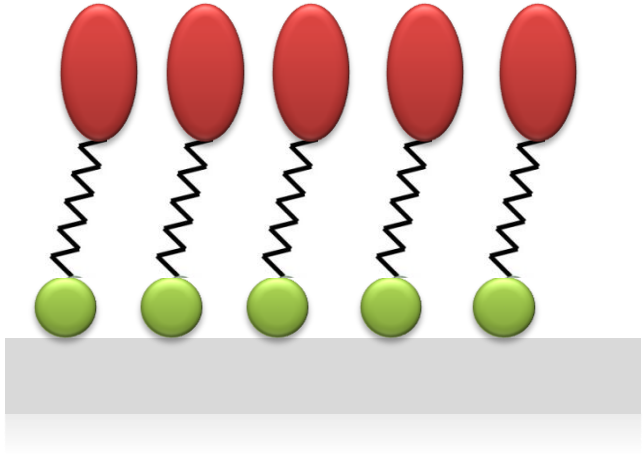
Functional self-assembled molecular monolayers for electrochemical devices

Marta Mas-Torrent



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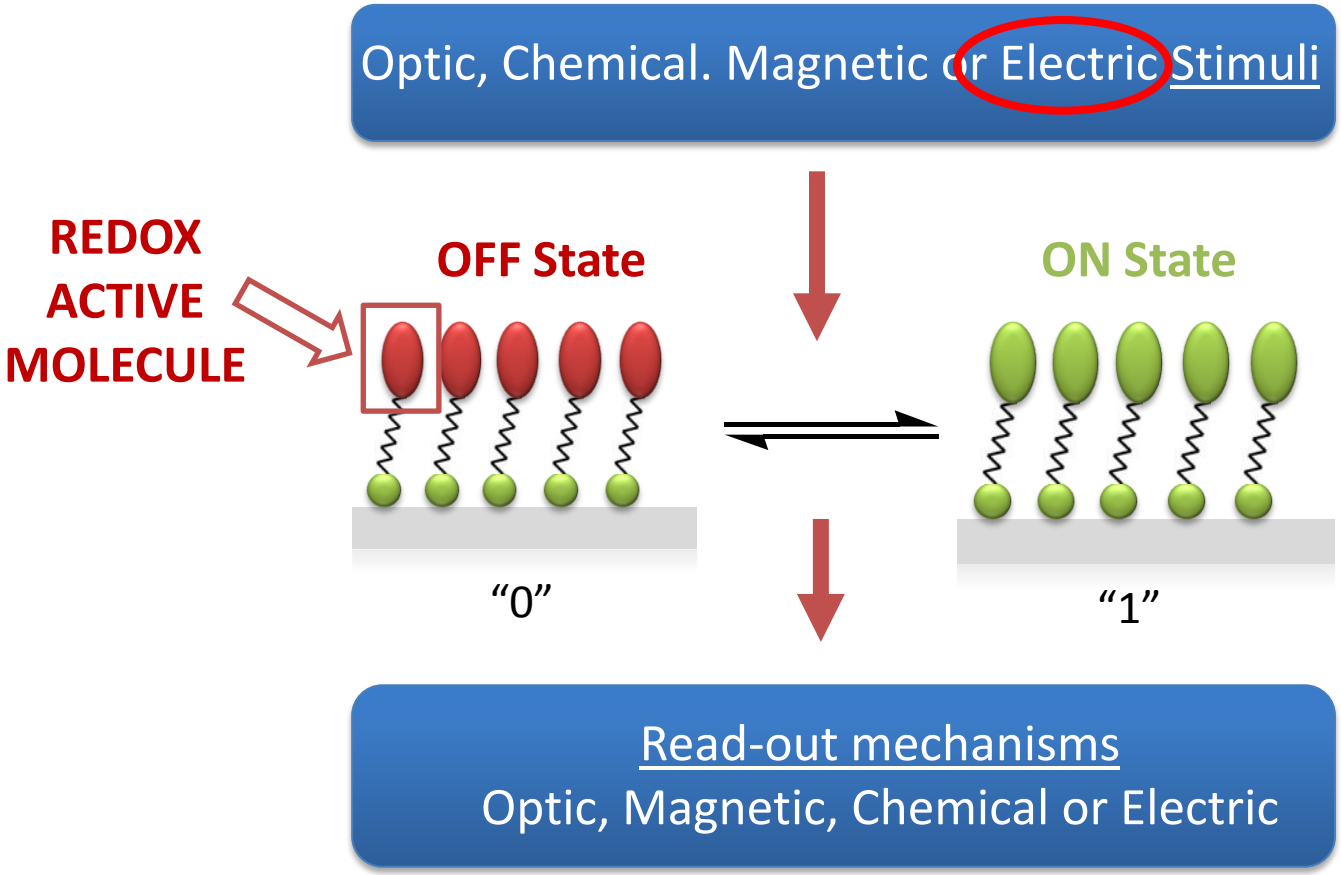
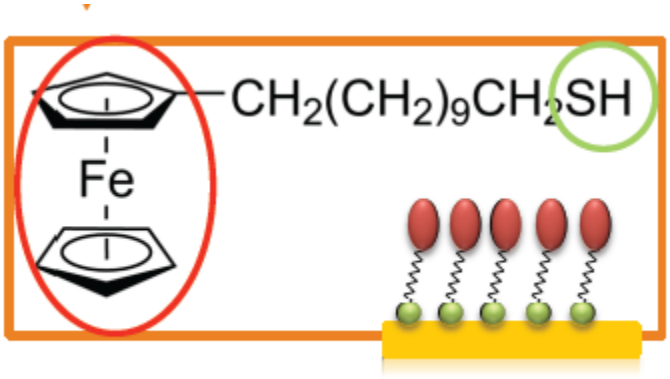
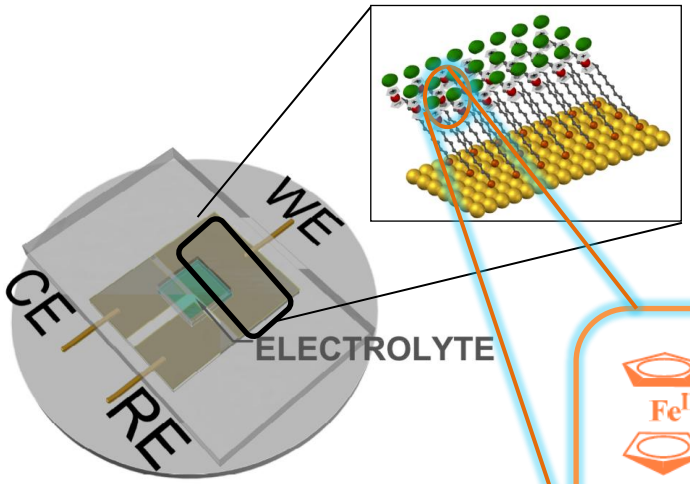
Bistable self-assembled monolayers (SAMs) for molecular switches/memories

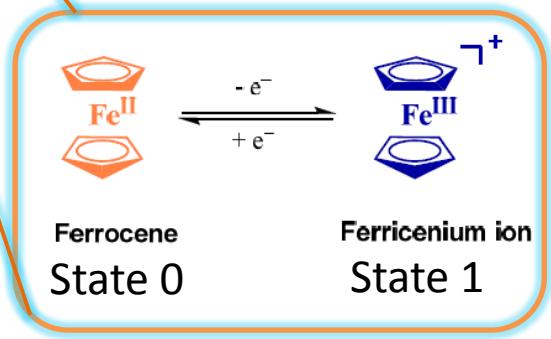


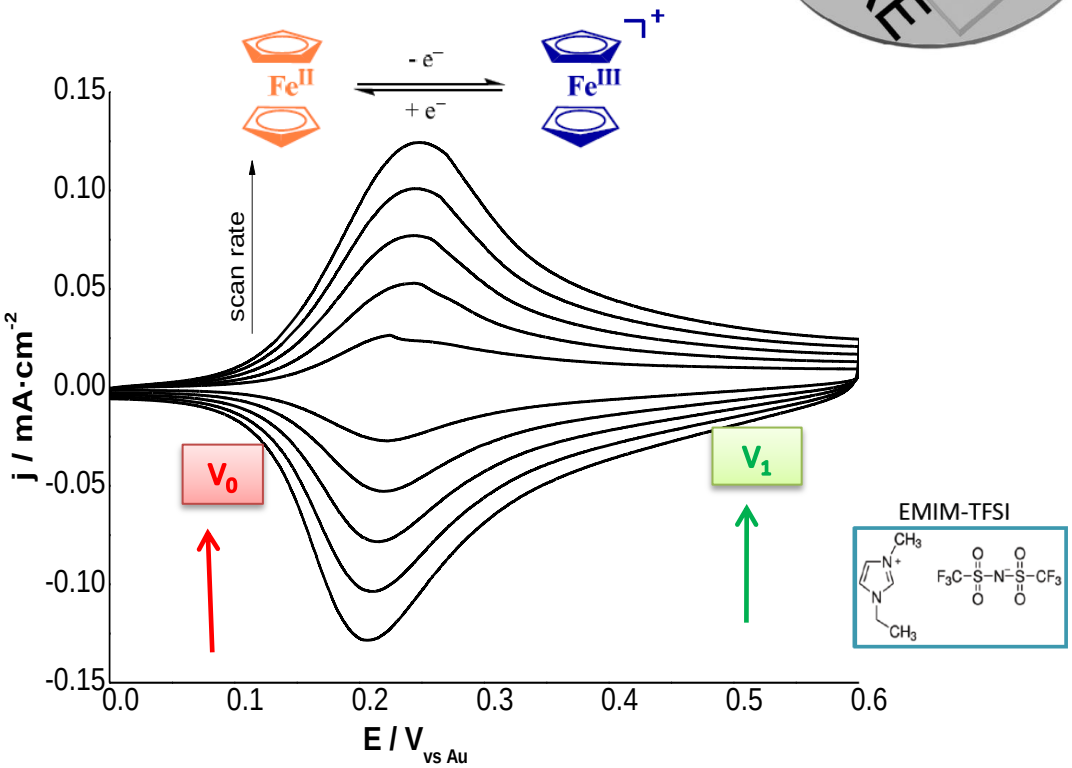
- Show stable and differentiated properties
- Reversible
- High stability of the SAM

Fc SAM as electroactive surface



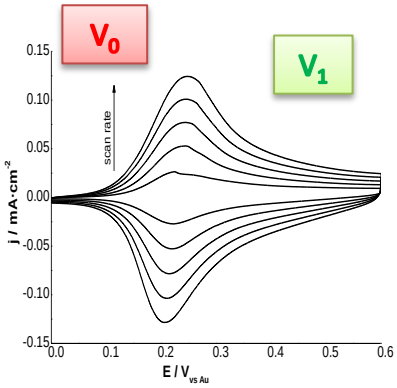


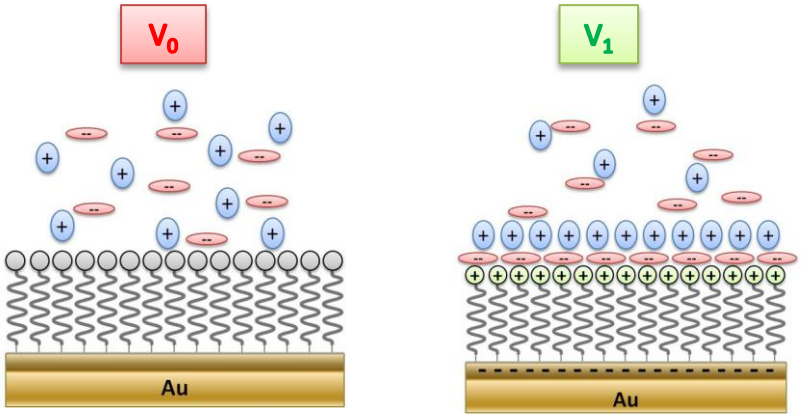


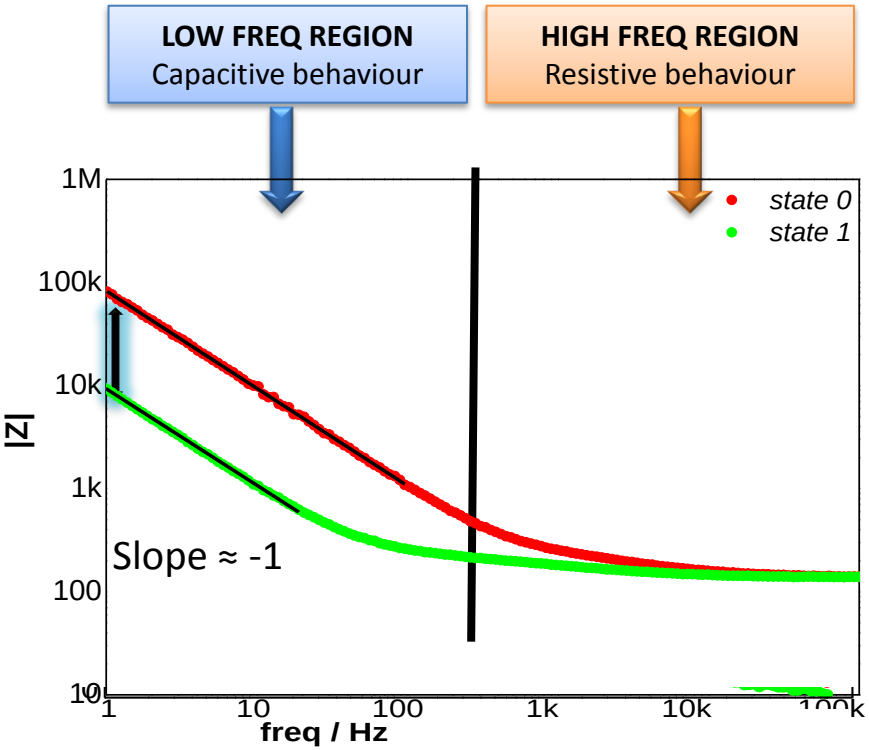


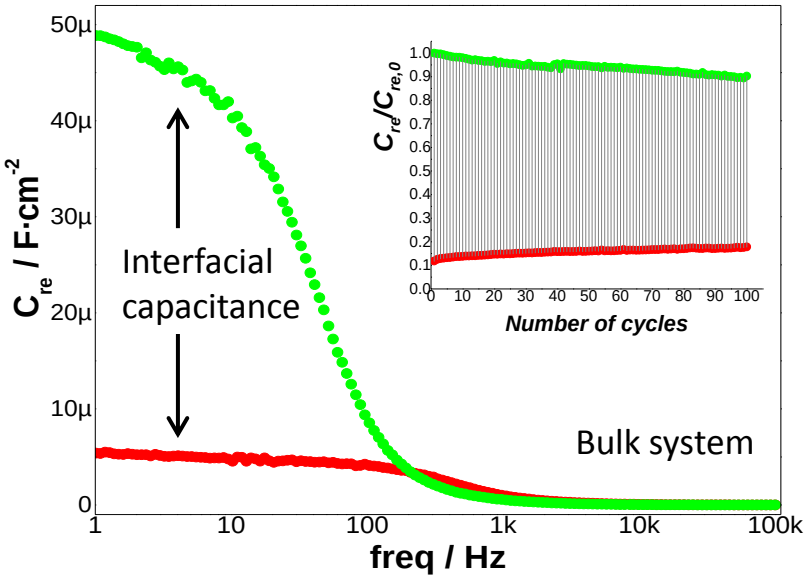
Electrochemical Impedance response

Electrical Response





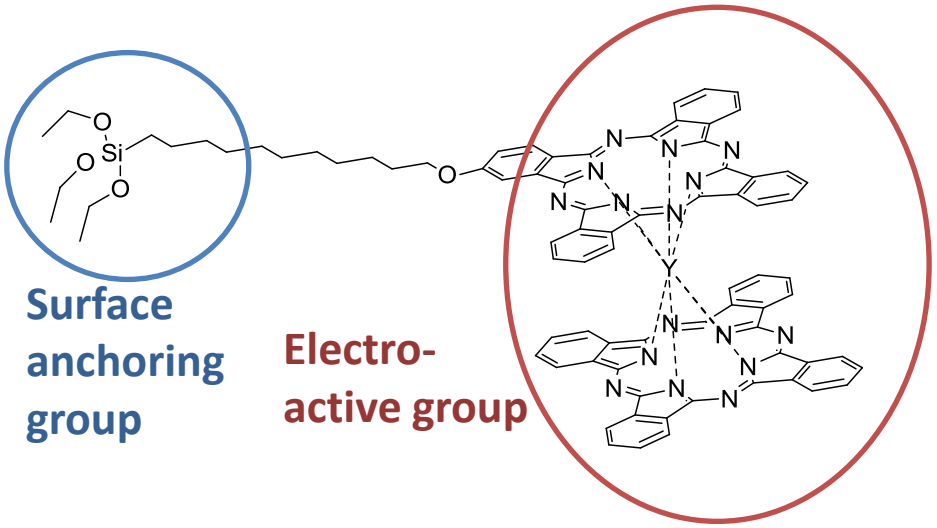


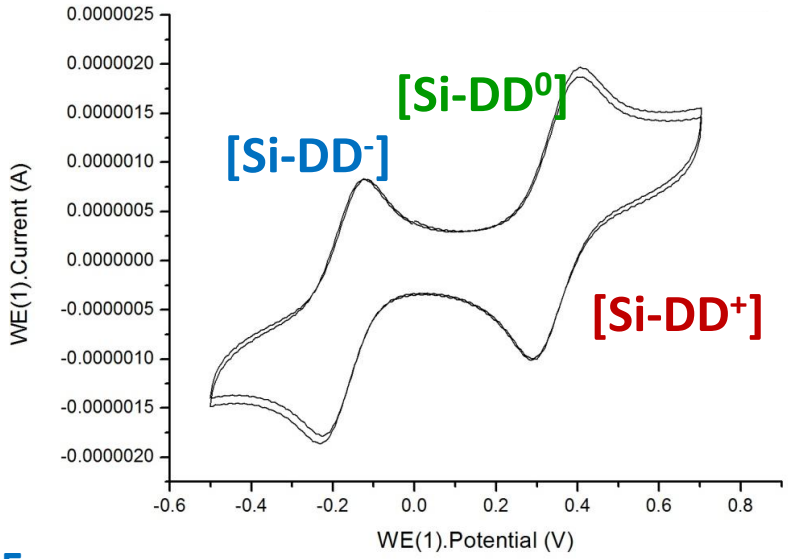


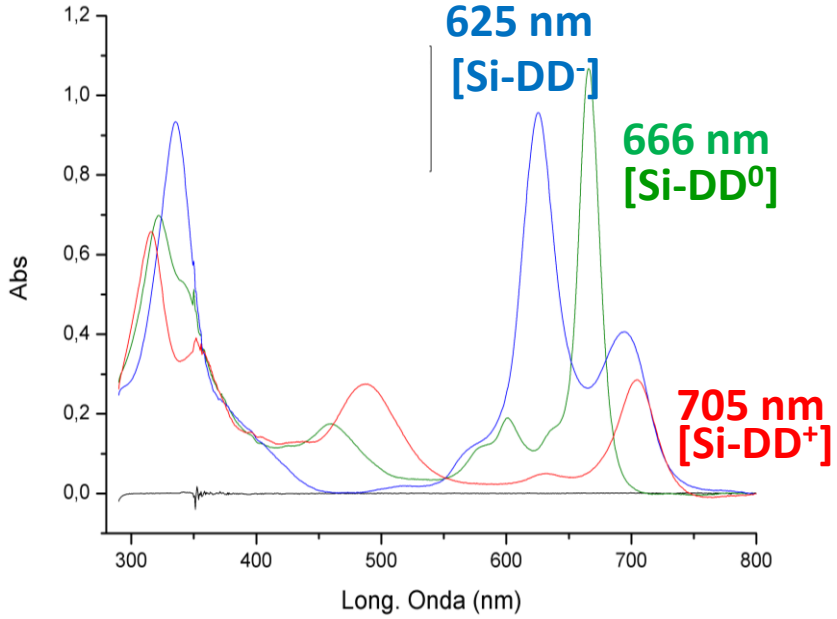
Angew. Chem. Int. Ed. (2016), 55, 368
RSCAdv, 7:5636-5641 (2017)

Electrochromic Target Molecule: Double Decker (DD)

Optical Response

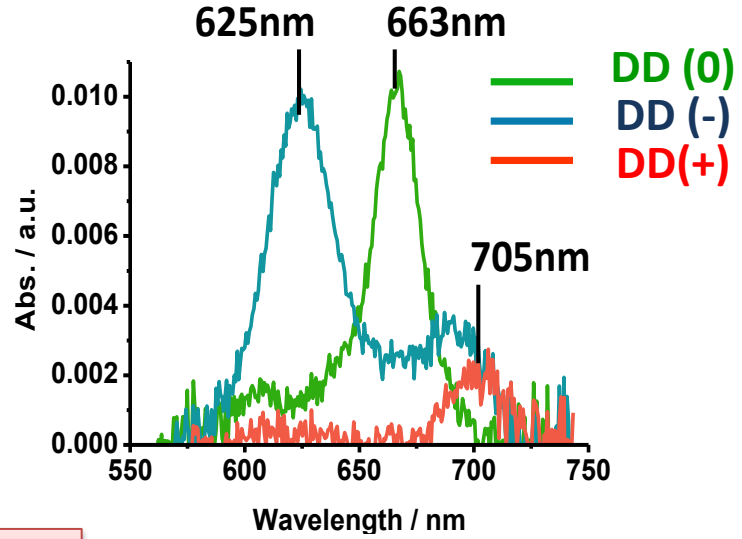


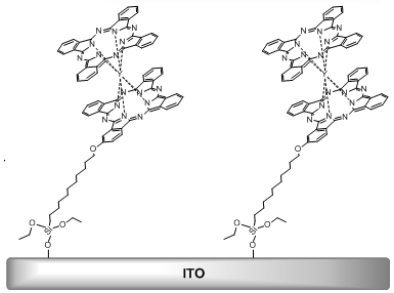


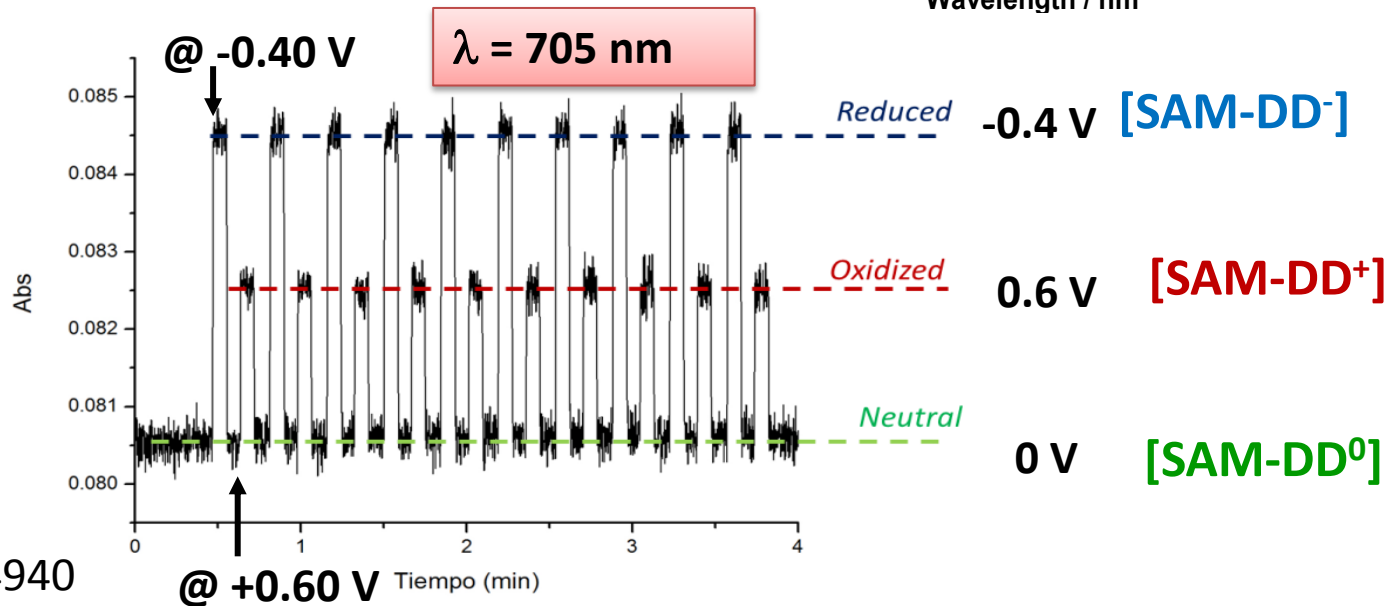


Spectroelectrochemistry

Optical Response



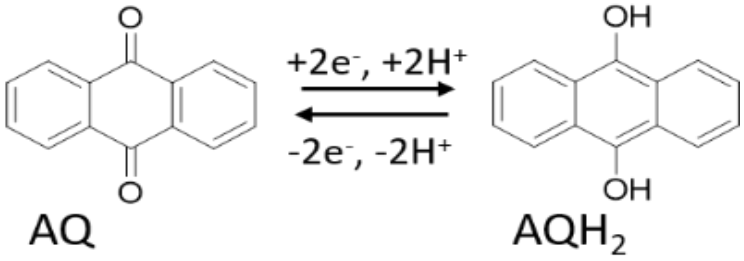


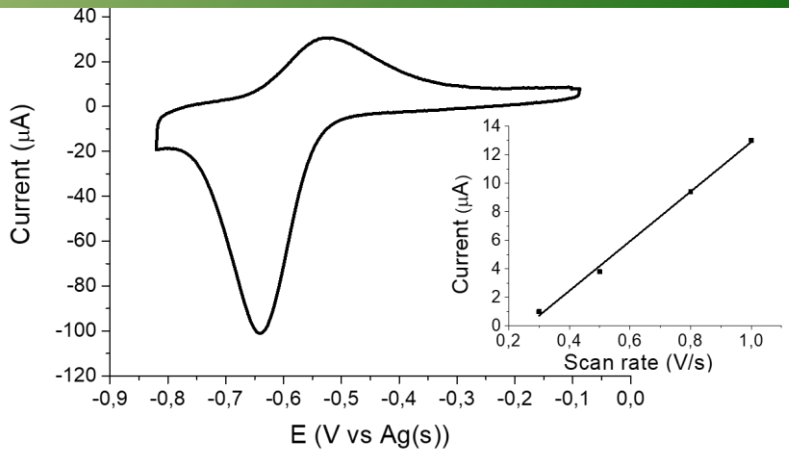


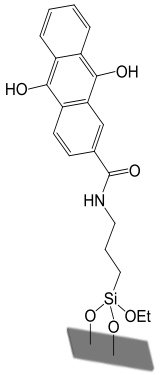
Chem. Sci. 2016, 7, 4940

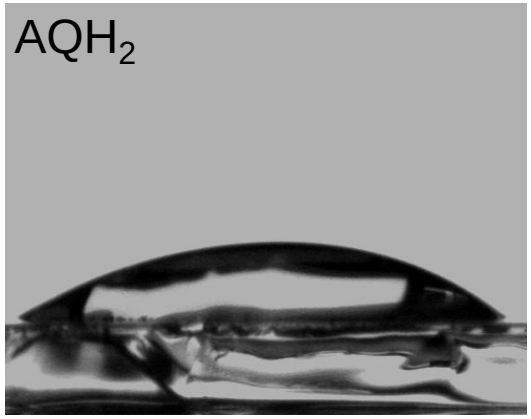
Anthraquinone SAMs

Wettability Response

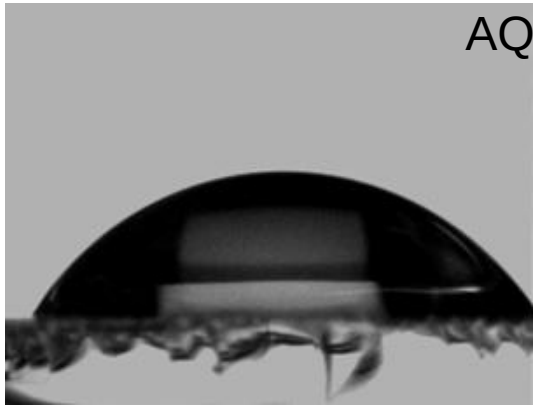


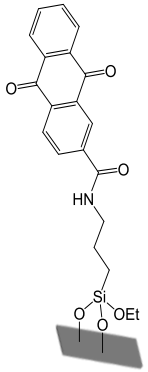






34º



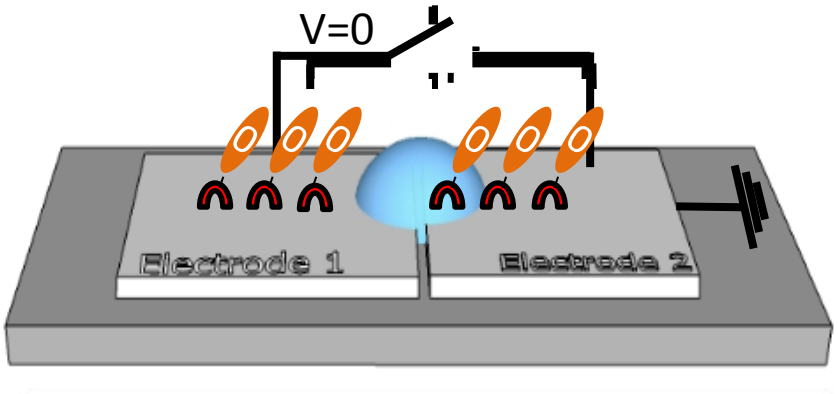


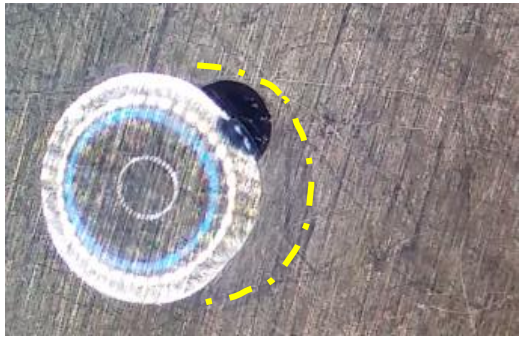
60º

5 μL water

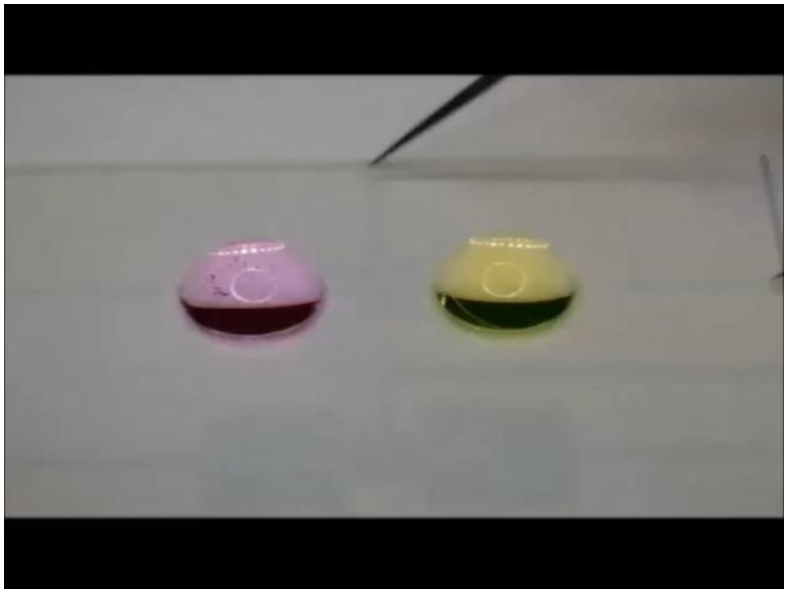
Anthraquinone SAMs: water actuation

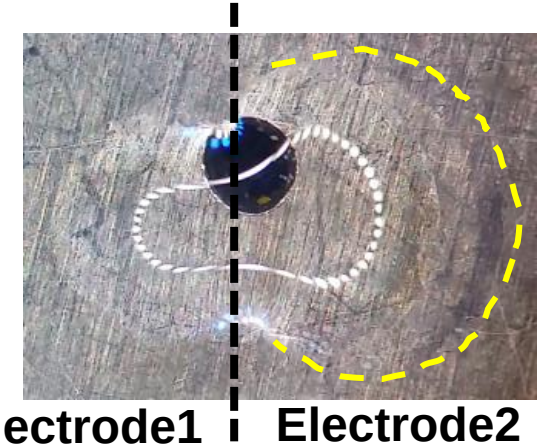
Wettability Response





Low Voltage Operation

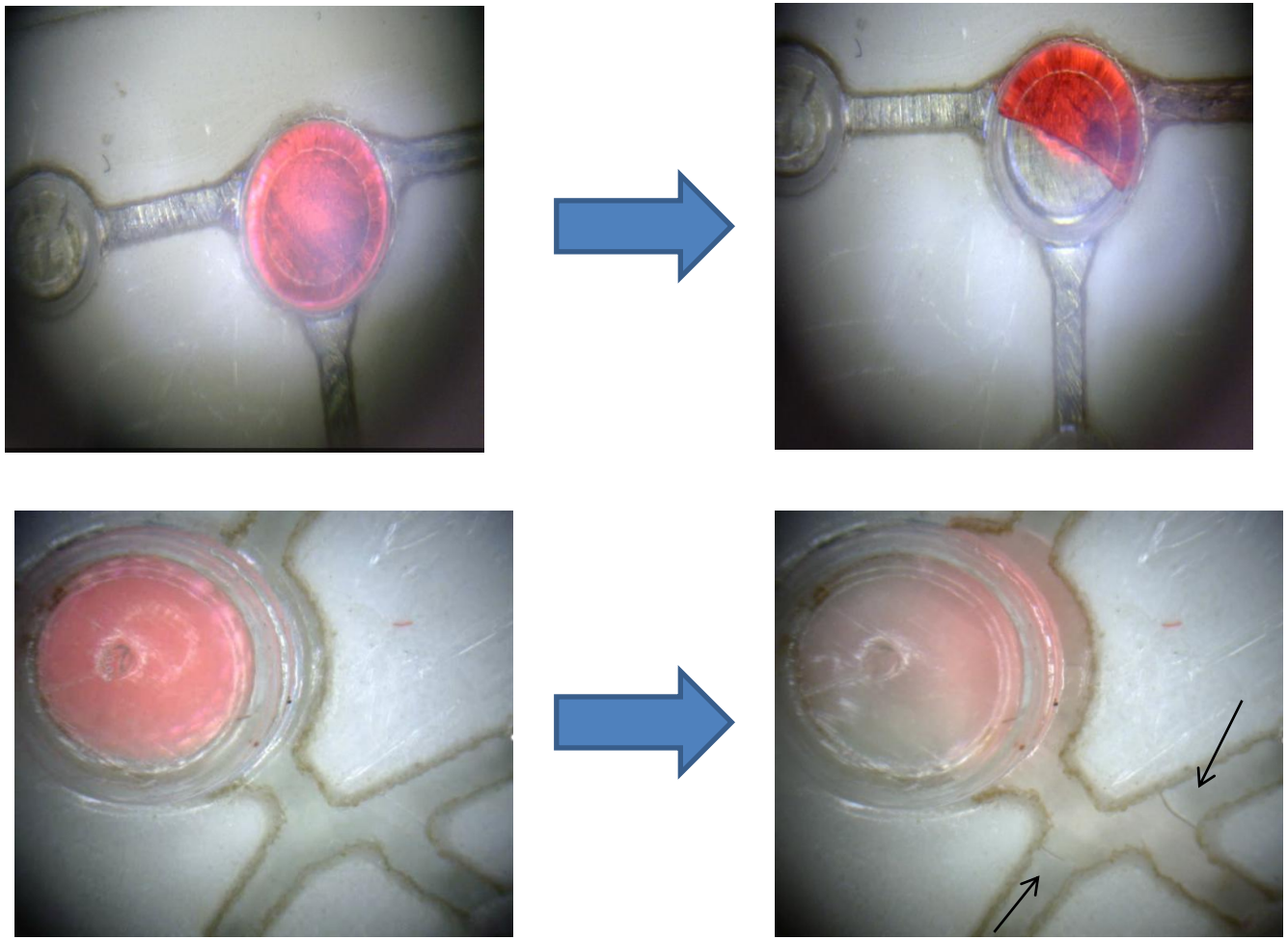




Small 2018, 1703344.

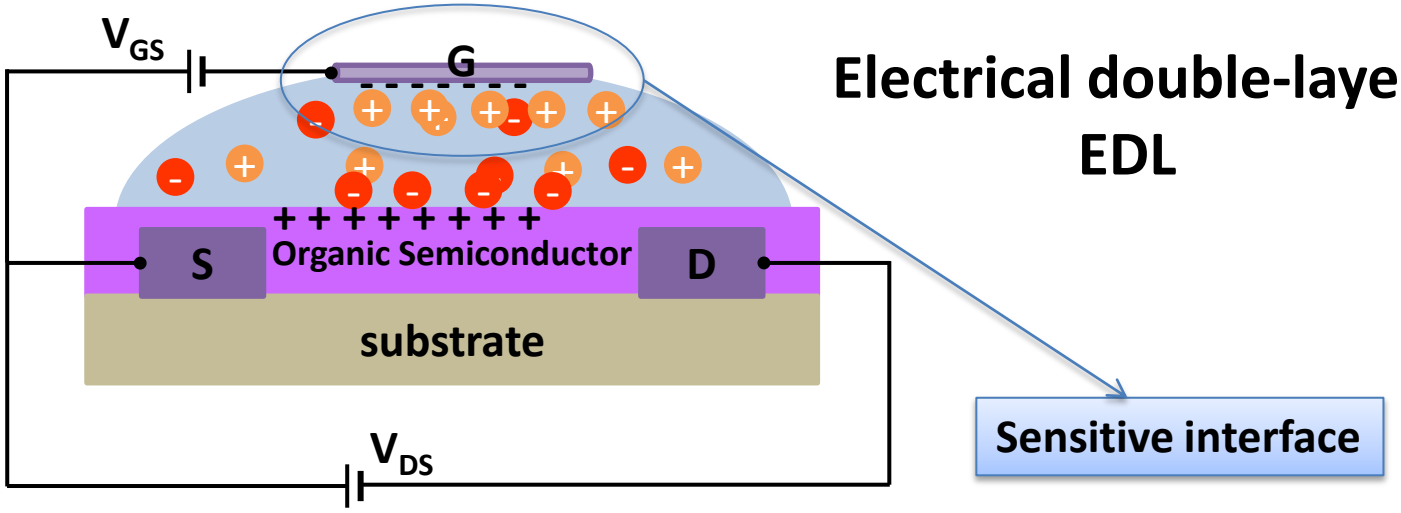
Anthraquinone SAMs: water actuation

In microfluidics chips



Small 2018, 1703344.

SAMs in Electrolyte Gated Field Effect Transistors

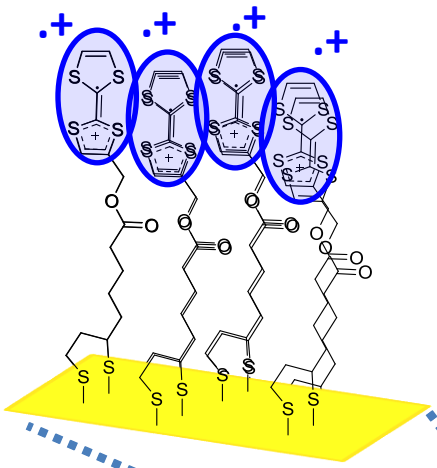


$V_{GS} < 0\ \text{V} \quad V_{DS} < 0\ \text{V}$

- ✓ Accumulation mode
- ✓ High water capacitance
- ✓ **Low-operating voltages**

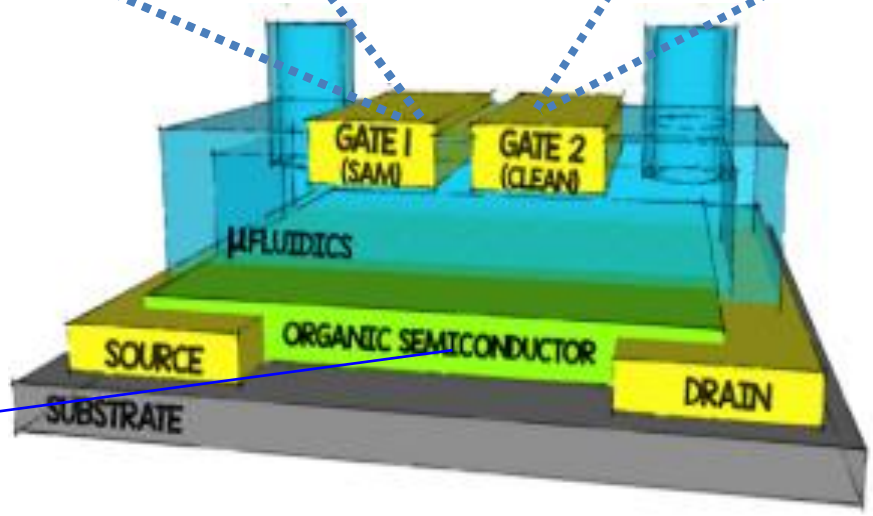
→ **Compatible with biomolecules**

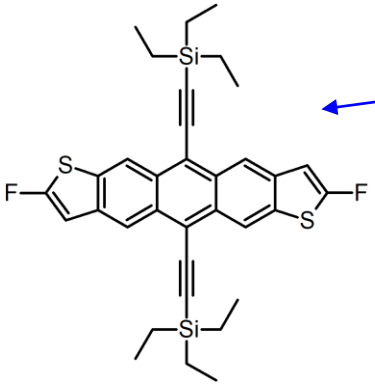
Gate Functionalisation with Electroactive Molecules



$GATE_1$= WG

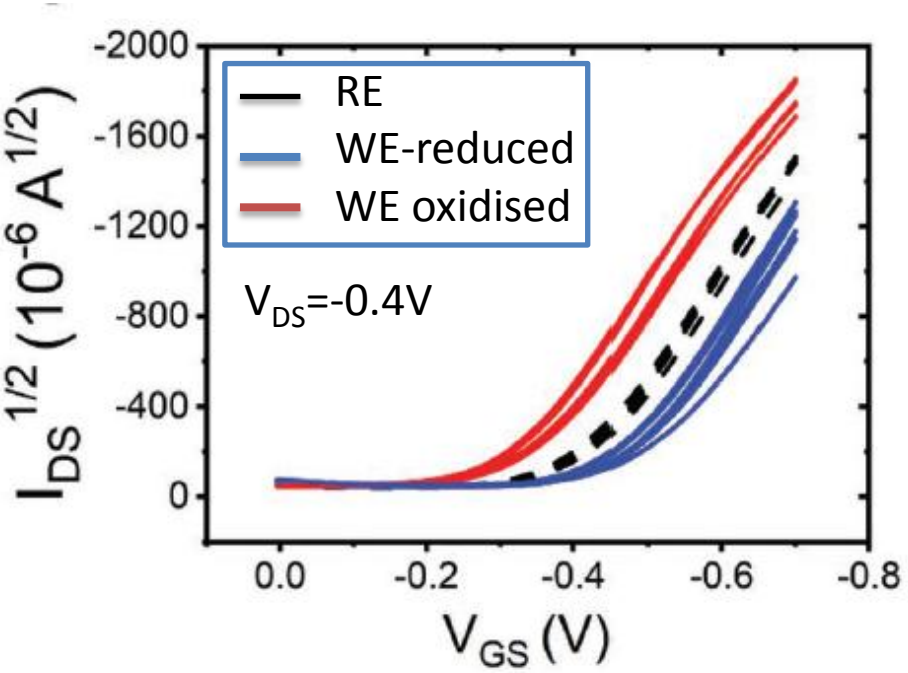
$GATE_2$= RG

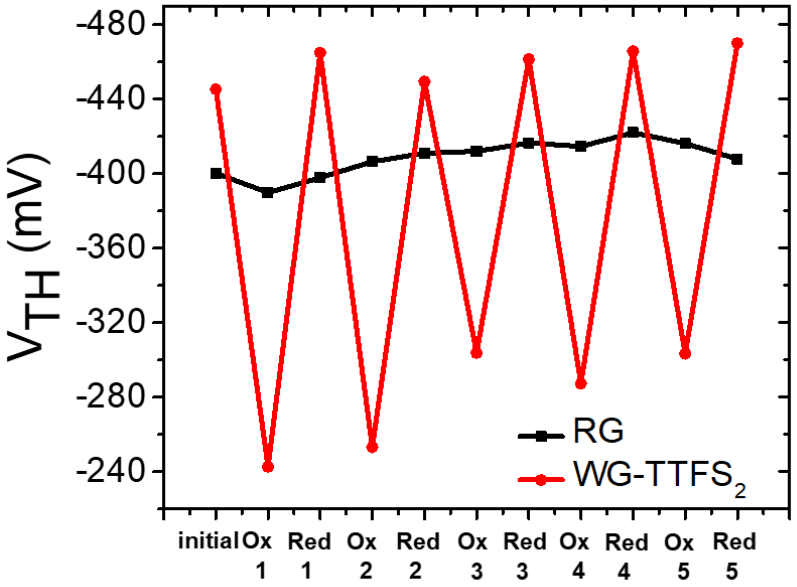




Adv. Electr. Mater. 2019, 1800875.

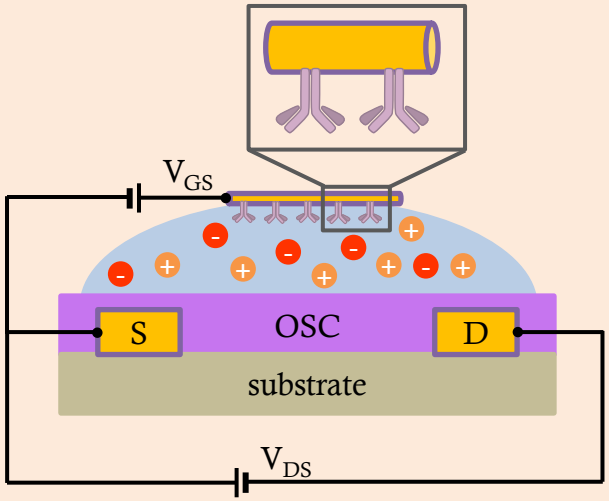
Switchable Transistor





Adv. Electr. Mater. 2019, 1800875.

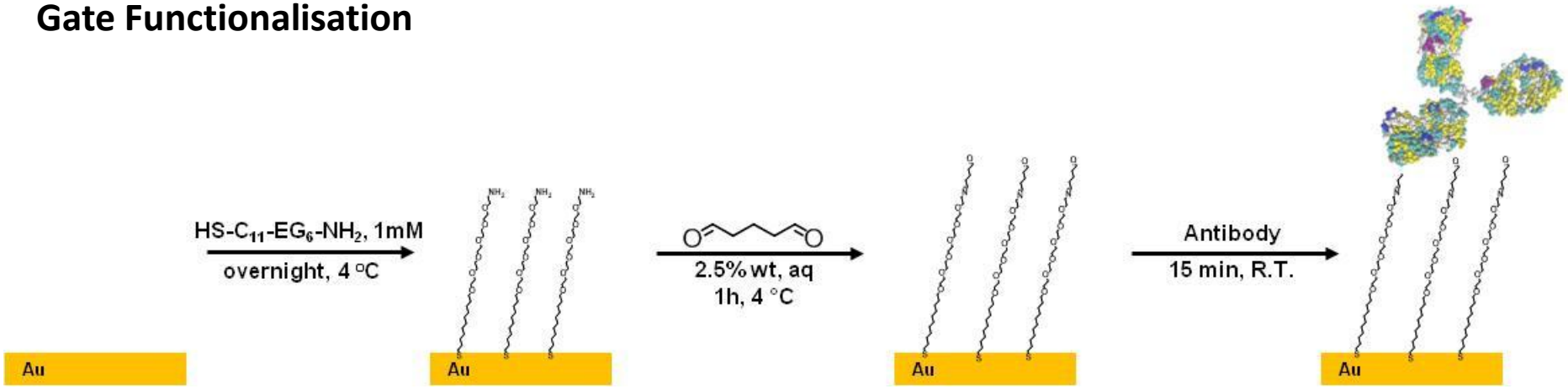
SAMs of α-synuclein antibodies



Label-free immunosensing:

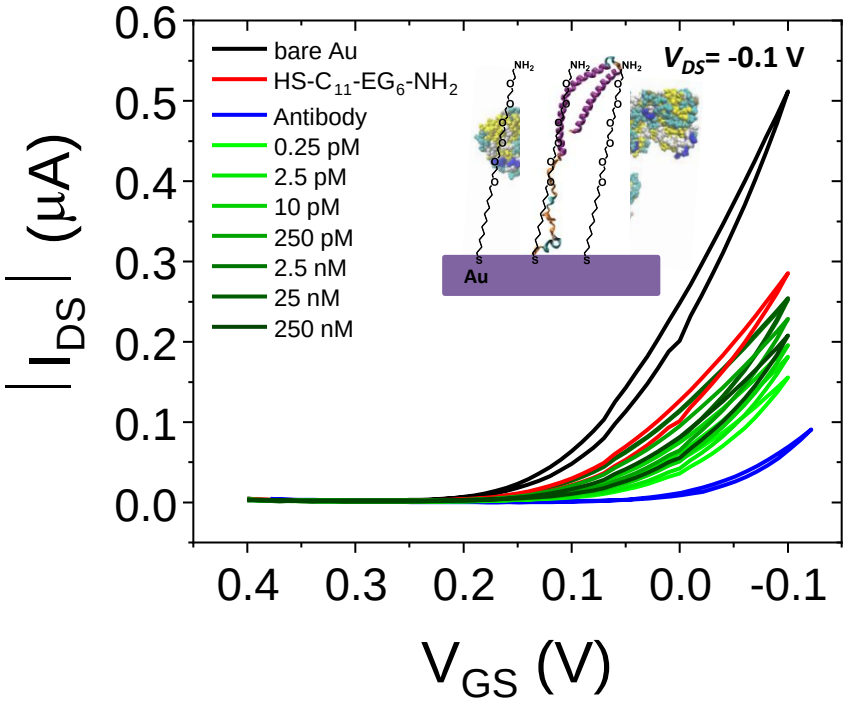
α-synuclein: a Parkinson biomarker

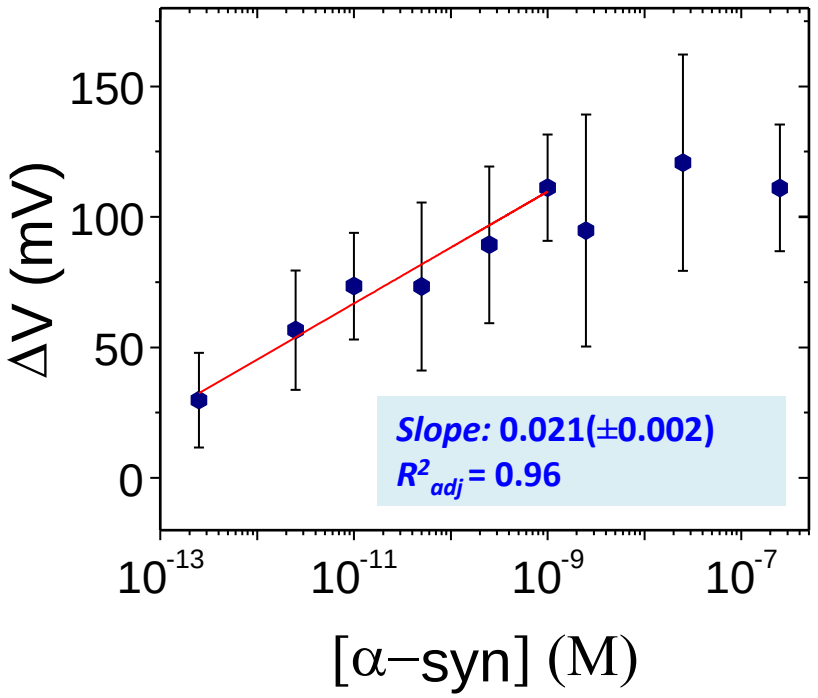
Gate Functionalisation



Biosensors and Bioelectronics 2020, 167, 112433.

Biosensors based on electrolyte gated transistors





Antigen binding promotes an increse of the source-drain current

Limit of detection: sub-picomolar

- ✓ **Low cost device**
- ✓ **Easily integrable electrical signal**
- ✓ **Portable, disposable, and compact device**

Biosensors and Bioelectronics 2020, 167, 112433.

Conclusions

- **Self-assembled molecular monolayers (SAMs) promising tool to modify the surface properties and to fabricate switchable hybrid systems.**

- **Optical, magnetic electrical and chemical properties can be tuned.**

- **SAMs can also be incorporated into more advanced devices such as Electrolyte Gated Field-Effect Transistors to provide them with additional functionalities.**

- **SAMs in transistors show high potential for the development of point-of-case sensors.**

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