Electrolyte Gated Organic Field-Effect Transistors (EGOFETs) For Point-Of-Care Tests

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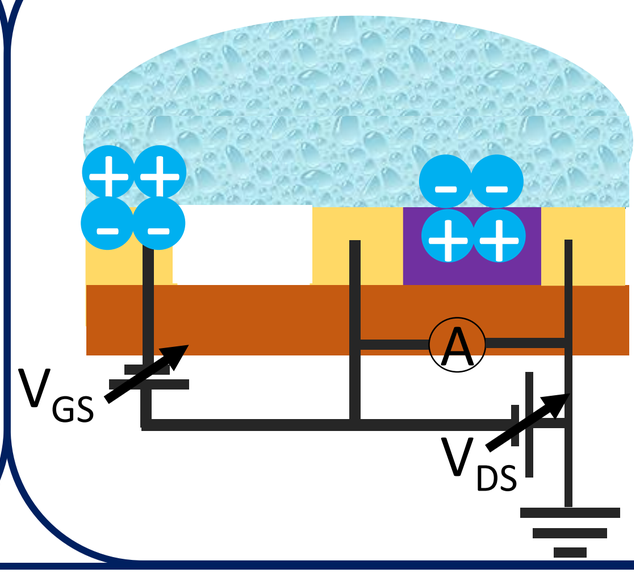
ABSTRACT

EGOFETs are raising considerable interest in biosensors due to their inherent advantages on miniaturization, low-cost fabrication using solution – processing methods, low power consumption, and label - free transduction, among others[1]. An interesting concept is to fabricate novel EGOFETs replacing the liquid electrolyte with a solid hydrogel. These novel devices, hydrogel – gated OFETs **(HYGOFETs)**, exhibit comparable electrical performance and long-term stability. Therefore, they could be employed in several applications such as sensors and Point-of-care (POC) devices. In this work, this approach is employed for developing a pH sensor, demonstrating that HYGOFET interfaces are sensitive to H^+ concentration.

EGOFET RATIONALE



When a voltage is applied at the gate-source, the drift of ions to the gate/electrolyte and electrolyte/OSC interfaces produce two electrical double layers (EDLs). The current then flows through the OSC under D-S bias. EGOFETs are highly sensitive to EDLs, and their perturbation with (bio)molecules makes them a powerful platform for (bio)sensing.

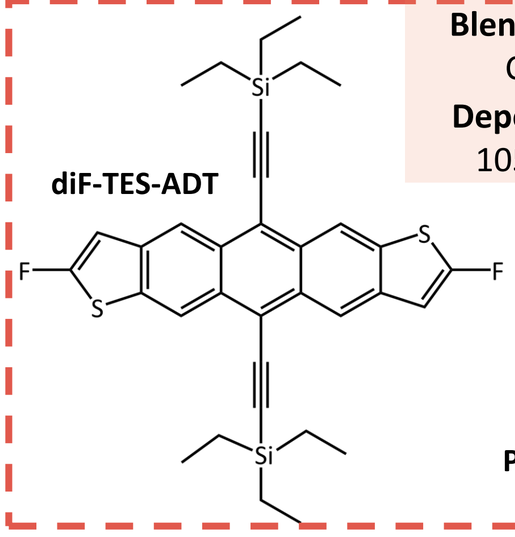
BAR ASSISTED MENISCUS SHEARING (BAMS) TECHNIQUE FOR MATERIAL DEPOSITION

BLENDED – ORGANIC SEMICONDUCTOR(OSC)

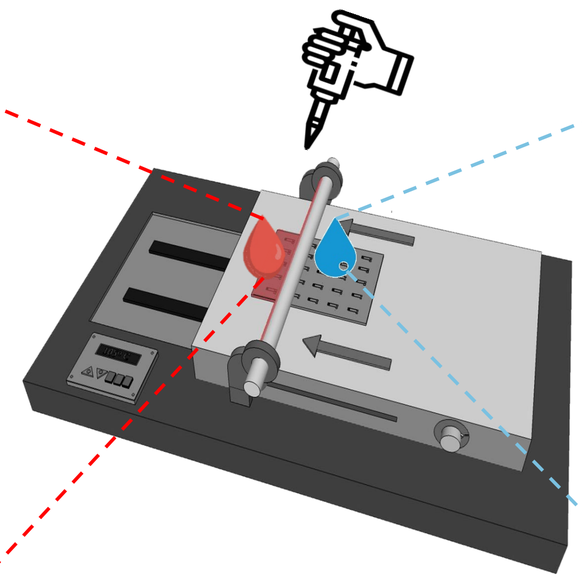
Blend ratio: 4:1 / 2wt% Chlorobenzene.

Deposition conditions: 105°C and 10 mm/s

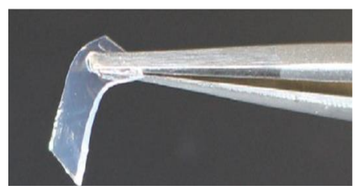
diF-TES-ADT



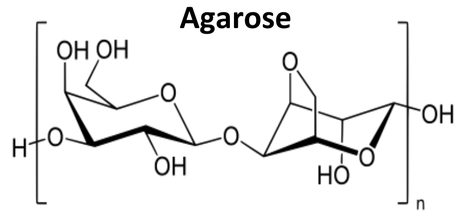
Polystyrene M_w = 10K (PS)

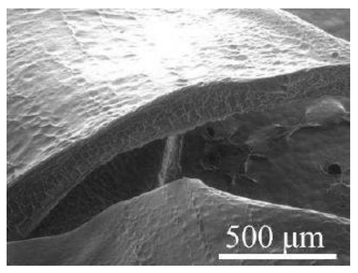


SOLID ELECTROLYTE LAYER



Agarose





Gel containing agarose in 1.5wt% DI water.

Deposition conditions: 35°C and 10 mm/s

BAMS alows the deposition of highly crystalline and homogeneous thin films of small organic semiconducting (OSC) molecules at high throughput, obtaining well – defined cristal domains[2]. In addition, the solid electrolyte layer (i.e., hydrogel) can be also processed by the same technique.

HYGOFET: EGOFET AS SOLID FORM?

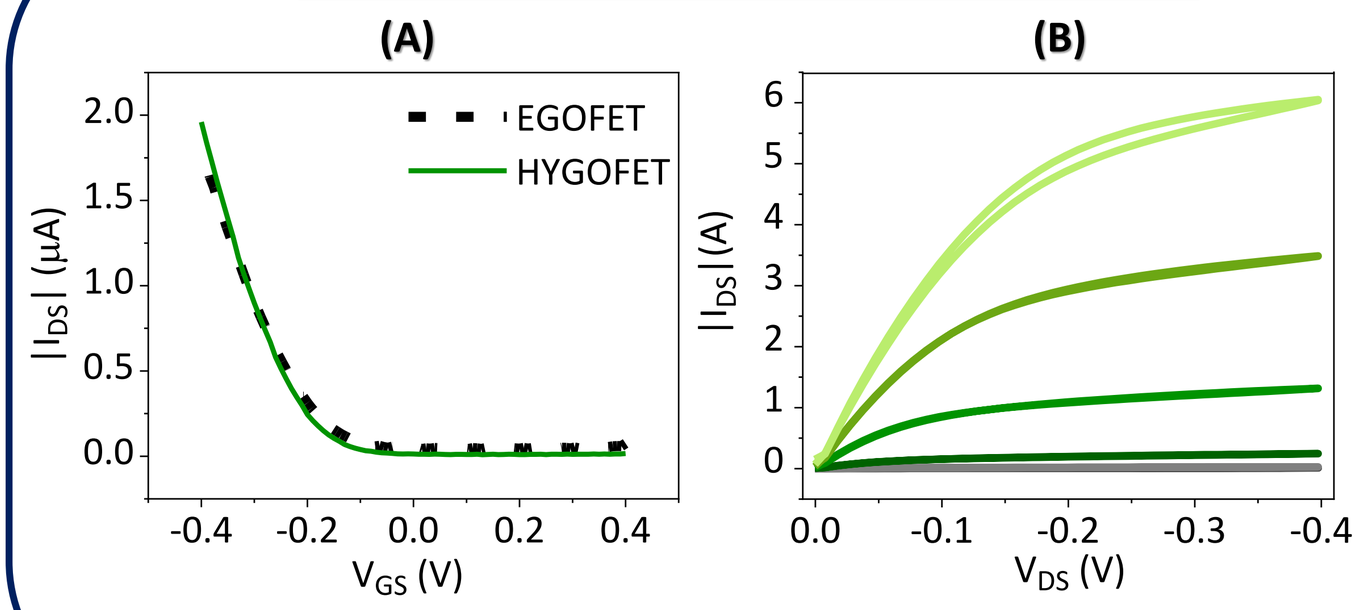
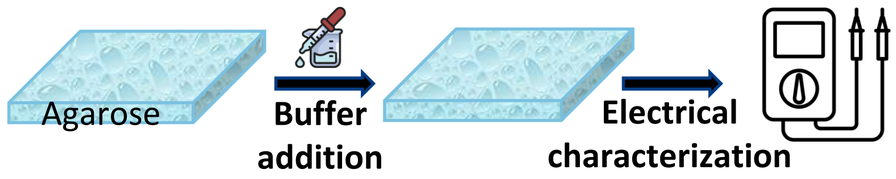


Figure 1. A) I – V transfer characteristics of of diF-TES-ADT:PS EGOFET (dark line) and diF-TES-ADT:PS HYGOFET (dashed curve). B) I-V Output characteristics of diF-TES-ADT:PS HYGOFET.

HYGOFET AS pH SENSOR



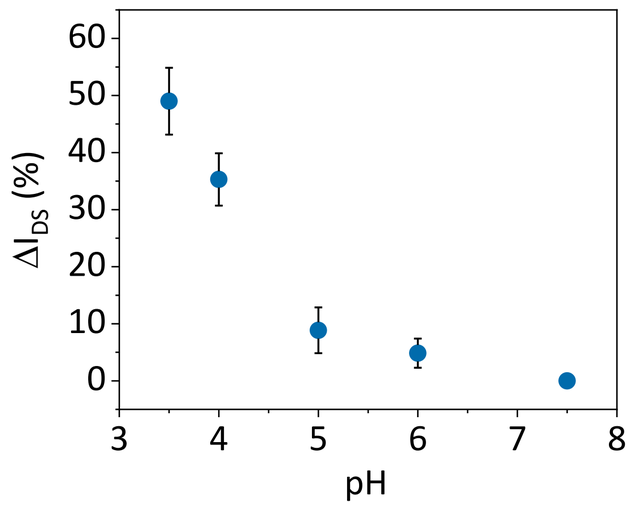


Figure 2. Response of HYGOFETs (N=5) in front of pH. The loose of the signal is correlated to the increase of H^+ concentration.

CONCLUSIONS AND OUTGOING

- A **solid-state EGOFET** employing an **agarose hidrogel** processed by BAMS has been fabricated.
- The water-based gel provide similar dielectric capacitances, electrical performances and relative long-term stability than the devices operating using liquid PBS electrolytes.
- With the novel approach, a pH sensor capable to detect H^+ concentration is developed.
- Agarose hydrogels could be employed as biomolecules reservoir, a considerable approach por POC development.

REFERENCES

(1) Wang, G. Y.; Lian, K.; Chu, T.-Y. Electrolyte-Gated Field Effect Transistors in Biological Sensing: A Survey of Electrolytes. *IEEE J. Electron Devices Soc.* **2021**, *9* (May), 939–950.

(2) Riera-Galindo, S.; Leonardi, F.; Pfattner, R.; Mas-Torrent, M. Organic Semiconductor/Polymer Blend Films for Organic Field-Effect Transistors. *Adv. Mater. Technol.* **2019**, *4* (9), 1900104.

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