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Imaging Functional Electrolyte-Gated Transistors at the Nanoscale

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Many organic bioelectronic platforms have emerged to bridge the signaling gap between biology and electronics. Organic bioelectronic platforms based on transistor architecture, commonly known as Electrolyte-Gated Transistors (EGTs), are an excellent tool to selectively sense, record, and monitor biological signals and states, and convert them into measurable electrical signals.[1,2] EGTs provide two sensitive and efficient biosensing interfaces: gate/electrolyte and semiconductor/electrolyte. The nanoscale biorecognition events modify the interfacial properties, which changes the device response. However, it is not well understood how this signal transduction happens. This gap in understanding is purely due to the lack of techniques to image the local electrical properties in a liquid environment under operating conditions.

Towards this objective, we have adapted in-Liquid Scanning Dielectric Microscopy to unravel the operating mechanism of Electrolyte-Gated Organic Field-Effect Transistors (EGOFETs) at the nanoscale.[3] The local electrostatic force is recorded at each pixel in the device, and its variation with gate and drain voltage is visualized. The electrostatic force maps obtained are a function of local conductivity and interfacial capacitance, and thus provides the access to relevant electrical properties. This development has allowed for the first time to visualize the onset of pinch-off as EGOFET transitions from linear to saturation regime. In addition, our method can reveal minute electrical heterogeneities attributed to different phases and materials at the semiconductor/electrolyte interface. The vast information extracted has made it possible to correlate the nanoscale properties with the macroscale response, offering improved understanding and the potential for substantial optimization of devices.

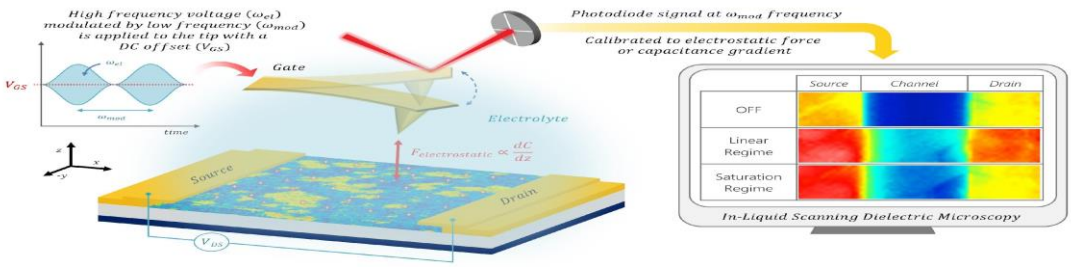

Figure 1: Illustration of In-Liquid Scanning Dielectric Microscopy on Operating EGOFET

References

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