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# Field-Effect Transistor with a Plasmonic Fiber Optic Gate Electrode as a Multivariable Biosensor Device

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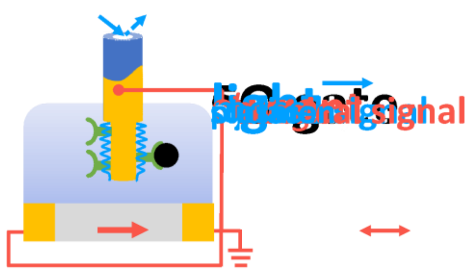
Electrolyte-gated field-effect transistors (EG-FET) are excellent candidates for affinity biosensors, where a biorecognition unit can be attached, for instance, on the surface of the gate electrode.[1] Binding events manifest themselves as changes in the current measured between the drain and source electrode. To validate the sensor response, additional insights are required, preferably using a multivariable readout of the sensor surface, e.g., combining a quartz crystal microbalance and a FET leading to additional information about the mass uptake.[2] Such sensor fusion concepts allow for additional insights and provide a deeper understanding of (bio)surface processes. We have previously demonstrated this advantage by simultaneous measurements using plasmonic and electronic sensors to monitor mass and charge uptake on the same surface.[3] In this context, we present a novel EG-FET sensor platform using a gold-coated optical fiber that acts simultaneously as gate electrode and substrate for surface plasmon resonance (SPR) spectroscopy.[4] A binding event at the fiber gate/electrolyte interface leads therefore, in addition to the electronic readout, to an optical signal due to a local refractive index change, associated with a mass uptake on the fiber gate surface. The coupling to surface plasmons via optical fibers allows for the miniaturization of the optical components and simplifies the integration to an EG-FET sensor significantly. Furthermore, we optimize the sensor geometry by investigating the influence of fiber area to transistor channel area ratio and distance. We show that larger fiber optic tip diameters are favorable for electronic and optical signals and demonstrate the reversibility of plasmon resonance wavelength shifts after electric field application. As a proof of principle, a layer-by-layer assembly of polyelectrolytes is performed, to benchmark the system against multivariant sensing platforms with planar surface plasmon resonance configurations. Furthermore, the biosensing performance is assessed using a thrombin binding-assay with surface-immobilized aptamers as receptors, allowing for the detection of medically relevant thrombin concentrations. The coupling of the two systems allows a controlled gate functionalization, confirmation of analyte binding and a quantification of the electronic response. Based on the obtained results, we envision this platform will not only lead to new insights into bio-analyte interactions by detailed analysis of mass and charge contributions but can also lead to more robust and reliable biosensors.



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