Direct, label-free and rapid transistor-based immunodetection in whole serum

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Transistor-based biosensors fulfill many requirements posed upon transducers for future point-of-care diagnostics devices such as scalable fabrication, label-free and real-time quantification of chemical and biological species with high sensitivity. However, the short Debye screening length in physiological samples (<1 nm) has been a major drawback so far, preventing direct measurements in serum. In this work, we demonstrate how tailoring the sensing surface with short specific biological receptors and a polymer polyethylene glycol (PEG) can strongly enhance the Debye length. The mechanism is explained in terms of local desalting of the sample by the polymer layer. In addition, the sensor performance can be dramatically improved if the measurements are performed at elevated temperatures (37°C instead of 21°C). With this novel approach, highly sensitive and selective detection of a representative immunosensing parameter -- human thyroid-stimulating hormone -- is shown over a wide measuring range with sub-picomolar detection limits in whole serum. To our knowledge, this is the first demonstration of direct immunodetection in whole serum using transistor-based biosensors, without the need for sample pre-treatment, labelling or washing steps. The presented sensor is low-cost, can be easily integrated into portable diagnostics devices, and offers a competitive performance compared to state-of-the-art central laboratory analyzers.

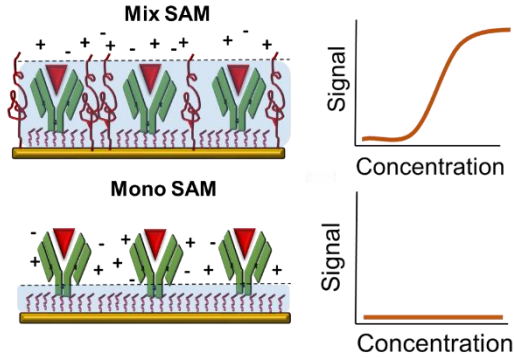

Figure 1: Schematic representation of the readout configuration of the sensor and both electrode configurations used to study the effect of PEG on the Debye length.