# SENSITIVE BIOSENSORS EXPLOITING THE MINUTE CHANGES IN THE CAPACITANCE OF PROTEIN LAYERS ASSOCIATED TO THE LIGAND RECOGNITION

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Soft matter systems interfaced to an electronic device are presently one of the most challenging research activity that has relevance not only for fundamental studies but also for the development of highly performing bio-sensors.
Layers of proteins anchored on solid surfaces have small capacitance that undergoes to only minute changes as the ligand–protein complex is formed.
For properly designed systems, the protein layer represents smallest capacitance in a series of capacitors and as such dominates the overall capacitance. When such a protein layer is integrated in a Field Effect Transistor (FET) transduction is remarkably sensitive as the transistor output current is governed by the small changes due to ligand binding. These devices operate in aqueous solutions and are promising as portable sensors for point-of-care applications

Two recent achievements will be illustrated:

A) the sensitive and quantitative measurement of the weak interactions associated with the binding of neutral enantiomers to Odorant Binding Proteins (OBPs) [1]. immobilized to the gate of a bio-FET. Here the minute change in protein layer capacitance upon binding of S(-)-carvone and R(+)-carvone modulate the response of a water-gated OFET, allowing for chiral differential detection. The FET binding curves modelling provide information on the electrochemical free energies derived from the FET dissociation constants while the electrostatic component is isolated from the threshold voltage shifts. These can be combined with the chemical free energies gathered from the complex formation in solution, overall providing a comprehensive picture of the energy balances for a surface-bound pOBP-carvone complex undergoing chiral interactions.

B) Hierarchically organized layers of phospholipids and proteins anchored on the surface of the semiconductor and acting as selective recognition elements independently form the solution ionic strength [2-3].
The charged moieties of the bound proteins along with the counter-ions form a layer that is analogous to an ionic gel. The fixed polyelectrolyte ions generate an electric field that confines the mobile counter-ions in the region of the fixed charges. Eventually a Donnan's equilibrium is reached and the smallest capacitance in series is associated to the Donnan's electrical double layer. The molecular recognition process (antigen/antibody in the present case) modify the charge density of the outermost layer and thus its capacitance.
This capacitive tuning of the bio-FET response is virtually insensitive to the Debye's length value and therefore is compatible with use of the transistor as sensor directly in biological fluids at high ionic strength .

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