Organic Electrochemical Transistors (OECTs) for dynamic monitoring of the effect of toxic agents on cell tissue integrity

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Standard methods to investigate cell viability and cell stress response induced by drug treatment are mostly based on the evaluation of in vitro cell colture conditions by optical monitoring, which provide high reliability and sensitivity, but require complex instrumentation and laboratory protocols. A viable alternative is electrical monitoring using Organic Electrochemical Transistors (OECTs). In OECTs, the electronic current flowing in the conducting polymer channel is modulated by the ionic current crossing the interface with an electrolyte solution. The presence of cell monolayer at this interface limits the number of ions interacting with the conducting polymer, thus providing an electronic readout of the layer integrity. Moreover, the transistor configuration enhances the sensitivity due to amplification of the ionic current.
In our work, we realized OECTs based on conductive polymer PEDOT:PSS, with low cost fabrication techniques. The biocompatibility of this polymer allows the growth of cells directly on the electrode and, thanks to its high transparency, we permits to correlate the electrical measurement with the high resolution imaging commonly used for life-science research. Electrical monitoring is based on two parameters quantitatively related to cell tissue integrity: current modulation and time response of the OECTs to a square voltage applied on the gate.
We demonstrated that our devices provide a simple, low-cost and dynamic method to study cell growth and adhesion on one side, and the effect of toxic agents (i.e. trypsin) on cell layer disruption and death on the other, enhancing the information normally obtained by optical images.