Bio-Electroactive Architectures for a New Generation of "DNA chips"

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The sensing of biologically active material, DNA, RNA, proteins,. has become a highly worked area owing to its fundamental interest and for the numerous clinical applications. The complexity of biological systems has led to the design of multidot devices, e.g., DNA chips which integer 10^4 to 10^5 sensing dots per cm^2. The criteria for such sensing devices are their selectivity, their sensitivity. These devices must also be easily fabricated and they should allow a fast, precise and real-time readout.

With this aim, electroactive sensors have been developed, based on a thin film of a functionalized conducting polymer, e.g., polypyrrole. The intrinsically conducting macromolecular chains of polypyrrole form a network of molecular wires, which have been further substituted with a pendant oligonucleotides, ODN. These polymer films possess an electrochemical signature associated to their redox behavior. When in presence of a complementary ODN target in solution, a very specific hybridization occurs, which results in a significant modification of the electrochemical signature of the polymer. The recognition of the ODN target is thus transduced into an electrical signal, addressed to the supporting electrode.

We will discuss the main parameters which describe these sensing devices. Their *selectivity* is ensured by the specificity of the interactions between the bases composing both ODNs. Their *sensitivity*, i.e., the detection limit, is primarily due to the precision of the electrochemical signal, which can be enhanced by the use of an internal electrochemical probe such as ferrocene. Detection limits down to 10^{-12} mole of ODN target in 1 ml solution can be achieved. These two last parameters are in fact not independent, as the sensitivity also increases with the strength of the interaction between the two ODNs. The *ease of fabrication* is associated with i) the use of an electrochemical polymerisation technique for growing the thin polymer film on a micron-sized electrode, and ii) the use of a precursor polymer route, an activated ester-functionalized polypyrrole, which is further substituted by an ODN bearing an amino group. Finally, the transducing of the ODN hybridization into an electrical signal allows a *direct and real-time reading* of the ODN recognition, which does not require any labelling of the ODN target.