Label-free sensing strategies using impedance spectroscopy, SPR and protein electrochemistry

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Label- free methods are valuable tools during the development of sensors and biosensors since they allow to optimize the conditions for surface modifications and biomolecule binding. However, these methods have also increasingly be used as transduction methods in the sensing process itself. The attractiveness results mainly from the ease of operation and the fact that these techniques can also help to understand the behaviour of molecules on surfaces. The presentation will address different directions of our research demonstrating the potential but also drawbacks of label-free techniques.

Electrochemical impedance spectroscopy (EIS) can be used for the detection of nucleic acids exploiting their highly charged character [1,2]. This can be applied for concentration analysis, mismatch detection or the analysis of binding events of molecules to nucleic acids. A recent interest can be seen in the binding behaviour of abasic DNA [3].

SPR exploits changes in the optical density near the surface. Limitations occur when only small changes happen. It can be shown however, that even conformational changes such as the formation of G quadruplex structures can be detected when a proper capture strand design is used [4]. Furthermore, the potential of online binding detection can be used for the discrimination of structurally similar proteins [5].

A focus point of our research is the development for efficient enzyme -electrode coupling strategies allowing the electrochemical detection of enzymatic conversions. Here we have been exploiting SAM layers, nanoparticles, the self exchange properties of the small redox protein cyt c or the interaction of enzymes with conducting polymers [6-8]. Application is not limited to analytics, but also directed to the construction of biofuel cells. A more recent development includes ligth-sensitive electrodes since they allow not only a light-directed read out, but also provide an attractive potential behaviour [9-11].

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