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A New Generation of Biomolecular Sensors Based on Polymeric Ion Conducting Nanopores for Medical Diagnostics

Wolfgang Ensinger
Technical University of Darmstadt
Institute of Materials Science
and Centre for Synthetic Biology
Alarich-Weiss-Str. 2, Darmstadt, Germany
wolfgang.ensinger@tu-darmstadt.de

Extended Abstract

Analyzing biologically relevant molecules is an important aspect of biomolecular analysis and medical diagnostics. The biomimetic approach presented here aims at developing a device that is able to specifically detect and quantitatively analyze (bio)molecules, in analogy nanopores that play a role in cells [1]. An example is tumor markers that are emitted by the tumor at elevated levels and can be found in body liquids. If they are discovered in time, more effective countermeasures against further tumor growth can be taken.

The core of the analyzing device consists of a polymeric foil containing a single nanopore. In analogy to biological nanopores that control e.g. mass transfer into and out of a cell, the biomimetic artificial nanopore allows the passage of ions of an aqueous electrolyte in an electrochemical two-compartment cell from one compartment to the next one under the influence of an electrical field. When the nanopore wall contains certain immobilized molecules that specifically react with the biomolecules to be analyzed in a bioconjugation reaction (the receptor that reacts with the ligand, in analogy to a key-lock-system), the electrolyte-based ionic current is influenced. Thus, it is possible to detect e.g. phophoproteins with nanopores functionalized with Zinc chelates, but also physiologically relevant ions, such as Lithium by means of host-guest complexation [2,3]. The difference in the current can directly be correlated to the presence and the quantity of the biomolecule or ion type to be analyzed.

So far, this works well in macroscopic laboratory set-ups with electrochemical cells. Recently, the nanopore-carrying polymer foils have been incorporated in microfluidic electronics devices thus creating a new type of (bio)molecular sensor.

As an example, the measurement of small quantities of histamine, the well known neurotransmitter that plays a role in inflammatory response, allergies, and immune system functionality [4], is shown.

References

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