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Biomolecular Sensing by Modulated Ion Transport Through Ion Conducting Polymeric Nanopores

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Extended Abstract

Living cells communicate and exchange small molecules and ions with their surroundings via nanopores in their biomembranes [1]. Among these, ion conducting nanopores, based on membrane transport proteins, are of particular interest. Channel proteins can be engineered in such a way that they alter their ionic conductance in the presence of certain molecules to be analysed [2]. With this approach, highly sensitive biomolecular sensors can be realized. The major drawback of such natural nanopores is that they are embedded in a fragile and unstable lipid bilayer. Thus, they are not suitable for technical applications. In order to get rid of such restrictions, various routes have been tried for fabricating nanopores in solid-state materials with the ability to mimic functions of biological nanopores, being more robust than the latter while keeping their sensoric sensitivity and selectivity as much as possible [3]. The approach, used for the present studies, is the so-called ion track etching technique. Here, polymer foils are through-irradiated with a beam of highly energetic ions in a particle accelerator. The ion damage track is chemically etched into a nanopore. The nanopore walls are functionalized by an appropriate coupling chemistry with a biorecognition unit, i.e. a molecule which specifically reacts with another molecule, in a key-lock principle. In an electrochemical two-compartment cell, the polymer foil acts as separation membrane. The electrolyte current flowing through the nanopore is measured as a function of the applied potential. In the presence of specific analyte molecules, which selectively bioconjugate with the biorecognition unit insider the nanopore, these ionic currents are changed. Thus, a highly sensitive nanosensor for biomolecules is available. The preparation and working principle of this type of nanosensor that constitutes a new type of biomolecular detection device is described [4]. As example, results on the sensing of biomolecules such as the neurotransmitter histamine are shown [5].

References

[1] B. Hille, *Ionic channels of excitable membranes*, Sinauer Associates Inc., Sunderland, MA, 2001.
[2] H. Bayley, P.S. Cremer "Stochastic sensors inspired by biology," *Nature*, vol. 413, pp. 226-230, 2001.
[3] J. C. Dekker, "Solid-state nanopores," *Nat. Nanotechnol.* vol. 2, pp. 209-215, 2007.
[4] W. Ensinger, M. Ali, S. Nasir, I. Duznovic, Ch. Trautmann, M. E. Toimil-Molares, G. R. Distefano, B. Laube, M. Bernhard, M. Mikosch-Wersching, H. F. Schlaak, M. El Khoury, "The iNAPO Project: Biomimetic Nanopores for a New Generation of Lab-on-Chip Micro Sensors," *Int. J. of Theoret. Appl. Nanotechnol.* vol. 6, pp. 21-28, 2018.
[5] M. Ali, P. Ramirez, I. Duznovic, S. Nasir, S. Mafe, W. Ensinger, "Label-free histamine detection with nanofluidic diodes through metal ion displacement mechanism," *Colloids and Surfaces B: Biointerfaces*, vol. 150, pp. 201-208, 2017.