Preparation and Applications of Resistive-Pulse Sensors to Detect Biomolecules

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Abstract— Using nanopore based sensors for the detection and analysis of biomolecules has become a fast developing field. The technique using the nanopore based devices is called 'resistive-pulse' sensing and with great selectivity and sensitivity this technique opened a new research field. Various platforms have been developed to succeed this sensing paradigm such as ion-beam etching, electron beam lithography and micro molding. In this study we offer alternative techniques to farbricate nanopores in easier ways and show their applicability in biomolecule detection.

The sensing paradigm based on the measurement of ion current flowing through an aperture is known as resistive-pulse (or stochastic) sensing. The resistive-pulse sensor is known as the single-particle (or molecule) sensors which are based on the electrophoretic movement of molecules through a nanopore and registry of their momentary current drops (i.e., events) caused by translocation. Investigation and analysis of these individual events makes these technique powerful in terms of the possibility of the ultralow detection limit [1].

Various nanopore fabrication techniques and materials have been used to improve sensing paradigm in resistive-pulse sensing. Wide ranges of molecules and conjugates have been detected by using resistive-pulse with high sensitivity and different nanopore fabrication techniques have been used. Focused-ion beam and electron-beam lithography are some of the examples of these fabrication techniques which employ the drilling the nanopore through a silicon based chip/wafer. However, high cost of instrumentation and requirement of trained personnel limit usage of both techniques [2].

Alternative techniques such as track-etch method and glass nanopipettes are also used with the ease of fabrication of nanopores. The track-etch method is based on the irradiation of materials such as films and membranes with heavy ions. During the irradiation process latent tracks form through the material and these tracks are chemically etched to fabricate nanopore(s). The other technique, glass nanopipettes, is based on the pulling of glass capillaries at high temperatures by the aid of laser. After pulling process, two identical pipette tips, in nano scale, are obtained and can be directly used without any additional step [3, 4].

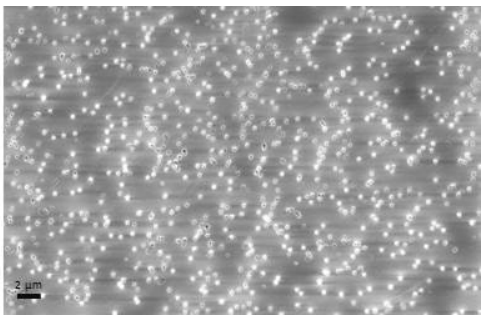

Figure 1. SEM image of polycarbonate multipore membrane

In this study, we show the applications of nanopores as a resistive-pulse sensor prepared by both track-etch method and nanopipettes. Ion-tracked polycarbonate (PC) membranes were used to fabricate nanopores and DNA molecules were used as analytes. In addition to track-etched membranes glass nanopipette tips were used and gold nanoparticle conjugated antibodies were used as an analyte. The capabilities of resistive-pulse technique have been showed in terms of the quantification of resistive-pulse data and applicability to detect biomolecules.

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