selectivity for chemical modification, PET has become an excellent material for use in nanotechnology applications. In particular, PET membranes have been used to build very small pores with nanometer-scale diameters, so called ''nanopores''. Several interesting phenomena have been observed in PET nanopores, such as ionic current rectification, reverse rectification due to divalent cations, and nanoprecipitation. However, understanding the physical basis behind such phenomena is still a challenge. We have used molecular dynamics (MD) simulations to study the ionic transport properties of PET nanopores, including the conduction of KCl under different pH conditions and the effect of divalent ions on the ionic conduction and nanoprecipitation. To carry out these simulations, we have developed a protocol to build PET nanopores: First, we constructed a periodic model of bulk PET; then, we created a PET nanopore by removing atoms from a conical region and patching the exposed ends with benzoic groups, the PET surface reproducing the surface charge observed in experiments; finally, the PET nanopores are solvated and simulated under a variety of voltage biases using different ionic species, such as K(+1), Cl(-1), Ca(2+) and HPO4(2-) ions. We applied the protocol and found that it resulted not only in good agreement with experimental data, but also provided an atomic description of the ion dynamics in PET nanopores. Specifically, we observed the enhancement of ionic current due to the surface charge, the permanent binding of Ca(2+) ions to the PET surface, and the dynamics of HPO4(2-) ions inside PET nanopores.

**3327-Pos Board B374**

**Nanopore Unzipping Of Ultra-long Dna Repeats For Single-molecule Mutation Detection**

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Rolling-circle amplification (RCA) is an isothermal method for the hybridization-triggered enzymatic synthesis of hundreds to millions repeats of small, single-stranded, circular DNA. Using RCA, we create tandem repeats of a DNA sequence from human genome source, serving as a signal amplifier for ultra-sensitive detection of specific nucleic acids mismatches. Solid-state nanopores have been shown to be an extremely useful tool in probing and characterizing biopolymers on the single molecule level. In our recent study[1] sub-2 nm solid state pores have been successfully utilized to unzip small DNA duplexes, and detect base mismatches. Here we demonstrate for the first time that kilo-base RCA products can be characterized using solid-state nanopores, allowing us to enhance mismatch detection sensitivity and accuracy by hybridization with oligos' containing the consensus sequence. This study is an important milestone for the realization of single nucleotide polymorphism and for nanopore sequencing methodologies, demonstrating the feasibility of sequential unzipping, and translocation of extremely long ssDNA molecules.

1. McNally, B., Wanunu, M. & Meller, A. (2008) Electro-mechanical unzipping of individual DNA molecules using synthetic sub-2 nm pores. *Nano Letters* **ASAP article 10.1021/nl802218f**, in press.

**3328-Pos Board B375**

**Salt Dependence Of RNA Translocations Through Solid State Nanopores**

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Solid state nanopores have become a powerful tool to probe structural features of single biopolymers. Here, molecules are passed through a nanometer sized hole by a strong electrical field, causing a small change in the ionic current through the pore. Where previous studies have mostly focused on studying DNA, we present translocation results for single RNA molecules. In particular, we present current blockades of double-stranded RNA molecules at varying concentrations of background salt. Similar to what was found for DNA, our preliminary results suggest a crossover from current blockades at high salt (1M KCl) to current enhancements at low salt concentration (0.1 M KCl). This can be explained by an increasing contribution from the counter-ions screening the RNA backbone as the background salt concentration is decreased. These experiments demonstrate the strength of solid state nanopores in studying RNA, and pave the way towards unraveling more complex RNA structures through the use of solid state nanopores.

**3329-Pos Board B376**

**Fabrication And Characterization Of Tunable, Low Stress $Al_2O_3$ Nanopores For The Electronic Detection Of Biomolecules**

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Understanding the biophysics governing single molecule transport through solid state nanopores is of fundamental importance in working towards the goal of genome sequencing using nanopore based sensors. Here, we present a simple process for the fabrication and characterization of novel, low stress, low noise aluminum oxide nanopores for biomolecule detection. Aluminum oxide has numerous attractive properties including high mechanical hardness, low surface charge, chemical inertness to strong acids and excellent dielectric properties from DC to GHz frequencies.

Device fabrication involved the use of Atomic Layer Deposition and Deep Reactive Ion Etching tools to form low stress, mechanically robust aluminum oxide membranes. High temperature process steps were avoided to allow for possible process integration with metal nano-electrodes and optical probes. The nanometer sized pores themselves were formed through Field Emission Gun Transmission Electron Microscope (FEG-TEM) based sputtering. We demonstrate the precise size tunability of these structures in the nanometer regime and examine the physics governing pore contraction in aluminum oxide. Diffraction patterns reveal polycrystallinity localized to the pore region post sputtering suggesting localized heating and possible thermal annealing under the electron beam. Film composition and thickness were characterized. In addition, we examine the surface charge properties of these structures as a function of buffer pH and molarity. The single molecule sensing ability of this novel structure was tested using dsDNA. Electrical characterization revealed a significant reduction in membrane capacitance and reduced high frequency dielectric noise relative to existing silicon nitride and silicon dioxide topologies. These improvements can greatly enhance device performance by improving sensitivity and signal-to-noise ratio. In summary, our work provides a novel yet simple approach to fabricate tunable, low stress chemically functionalizable nanopores for the detection of biomolecules.

**3330-Pos Board B377**

**Asymmetric Spectral Characteristic of Ion Currents in Conical Nanopores**

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The noise analysis of ion current signals through single nanopores is a critical problem in using nanoporous systems for biosensing. We have examined the noise characteristics of ion currents in single asymmetric polymer nanopores. These pores are conical in shape with openings of several nanometers at the cone tip. The pore walls are negatively charged at pH 8 due to the presence of carboxyl groups with density of one group per square nanometer. These conically shaped pores are cation selective and rectify the current with preferential direction for cation flow from the narrow entrance of the pore to the wide opening of the pore. With our electrode configuration, the average currents for negative voltages are higher than the average currents for positive voltages. We have found that the noise characteristics for the positive and negative currents are very different. The time signals were examined through power spectra analysis and Hurst analysis. At low salt concentration, the transient behavior of currents flowing in the direction from the narrow opening towards the wide opening show a power spectra with distinct 1/f behavior, where f is the frequency. The Hurst analysis of these currents reveals a deterministic component in the current behavior. In contrast, the spectra of currents from the wide opening towards the narrow opening show a thermal noise characteristic. We will discuss how these differences in the transient signals of ion current in conical pores reflect differences in the electrochemical potential of cations in the nanopores, and how they can be important for biosensing.

**3331-Pos Board B378**

**Direct Probing of DNA/Nanopore Interactions Using Optical Tweezers**

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Solid-state nanopores can be used to analyze the structure of long double-stranded DNA molecules and to probe their interactions with proteins. This method utilizes the native biopolymers' charge to electrically draw the molecules from the *cis* to the *trans* side of the pore. In small pores ($<5$ nm) the transport time of the biopolymer is determined by a balance of the electrical field and the frictional force resulting from interactions with the pore walls and hydrodynamic drag. Despite the central importance of biopolymer dynamics in virtually all nanopore applications, to date there have been no direct measurements of force in small pores during biopolymer transport. Here, we use optical tweezers to dynamically manipulate a λ-DNA molecule threaded through a $<5$nm pore while simultaneously recording force and ionic current. To characterize the interaction strength in the pore, we measure force/velocity profiles as a function of the applied voltage and ionic strength. By comparing experiments using different-sized pores, we quantify the relative contribution of interactions to the overall translocation dynamics. These measurements provide basic insight into the principles governing translocation in the interaction-dominated regime.

**3332-Pos Board B379**

**Conductivity of Room Temperature Ionic Liquids in Single Nanopores**

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