attached DNA occludes sub-10 nm in diameter nanopores with an extent that depends on the ionic strength of the electrolyte medium. The result can be explained by the ionic strength dependent DNA conformation. At low KCl concentrations (e.g. 10 mM KCl) the DNA is expected to be fully extended and rigid, which is observed as a large reduction in current compared to the current values before DNA attachment. In addition, for pores with diameters below 5 nm, the deflection of the DNA strands in the electric field reverses the direction of ion current rectification compared to the as prepared pores. These pores feature therefore a voltage-dependent opening diameter. The effect of pH of the background KCl solution will also be discussed. This system has possible applications in drug delivery and separations.

**1019-Pos Board B805**

**Biological Nanopore MspA for DNA Sequencing**

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Nanopore sequencing is a single molecule technique that has the potential to provide fast and low-cost DNA sequencing. In nanopore sequencing, an ionic current passing through a small pore would directly map the sequence as single stranded DNA is driven through the constriction. The mutant pore protein, MspA, derived from Mycobacterium smegmatis forms a short and narrow channel ideal for nanopore sequencing. Here we present recent advances in nanopore sequencing using the biological porin MspA. Homopolymers of adenine, cytosine, thymine, and guanine each generate unique current signatures when held in MspA. Additionally, we show that individual nucleotides passing through MspA modulate the ionic current in a predictable manner providing sequence information. MspA has a high signal-to-noise ratio and the single nucleotide sensitivity desired for nanopore sequencing. These results indicate that MspA is an ideal candidate for nanopore DNA sequencing.

**1020-Pos Board B806**

**Parametric Study of Nanopore Versus Analyte Dimensions for Viral Detection Optimization**

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Developing our ability to quickly and accurately assess the presence of potentially harmful biomaterials is an essential endeavor for several reasons, including public health and national security. In particular, current approaches for detecting viruses are quite sensitive, but often require labeling for virus identification and may take hours for detection and up to several days for confirmation.

The resistive pulse technique was introduced in 1970 as a candidate for rapid, label-free viral sensing in which viruses suspended in an electrolyte were driven through a single pore hundreds of nanometers in diameter embedded in a micron-thick polymer membrane. By characterizing the magnitude and duration of ionic current blockages, the virion's size and geometry could be extracted. However, due to the dimensions of the system relative to the size of viruses (~25nm to 600nm), these early devices could not achieve the sensitivity required. Recently, researchers have taken advantage of developments in nanofabrication techniques to create smaller pores and thinner membranes to address device sensitivity.

Building on these recent reports, we systematically investigate the role of membrane thickness and pore diameter relative to the size of the analyte using a focused ion beam to prepare nanopores in silicon nitride membranes. Employing synthetic nanospheres as models for viral particles, we explore a representative range of particle sizes to optimize device performance. In doing so, we aim to not only present a more complete assessment of the limitations of this approach (including the need for tailored pores or multiplexed platforms to detect a broad range of viruses) but also illustrate pathways to address these through straightforward modifications to the fundamental sensor design.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-502091

**1021-Pos Board B807**

**Hydrophobic Gating in Single Synthetic Nanopores**

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In nature, nanopores play a critical role in a number of vital biological functions. These pores can be ion selective based on their size and/or surface charge, but further functionality is achieved by modulating, or gating, their conductance state. The conductivity of a particular nanochannel can be controlled in a number of ways, including mechanically, chemically and electrically. By studying these phenomena in model systems, we may be able to create abiotic analogues of these biostructures with similar transport properties. Here, we present what we believe is first study to show the spontaneous opening and closing of a synthetic hydrophobic nanopore with no leakage current in the closed state. Hydrophobic gating has been observed before in biological channels.

Single conically shaped nanopores in polyethylene terephthalate prepared by the track-etching technique were functionalized with hydrophobic groups either throughout the pore or on the outside of the tip region. These hydrophobic pores would be closed at low voltages below ~1V but would open up for ionic transport when a transmembrane potential was increased above a threshold value. At the threshold voltages the pores would fluctuate between conducting and non-conducting states, which we attributed to reversible wetting and dewetting of the pores. Prior to the hydrophobic modification, aqueous electrolyte solutions were able to conduct readily through the structures for all voltages. Another feature of nanopores with a local hydrophobic layer is a strong dependence of their gating behavior on pH. At pH 8 the pore would typically conduct the current, but at pH 3 the pore was either closed or rectifying in the opposite direction. Transport properties of hydrophobic nanopores also provide information on hydrophobic interactions at the nanoscale.

**1022-Pos Board B808**

**Characterizing Contact Friction Between DNA and a Chemically Modified Nanopore Surface**

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Nanopore based DNA sequencing can be potentially high-throughput and low-cost. Essential to this approach is the ability to control the electrically driven motion of a DNA molecule that transits a solid-state nanopore. One dominant factor affecting DNA translocation is contact friction between DNA and a pore surface. Nanopores after being drilled by a transmission electron microscope usually exhibit different surface properties, such as surface charge density and surface roughness, resulting in different friction on DNA. Even for the same pore, translocation (dwell) times for same DNA molecules can vary dramatically due to the irregular occurrence of contact friction. It has been experimentally demonstrated that a self-assemble monolayer (SAM) can be coated on a nanopore surface, providing a method to reduce the contact friction between DNA and the pore surface. Using all-atom molecular dynamics simulations, we characterized interactions between DNA and different SAM-coated pore surfaces. When DNA was in a hydrophilic SAM-coated pore, an intermittent stick-slip motion occurred because of the contact friction and resulted in a wide distribution of translocation velocity of DNA. However, in a hydrophobic SAM-coated pore, DNA was rarely stuck on the coated surface and the translocation velocity was nearly constant. Therefore, by coating a proper SAM on a pore surface, it is possible to achieve controlled motion of DNA and improve the resolution of DNA sequencing.

**1023-Pos Board B809**

**Single Cell Electroporation using a Nanopore**

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A nanopore is the ultimate analytical tool with single molecule sensitivity. Going beyond analysis, synthetic biology also demand tools capable of reprogramming a cell's genetic code. Conventional electroporation lacks biomolecular specificity resulting in low cell viability and non-uniform transfection. We developed a single molecule specific and highly efficient strategy transfection single cells. Figure (a) illustrates the new nanopore-electroporation-tool (NEP): A confocal micrograph showing the silicon nitrate membrane with nanopore (b). The membrane separates the cis microfluidic channel from the trans. On the cis-side, 20 kbp double-stranded DNA intercalated with YOYO dye is conveyed via the microfluidic to the membrane. Inside the trans channel an E. coli cell is placed using optical tweezers in close proximity to the pore_so close that the field emanating from it affects cell membrane potential causing it to electroporate; consequently the bacteria fluoresces (a) and is subsequently encapsulated in hydrogel (c). With precise engineering of the geometry molecules such as ions, proteins or RNA can infuse into the gap between membrane and cell, or directly into the cell via electroporation. A pore so close to the cell offers the opportunity to both transfect the cell and measures its secretome simultaneously.