➢ Science and Applications of Nanoscale Materials (E, Li)

The current research activities include solid-state nanopore fabrication, single molecule DNA and protein detection, and artificial photosynthesis. There are **three** research projects that would benefit from contributions of undergraduate researchers. Two of them are nanopore related research projects and the third one is related to artificial photosynthesis.

Project 1. *Molecular Size Solid State Nanopore Fabrication*. Nanometer size pores function as membrane channels in all living systems, where they serve as sensitive electro-mechanical devices, regulating electrical potential, ionic flow, and molecular transport through the cell membrane. Studies of nanopore construction and their characterization for single molecule transport will eventually lead to man-made cell membranes and single molecule detectors.

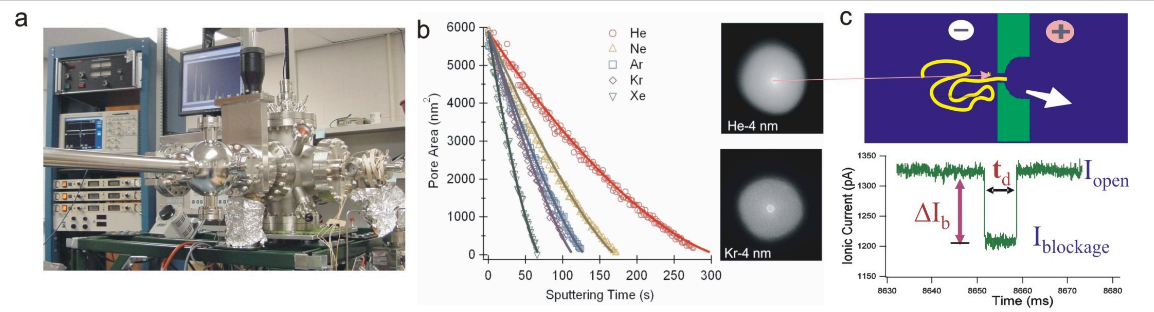

FIG 3: (**a**) Feedback Controlled Ion-Beam Sculpting System built in Physics at UA. **(b)** Ion-beam sculpted nanopores with He, Ne, Ar, Kr, and Xe ion beams. **(c)** a sketch of a solid-state nanopore-based single molecule sensing system (top) and a DNA translocation event (bottom).

Voltage-biased protein channels were first demonstrated capable of detecting single stranded DNA and RNA molecules 15 years ago and 5 years later solid-state nanopores were fabricated to overcome the stability of protein membrane structure. Since that time, nanopore technology has evolved rapidly due to its potential applications in single molecule DNA sequencing. Towards this goal, we have designed and successfully built a feedback-controlled low energy ion beam sculpting system for solid-state nanopore fabrication and nanoscale materials science study [Fig. 3(a)]. This system is capable of making solid-state nanopores of desired dimensions with low energy noble gas ions (Fig. 3 (b)).

Project 2. Detection and characterization of single DNA molecules.

A solid-state nanopore based single molecule sensing system [Fig. 3 (c)] capable of working at different temperatures and solution conditions was designed and constructed. The sensing capabilities of this system were demonstrated by measuring the shape of DNA molecules, the melting of double-stranded DNA to single stranded at high pH values, and the kinetics of single DNA molecules translocation through solid-state nanopores.

Project 3. Developing methods to make light-driven proton pumps.

This research seeks to develop a system that can generate proton gradient (voltage difference) across a lipid bilayer membrane from photon energy as a way of harnessing light energy from the sun. Proton pumps are capable of continuous, renewable conversion of energy in the form of a proton gradient across a membrane. Initially, one of the best characterized proton pump protein, Bacteriorhodopsin (Fig. 3 (d)), will be used to study and generate photocurrent.

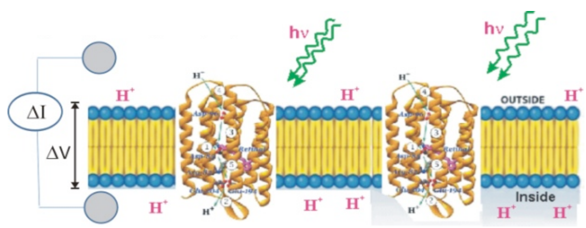

Fig. 3 (d) Light Driven proton pump