Versatile nano-porous silicon dioxide membranes: fabrication, characterisation and application

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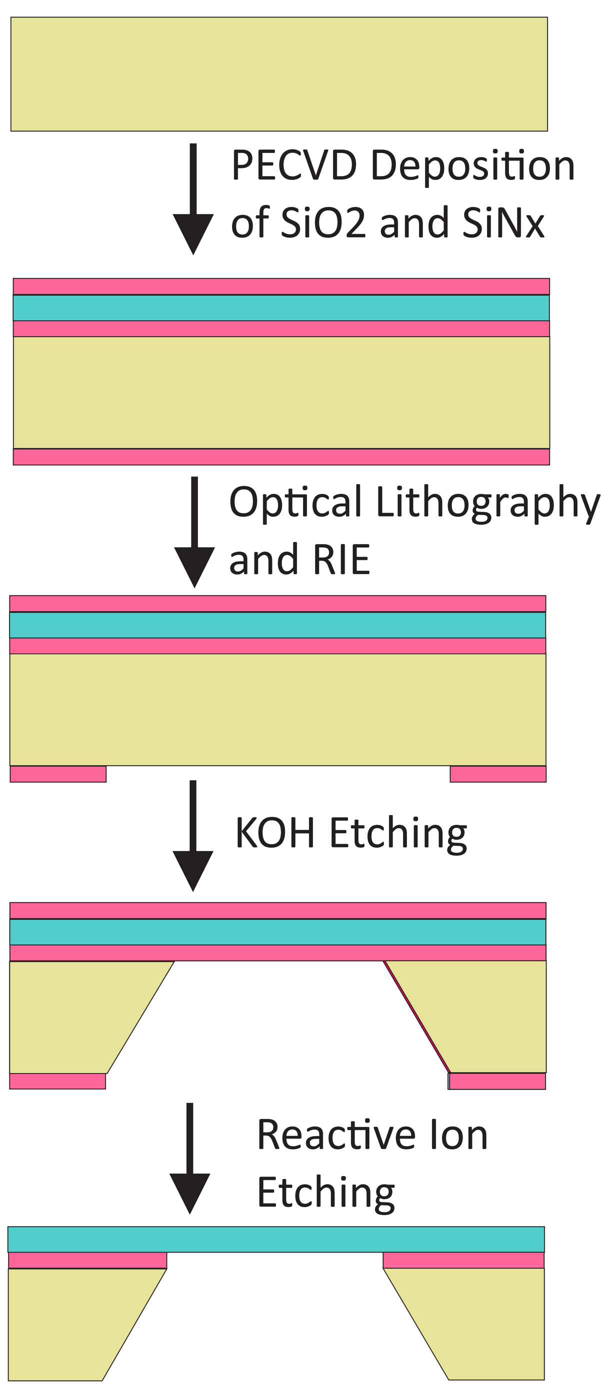
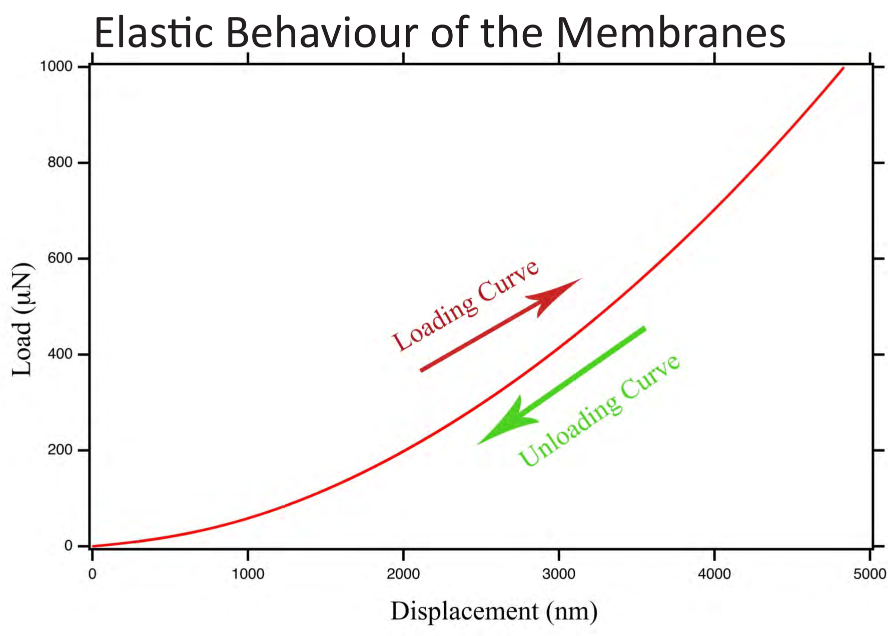
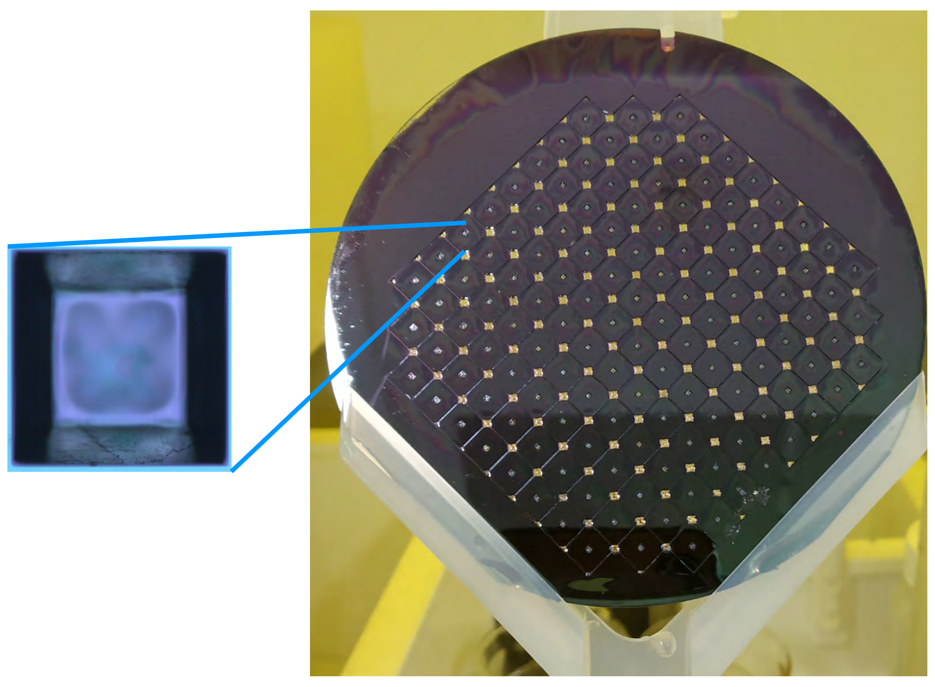
Aims

- Fabrication and characterisation of tunable nano-pores in free-standing SiO_2 membranes using MEMS processing. These membranes have promising applications such as size-selective filtration, ion pumps, direct detection of proteins, desalination etc.
- Functionalisation of nano-pores for detection of bio-markers, proteins, antibodies and gas sensing. For example, coating the nano-pore surfaces with conductive polymer allows the detection of gases such as acetone in the lower parts per billion range. As acetone is a bio-marker for diabetes, these nano-pores will be used to fabricate small devices for diabetes detection - in line with the OHIOH goals.

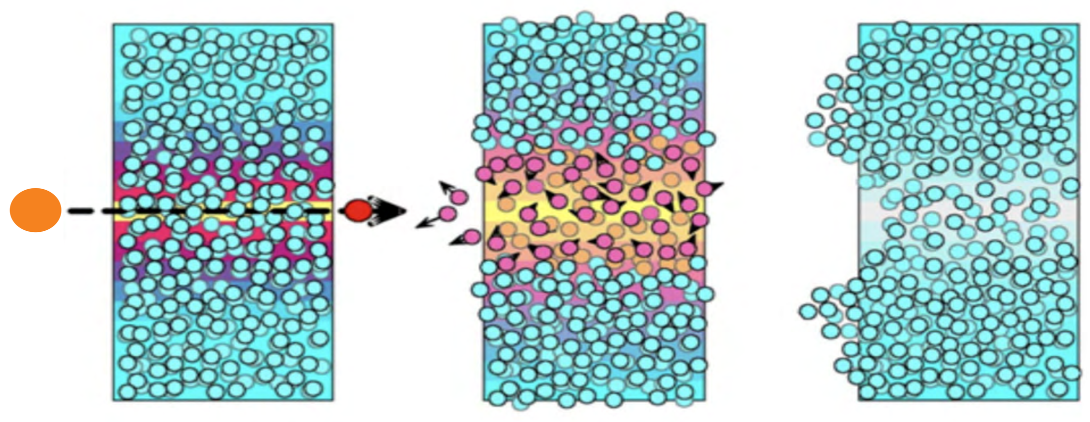
Fabrication of nano-porous membranes





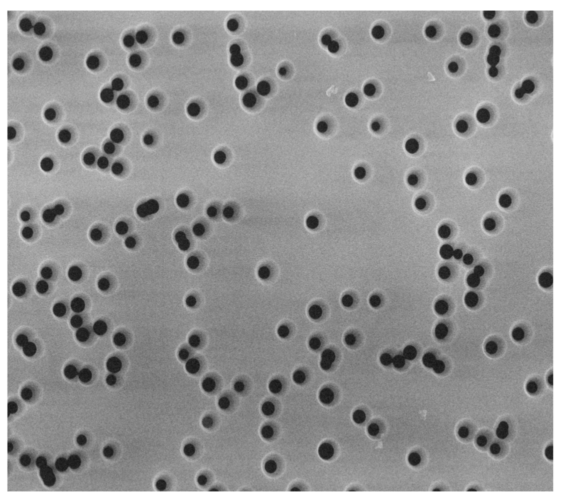


SiO_2 membranes of sizes 20, 50, 200 and 500 square microns were irradiated with 185 MeV and 1.6 GeV Au ions at the 14 UD Pelletron Accelerator and the UNILAC Linear Accelerator respectively with $1x10^8$, $5x10^8$ and $1x10^9$ ions per cm^2. The uniform and randomly distributed ion tracks formed through irradiation were etched in a custom-built etching cell (enabling single sided and double sided etching) using different concentrations of HF.

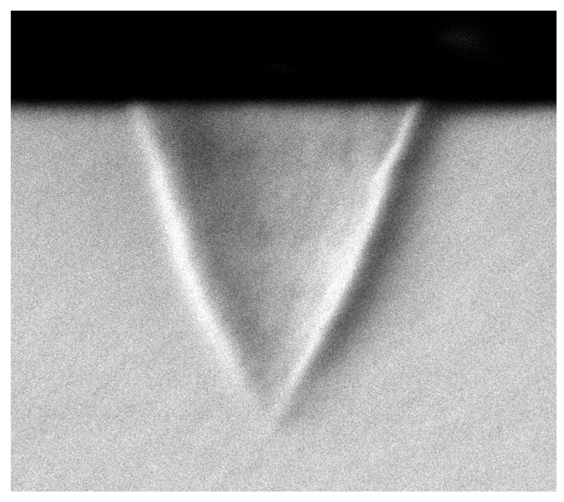


Characterisation

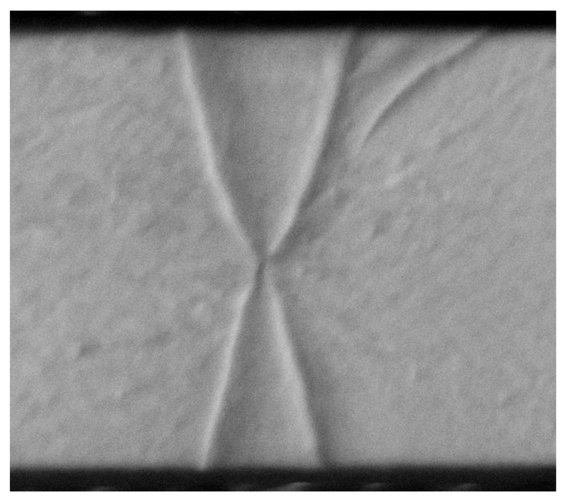
By controlling the etching conditions, the shape and size of the pores can be tailored according to the need of different applications. The opening of the conical pores can be tailored to ~ 10 nm.



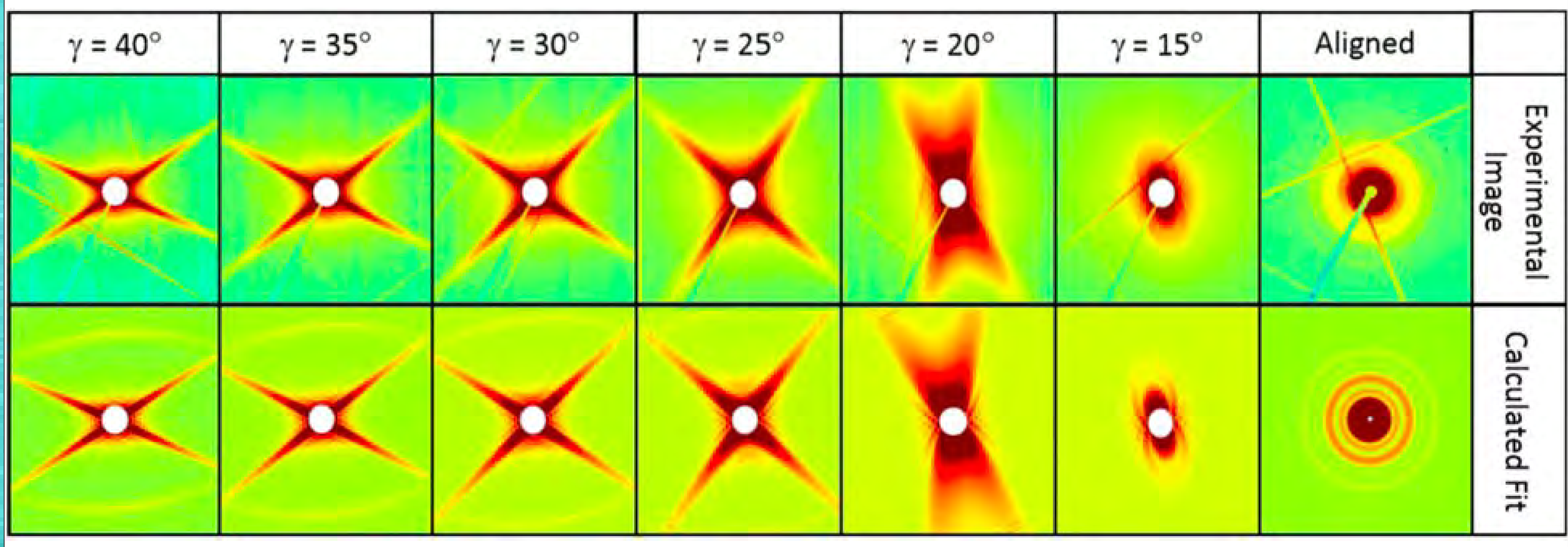
SEM image of etched nanopores in SiO_2



Cross section SEM of single sided etched nanopore

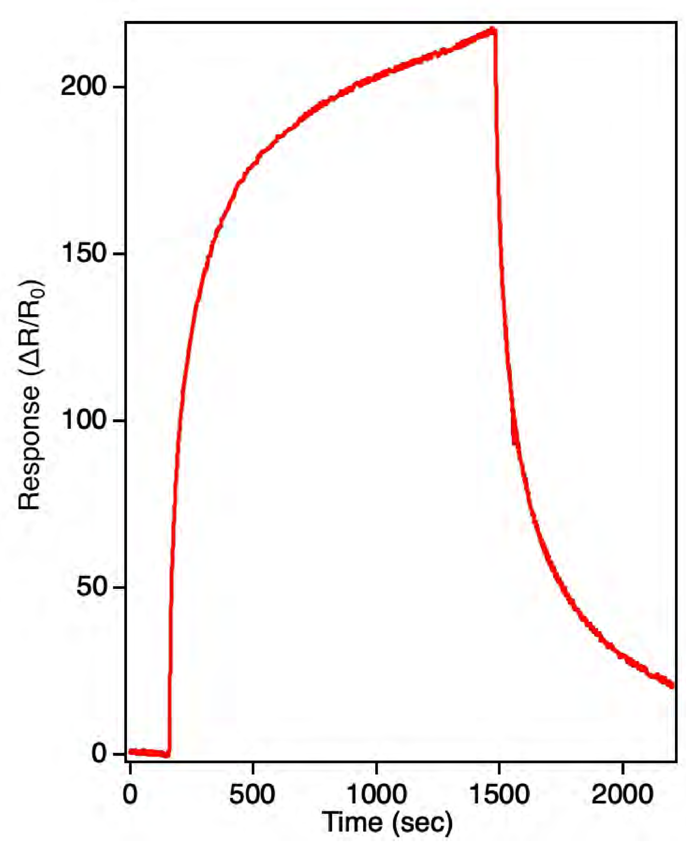


Cross section SEM of double sided etched nanopore



Experimental 2D small-angle X-ray scattering images along with their calculated fits.

Application



No_2 (5ppm) response at room temperature

By coating the nanopore surfaces with a conductive polymer layer, we have modified the surface to sense gases. Based on preliminary results, with adequate optimization, we envision the platform to have a detection resolution in the lower parts per billion (ppb) range and provide a promising platform for health and environmental monitoring.

Future Work

- Optimising the surface coating of the nano-pores to achieve maximum surface area and achieve the ability to sense different gases together.
- Use nano-pore membranes for detection of proteins, DNA, antibodies etc. (See Poster by A. Kiy : Design of a novel electrochemical solid state nano-pore sensor for medical applications)

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