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

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Nanopore membranes have been investigated for over two decades with applications including chemical- and bio-sensing, nano-electronics, nano-fluidics, and filtration. To realize these applications, excellent control over the shape, size, and other properties of the pores is desired. In the present study, we report on the fabrication, characterization, and applications of single- and double-conical nanopores on silicon dioxide (SiO_2) membranes.

Plasma-enhanced chemical vapor deposition is used to deposit thin SiO_2 layers, followed by standard Micro-Electro-Mechanical Systems processing to get a window of a free-standing thin membrane of SiO_2. The nanopore array was fabricated using high energy Au ion irradiation leading to the formation of ion-tracks which were subsequently etched for a predetermined time using hydrofluoric acid. The nanopores were characterized using synchrotron based small-angle X-ray scattering and scanning electron microscopy. Our fabrication procedure permits fine control over the film properties, including stoichiometry, density, thickness, resultant stress, pore size, as well as pore shape. By coating the nanopore surfaces with a conductive polymer layer, we modify the pore-surface to sense gases. Based on preliminary results, we envision the platform to have a detection resolution in the lower parts per billion range and provide a promising platform for health and environmental monitoring.