Swift Heavy Ion Irradiation for Advanced Materials Manufacturing

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When highly energetic heavy ions traverse through a target material, the high electronic excitations can generate long cylindrical damaged regions termed 'ion tracks'. Ion tracks have many interesting applications across a variety of scientific areas such as materials science and engineering, biophysics, nanotechnology, geology, archaeology, nuclear physics, and interplanetary science.

Ion track damage often exhibits preferential chemical etching over the undamaged material. This etch-anisotropy can be used to create pores of up to tens of micrometres in length, with pore diameters as small as several nanometres. Nanopore membranes fabricated by this method are well suited for many advanced applications including ultra-filtration, bio- and medical sensing, nano-fluidics, and nano-electronic devices. A key advantage of the technique is the ability to generate highly parallel pore arrays with extremely narrow size distributions and tuneable pore areal density (from single to millions of pores per cm^2).

The presentation will give an overview of our recent results on the development of functional nanopore membranes in polymers and inorganic materials using swift heavy ion irradiation [1-5]. Examples will include fabrication of nanopores in SiO_2 and $SiON_x$ with tuneable shapes and their application in nanofluidic diodes, separation membranes and biosensors. Characterisation of both the ion tracks and nanopores using small angle x-ray scattering enables the determination of the detailed morphology and etching kinetics of nanopores as well as the detailed geometry of tracks and pores. This does not only facilitate to establish precise fabrication protocols, but also enhances our fundamental understanding of ion track formation.

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