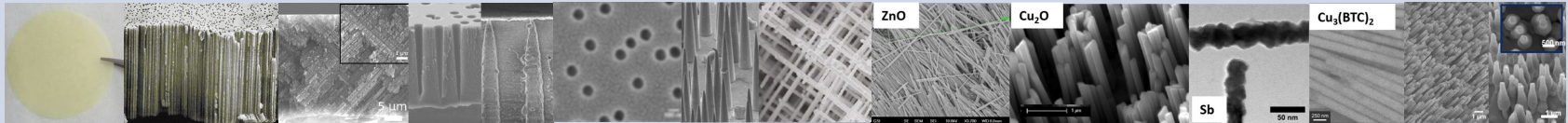


- When materials are irradiated with high-energy heavy ions, each projectile creates a cylindrical damage zone known as ion-track. In particular, in polymers, ion tracks can be selectively dissolved by chemical etching and converted into open channels. Etched ion-track membranes can be further processed by physical or chemical methods, e.g. such that the surface becomes hydrophobic, hydrophilic or responsive, to tailor their ionic transport properties.
- Single-channel membranes i.e. polymer foils with just one nanochannel are produced in a special facility at GSI and applied as nanochannel platform for bio- and chemical sensing.
- The membranes also serve as templates to synthesize tailored nanowires by electrochemical deposition.
- GSI can produce series of membranes or nanowires and, as research partner for development projects with academia or industry analyse and modify the properties of the membranes.



- By electrodeposition inside the nanopores, micro- and nanowires with controlled geometry and crystallinity can be fabricated. Nanowires fabricated by the template method are excellent objects to investigate size-effects on technologically relevant properties such as optical, electrical, and thermal.
 - Single nanopore membranes developed at GSI are employed by many groups around the world to investigate ionic transport through confined nanochannels, and develop novel chemical- and bio sensors.
- The technology could have the following fields of application:
 - Filters, filtration systems
 - Surface protection
 - Supporting tissue for responsive hydrogels and selective molecules
 - Single nanopore sensor
 - Nano- and microwire assemblies
 - Field emitter arrays
 - High surface area electrodes
 - Materials for z-axis electrical interconnectors

Strengths

- The etched ion-track membranes render high separation performance due to a very narrow channel diameter distribution (less than 5%).
- The channels can be parallelly oriented or interconnected under pre-selected angles.

Opportunities

- The combination of controlled channel geometry (cylindrical, conical,..), reduced channel size, and surface modification strategies render the membranes specific ion transport properties, specially for single-channel membranes, that result in specific and sensitive nanofluidic and nanopore-sensing platforms.

Weaknesses

- *Material*: polymer films like polyethylene terephthalate, polycarbonate, polyimide, mica.
- *Sample size*: diameters up to 50 mm.
- *Membrane thickness*: from 6 to 100 μm .
- *Channel density*: between 1 pore/sample and $\sim 10^{10}$ pores/cm².
- *Pore size*: adjustable between 20 nm and a few μm .
- *Aspect ratio*: (diameter/length) up to 1:1000

Threats

- GSI can produce series of the membranes, but large-scale production is not possible.

The technology is protected by the patents:

- DE102008015333A; EP2009001778W; WO2009115228A3
- EP2260125A2; WO2009/115227
- EP2260126A2; WO2009/115230

and complementary GSI proprietary know-how.

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The GSI Helmholtz Centre for Heavy Ion Research in Darmstadt operates one of the world's leading particle accelerator facilities for research. At GSI, FAIR, an international accelerator center for research with antiprotons and ions, is currently being built at GSI in cooperation with international partners. It is one of the largest projects for research worldwide.

<https://fair-center.eu>; <https://www.gsi.de/en>