Ion-Track Membranes and Nanostructured Electrodes

- 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.

Original/Potential Field of Application

- 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

Proposal SWOT Analysis

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.

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 10^{10} pores/cm^2.
- *Pore size*: adjustable between 20 nm and a few µm.
- *Aspect ratio*: (diameter/length) up to 1:1000

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.

Threats

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

IPR Status & Contact Information

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