MAT Ionenstrahlworkshop 2025
September 22-24, 2025 at GSI, Darmstadt

Contribution ID: **118** Type: **Poster**

Electrical Modulation of Ionic Transport in Track-Etched Nanochannels

Monday, September 22, 2025 6:55 PM (20 minutes)

The controlled transport of ions through nanoconfined spaces has emerged as a crucial field with applications ranging from sensing to energy storage. Ion-track technology uses swift heavy ion irradiation to create tracks within the materials, and chemical etching to produce well-defined nanochannels with precisely tunable dimensions and geometries [1]. This attribute makes the channels excellent model systems for studying confined ionic transport phenomena. Unlike approaches that rely on surface functionalization to introduce gating elements [2], our work uses gold-coated nanochannels as a reproducible and straightforward way to modulate ionic transport.

This study investigates the electrical addressability of single bullet-shaped nanochannels in polyethylene terephthalate (PET) membranes to regulate ionic transport. The asymmetric geometry of these nanochannels leads to ionic current rectification (ICR), exhibiting diode-like behavior with distinct "on" and "off" states under different voltage polarities. This behaviour can be tuned by external gate voltages. We systematically examine how deposited contact surfaces, nanochannel length and size influence voltage-gated ionic transport behavior in these systems.

Our findings demonstrate that external electric fields can effectively modulate ionic transport through these nanochannels, providing insight into the design of selective nanofluidic devices. This work contributes to the fundamental understanding of voltage-dependent ionic transport in confined geometries and has potential applications in nanofluidic field-effect transistors, biosensors, and energy storage systems.

References
[1] Toimil-Molares, M.E. Electrochim. Acta, 2012, 84, 98-105.
[2] Harrell, et.al. Journal of the American Chemical Society, 2004, 126, 48, 15646-15647.

Author: KAYA, Dila (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Co-authors: VOSS, Kay-Obbe (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI)); TOIMIL MOLARES, Maria Eugenia (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Presenter: KAYA, Dila (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Session Classification: Posters

Track Classification: Annual Workshop on Ion and Particle Beams (Ionenstrahl Workshop)