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IAPME Seminar

Mimicking the Multifunctionality of Ion Channels by Electrostatically Gated Graphene Nanofluidics

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Venue: N23-1004b
Time: 10:30 - 11:30
Hosted by: Prof. Pengzhan SUN

Abstract

Biological ion channels acting as life's transistors can gate simultaneously fast and selective ion transport through atomic-scale filters to maintain vital life functions. However, the quest of artificial structures to mimic biological systems for medical, sensing and energy applications has been hindered in achieving simultaneous ion selectivity, fast transport, and electrical gating at atomic scale. Recent progress in atomic-scale ion transistor research from fundamental mechanisms to potential applications will be firstly introduced. The atomic-scale ion transistor made of graphene channels of 3 angstrom size achieves simultaneously ultrafast and highly selective ion transport controlled by electrical gating. The underlying mechanism is attributed to the highly dense packing of ions and their concerted movement inside the graphene channels. we also report a subnanometer trilayer graphene (TLG) nanopore with a conical structure as a switchable biomimetic ion filter under electrostatic gating. The nanopores show high ion selectivity and rectified current−voltage characteristics. Inspired by the ultra-sensitive thermoelectric response of thermoTRP channels, boosted thermoelectric response in voltage-gated graphene nanofluidic channels will also be discussed. I will show that a voltage-gated nanofluidic synapse can also be developed based on atomic-scale graphene channels, which exhibits both short- and long-term plasticity. The cation-π interactions at graphene surface enable the nanofluidic synapse to exhibit ultra-long-term memory.

Biography

Prof. Yahui XUE is currently an Associate Professor at the Department of Mechanics and Aerospace Engineering in Southern University of Science and Technology (SUSTech). He received his B.S. in 2009 and Ph.D. in 2015 from College of Engineering at Peking University. Before joining SUSTech in 2021, he worked as a postdoctoral researcher in the Department of Mechanical Engineering at University of California, Berkeley. He received the Lloyd Hamilton Donnell Applied Mechanics Reviews Paper Award from ASME and has authored peer-reviewed articles in prestigious journals including Science, Nature Communications, PRL, Advanced Materials and JFM. His research interests lie in extremely confined ion transport under multifield coupling, microfluidic flow and heat transfer, micro- and nano-mechanics.