

Preface: Iontronics: from fundamentals to ion-controlled devices

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Studying interactions of solvated ions with interfaces and their transport inside ionic devices has been a recurrently hot topic for research at the interface of physics, chemistry, and processing technologies. Iontronics, in a general use of this term, concerns systems in which dissolved ions get transported; at first sight akin to electron and hole transport in semiconductors. However, the driving force in iontronics is not necessarily solely electric, but possibly also osmotic due to an advective fluid flow, or diffusive due to ion concentration gradients. Moreover, due to couplings a particular driving force can generate an “off-diagonal” response in which charge and fluid transport become intrinsically coupled, with a plethora of applications in neuroscience, chemical engineering, and catalysis. Next to continuous interest in the fundamental science behind iontronic phenomena, the societal urgency of the energy transition, especially electricity storage, is playing a focusing role in multidisciplinary collaborations around this topic.

The breadth and diversity of the applications however, creates a dispersion of parallel scientific tracks, which demands special attention to create opportunities for cross-fertilization between these tracks. Our goals in organizing this *Faraday Discussion* have been two-fold:

(1) To present the most recent experimental, theoretical, and numerical methods in the field (*e.g.* atomic force microscopy, single-molecule spectroscopy, nanofluidics, dynamic density functional theory) and review some of the existing challenges, both in fundamental research (*e.g.* understanding nanoscale ion transport) as well as industrial applications (*e.g.* membrane technology, energy storage, imaging at the nanoscale).

(2) To identify and create synergetic interactions between researchers addressing the microscopic and device-level mechanisms involved in these very pressing problems.

In the selection of session topics for this discussion, we have emphasized identifying the key building blocks of iontronic systems and devices. For each block, we have chosen speakers from at least two complementary sub-disciplines

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so as to create synergy in the discussions and create fertile conditions for identifying parallels and persisting challenges. The format of *Faraday Discussions* is ideal for complex and wide-ranging topics. The event in Edinburgh was indeed a meeting point for researchers from very different backgrounds and expertise, and succeeded in showcasing the breadth of this emerging field, as well as the futuristic potentials it is offering for the scientific community. This futuristic roadmap is beautifully put in words in the Concluding remarks article by Lydéric Bocquet (<https://doi.org/10.1039/d3fd00138e>).

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