PROBING DIELECTRIC AND CONDUCTIVE PROPERTIES OF 2D CONFINED AQUEOUS ELECTROLYTES

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Understanding the behaviour of water and electrolytes under nanoscale confinement is essential to emerging nanotechnologies and a wide array of physical, chemical, and biological phenomena such as biomolecular assembly, ionic transport, interfacial charge transfer, and electrochemical energy systems [1]. While it is well established that the properties of confined water and electrolytes differ markedly from those of bulk water, their dielectric behaviour remains poorly understood, primarily due to the difficulty of reliably measuring dielectric signals on the nanoscale [2]. Here we employ an advanced scanning probe technique, scanning dielectric microscopy, in combination with nanochannels made of van der Waals crystals to probe the dielectric properties of confined aqueous electrolytes at the atomic scale, extending our recent studies that revealed anomalous dielectric properties of confined water in the out-of-plane [3] and in-plane [4] direction. Our devices were fabricated adapting procedures presented in Refs. [3,4]. This work offers new insights into the behaviour of nanoconfined water and electrolytes, which are important for advancing technologies in energy storage, nanofluidics and electrochemistry, and our understanding of molecular structuring and interactions.

References

[1] Eisenberg, D. & Kauzmann, OUP Oxford, (2005).
[2] Fumagalli, L. et al, Nat. Mater, 11, (2012), 808-816.
[3] Fumagalli, L. et al, Science, 360, (2018), 1339-1342.
[4] Wang et al, Nature, 646, (2025), 606-610.

Figures

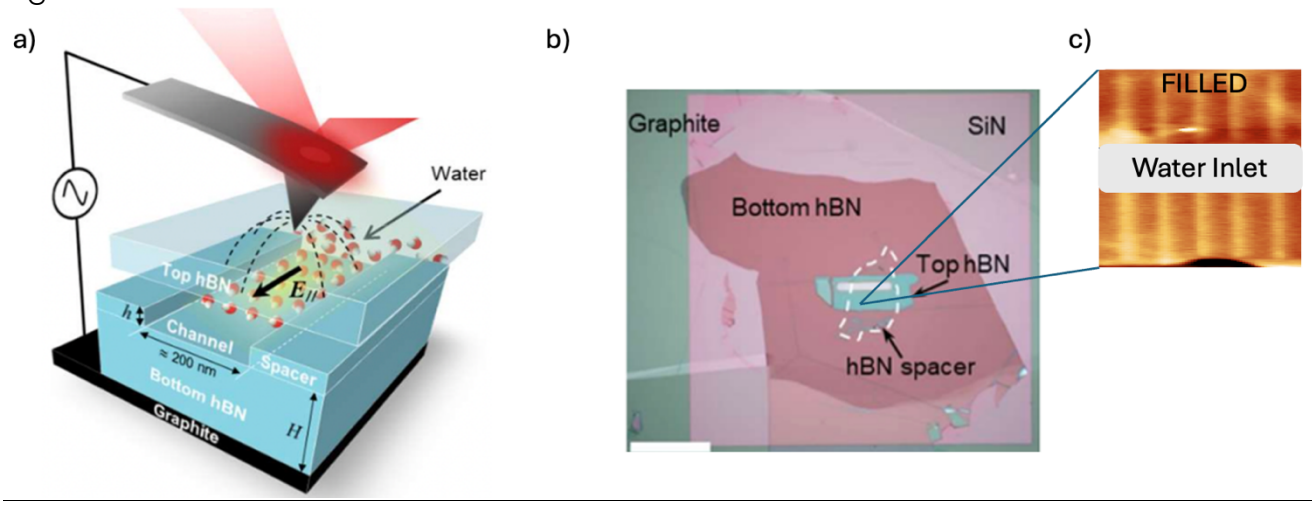

Figure 1: Broadband dielectric mapping and spectroscopy of water under confinement. (a) Sketch of the experimental setup (taken from Ref [4]). (b) Optical image of one of our hBN based device. Scale bar: 20 μm. (c) Representative topography image of one of our devices after filling the nanochannels with aqueous electrolytes.