Massimo Spina
Nathan Ronceray, Mordjann Souilamas, Kittipitch Yooprasertchuti, Slaven Garaj
NUS, 6 Science Drive 2, Singapore

C2dms@nus.edu.sg

Ionic mobility engineering in graphitic nanochannels

Nanochannels based on carbon materials have been intensively studied in the last decade because of their promising application in nanofiltration [1, 2] and the novel physical phenomena arising between graphitic surfaces at the nanoscale [3–6]. More recently, atomically-smooth graphitic channels with sub-nm heights have been fabricated and used to investigate the physics of ions and water molecules in slits comparable to the smallest ion sizes. It has been shown that water flows very fast inside those channels [3], while ionic mobilities are influenced by the distortion of their hydration shells within the narrow channels [4].
In this work, we investigated ionic flow in atomically-smooth graphitic channels with height ranging from 7Å to 35nm. We show that the mobilities of ions in such confinements do not scale with hydration shell in a simple fashion, and we further explored the role of the surface charge, physical confinement and chemical interactions. Engineering ionic mobilities within the graphitic channels, we could induce strong current driven by the salinity gradient. Such osmotic power generators – driven by mobility engineering, rather than surface charge – are more resilient on the variation of chemical environment and show orders of magnitude increase in osmotic power density compared to commercial membranes.

References

[1] S. Hong et al., Nano Lett. 17 (2017) 728–732
[2] J. Abraham et al., Nat. Nanotechnol. 12, (2017) 546–550
[3] B. Radha et al., Nature. 538, (2016) 222–225
[4] A. Esfandiar et al., Science. 358, (2017) 511–513
[5] E. Secchi, A. Niguès, L. Jubin, A. Siria, L. Bocquet, Phys. Rev. Lett. 116, (2016) 154501
[6] Q. Xie et al., Nat. Nanotechnol. 13, (2018) 238–245

Figures

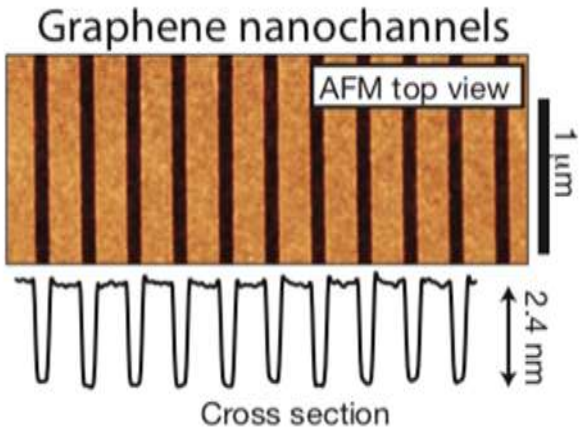

Figure 1: AFM image of few-layer graphene spacers.