Bottom-up synthesis of centimeter size, atomically/molecularly thin amorphous carbon membrane for efficient energy harvesting from salinity gradient

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Nanoporous atomically thin materials have recently attracted great attention owing to its potential application for bio-molecules sequencing [1], ion transport [1], gas separation [2], water purification [3] and energy generation [4]. However, the preparation of large size (a typical area bigger than square millimeters) atomically thin membrane with nanometer pores is still challenging. Here we report a bottom-up approach to synthesize centimeter size, atomically/molecularly thin amorphous carbon membrane from amphiphilic polycyclic aromatic hydrocarbons, with thickness even down to 0.35 nm. The ionic conductance measurements reveal that the molecularly thin membrane, comprising pores of 3.6 ± 1.8 nm, is cation-selective. The membrane can efficiently convert the salinity gradient energy into electricity, with an energy conversion efficiency of 40 % and an output power density of 67 W/m^2.[5] The atomically/molecularly thin amorphous carbon membranes we introduce therefore represent new scaffolds that will add to the rapidly developing fields of sustainable energy and membrane technology.

References

[1] H. Arjmandi-Tash, L. A. Belyaeva and G. F. Schneider, Chem. Soc. Rev., 2016, 45, 476-493.
[2] D.E. Jiang, V. R. Cooper and S. Dai, Nano Lett., 2009, 9, 4019-4024.
[3] E. N. Wang and R. Karnik, Nat Nanotechnol, 2012, 7, 552-554.
[4] J. D. Feng, M. Graf, K. Liu, et al, Nature, 2016, 536, 197-200.
[5] X. Liu, M. He, D. Calvani, et al, Nat. Nanotechnol, 2020, in press.

Figures

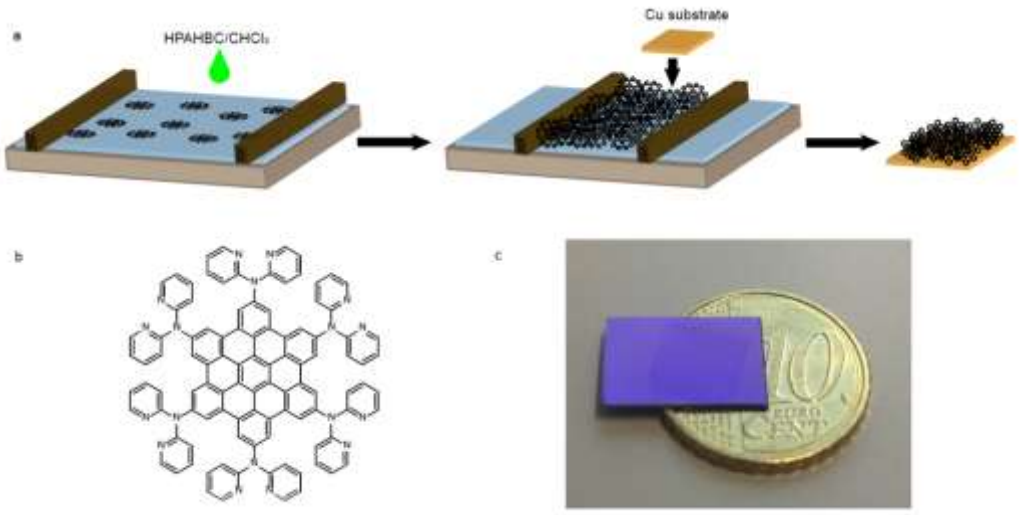

Figure 1: a) The preparation of the amorphous carbon membrane. b) Chemical structure of monomer used for membrane preparation. c) A photograph of membrane transferred on Si/SiO_2 wafer. The size of the membrane is about 1×1 cm^2.