# A nanoporous 2D membrane composed of graphene for direct methanol fuel cell

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Permselectivity of membranes is crucial in the design of high performance fuel cell which requires high permeability for charge carrier while preventing fuel crossover[1]. Functionalized graphene monolayer could trade off permeability and selectivity well owing to ultra-thin thickness which allows fast mass transport[2]. To integrate a nanoporous 2D membrane in a fuel cell, the challenges are three-fold: i) the need of high porosity with subnanometer pore ideally only allowing proton transport; ii) charged surface ensures high cation/anion selectivity; iii) proper support that allows easy fabrication of membrane electrode assembly (MEA)[3,4]. We prepared MEA for direct methanol fuel cell (DMFC) with sulfobenzendiazonium treated graphene monolayer supported by porous polycarbonate membrane and protected by a proton reservoir layer. For diazonium treatment, ~46% of ion pathways are selective to proton with respect to $K^+$ and trans membrane conductance reaches 180 S $cm^{-2}$. This also enhanced power output in DMFC by 102% comparing to Nafion 117. We attribute these to deformation of $SP^2$ network of graphene with diazonium reaction which also introduce positive charge to the surface. Investigation of MEA with diazonium treated graphene offers opportunities to an utilization of graphene in separation membrane based on the control in nanoscale.

## References

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[2] Holmes, S. M. et al. Adv. Energy Mater. 7 (2017) 7.
[3] Koenig, S. P., Wang, L. D., Pellegrino, J. & Bunch, J. S. Selective molecular sieving through porous graphene. Nature Nanotechnology, 7 (2012) 728-732.
[4] Wang, L. D. et al. Nature Nanotechnology, 12 (2017) 509-522.

## Figures

**a)** **b)**

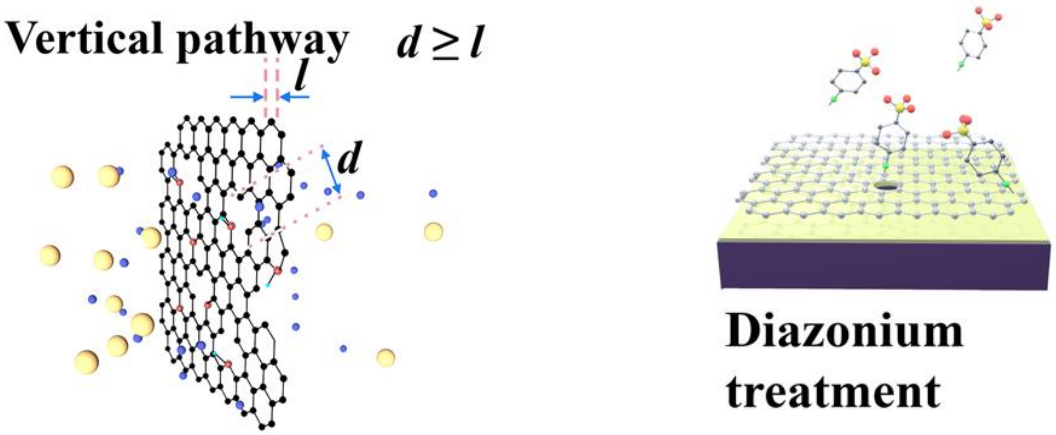


**Figure 1:** Illustrates of nanoporous graphene membrane. a) Vertical ion pathway through a nanoporous graphene membrane. b) Diazonium treatment of graphene on SiN/Si chip with 1 µm aperture.