Model and application for graphene proton exchange membrane

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Abstract
Graphene's selective transport for proton brings prospects in proton exchange membrane (PEM) area [1][2], and may solve the fuel permeation problem that hinders the development of fuel cell technology. In this work, we modified the surface of graphene with functional molecules, which can optimize its hydrophilicity, introduce strain and adjust its catalytic behaviour. We noticed the capacitive effect of ions in solution across graphene under bias, so we established an electrical model of protons passing through graphene and measured its impedance spectra. After optimisation, we developed the graphene PEM in a direct methanol fuel cell (DMFC). As shown in Figure 2, the graphene PEM can reach twice the performance of the commercially used Nafion 117 membrane under the same test conditions in DMFC, making fuel cells more powerful.

References

[1] Lozada-Hidalgo, M., Geim, A., Griffin, E. et al (Accepted/In press). Proton transport through nanoscale corrugations in two-dimensional crystals. Nature.
[2] Mogg, L., Zhang, S., Hao, GP. et al. Perfect proton selectivity in ion transport through two-dimensional crystals. Nat Commun 10, 4243 (2019).

Figures

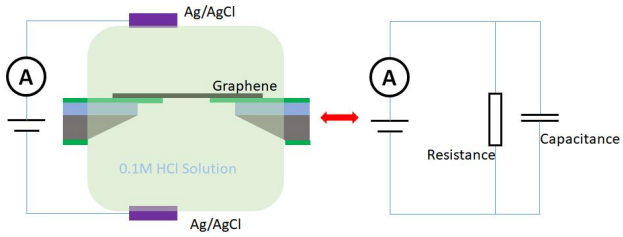

Figure 1: Graphene supported by micropore is used for the proton transmembrane test. It can be moulded to resistance in parallel with capacitance.

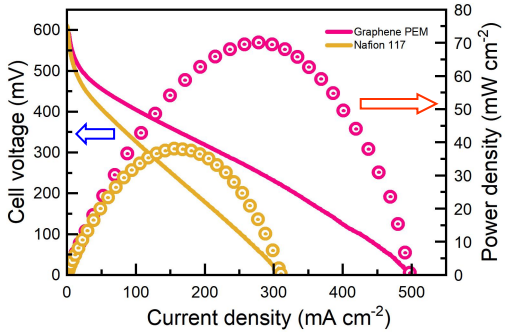

Figure 2: Output curve and power density curve tested in DMFC with 1M methanol at 60 °C.