Proton transport through non-covalently functionalized graphene

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Propositions

Accompanying the thesis

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1. Non-covalent surface functionalization is indispensable to tune the proton conductivity of graphene without sacrificing its structural integrity.
2. Using bare Ag/AgCl electrodes in graphene proton transport measurements is impaired by contamination from AgCl particles which inevitably alter the surface chemistry of graphene (*Chapter 2 of this thesis*).
3. Agarose hydrogel coatings should be considered a practical standard method for eliminating electrode-induced artifacts in graphene electrochemical measurements (*Chapter 2 of this thesis*).
4. The spatial distribution of functional groups on graphene can be deliberately engineered to control the directionality of proton transport, effectively creating a "proton diode" membrane (*Chapter 3 of this thesis*).
5. The graphene–Nafion interface, rather than graphene or Nafion materials alone, determines the ultimate performance of composite fuel cell membranes (*Chapter 3, Chapter 4 and Chapter 5 of this thesis*).
6. Sodium dodecyl sulfate (SDS) likely introduces sulfate groups at the graphene-Nafion interface, which increases the interfacial proton transfer sites and thus enhances its proton conductance (*Chapter 3 and Chapter 4 of this thesis*).
7. Proton-conductive 2D membranes represent a critical frontier in applied materials science with pressing industrial relevance (M. Lozada-Hidalgo *et al., Science*, **2016**, 351, 68-70).
8. Functionalizing graphene non-covalently improves the performance of direct methanol fuel cells and will also improve the performance of direct formic acid fuel cells and direct ethanol fuel cells.
9. Scientific innovation in advanced materials is a prerequisite for chemical sustainability and global technological competitiveness.
10. True creativity in science arises from mastering existing knowledge and the courage of scientists to challenge it.

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