

# Proton transport through non-covalently functionalized graphene

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## **Propositions**

#### Accompanying the thesis

## Proton transport through non-covalently functionalized graphene

- 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*).
- 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).
- 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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