Claims

1. A graphene oxide-based membrane comprising:
   - a porous conductive substrate; and
   - a plurality of layers of single-layered graphene oxide formed on a surface of the substrate, each of the plurality of layers of single-layered graphene oxide is functionalised by at least one diamine functional group,

wherein interlayer spacing between two adjacent layers of single-layered graphene oxide is ≤ 10 Å.

2. The membrane according to claim 1, wherein the interlayer spacing between two adjacent layers of single-layered graphene oxide is 5.5-7 Å.

3. The membrane according to claim 1 or 2, wherein the at least one diamine functional group is comprised in a spacer molecule.

4. The membrane according to claim 3, wherein the spacer molecule comprises methanediamine, ethylenediamine (EDA), p-phenylenediamine, or mixtures thereof.

5. The membrane according to any preceding claim, wherein the porous conductive substrate comprises a porous carbon-based conductive substrate.

6. The membrane according to any preceding claim, wherein the porous conductive substrate comprises a carbon fibre substrate.

7. The membrane according to any preceding claim, wherein each of the plurality of layers of single-layered graphene oxide is functionalised by at least one diamine functional group by cross-linking the at least one diamine functional group to the graphene oxide.

8. A method of forming a graphene oxide-based membrane according to any preceding claim, the method comprising:
   - dispersing graphene oxide flakes in a solvent to form a single-layered graphene oxide dispersion;

- mixing the dispersion with spacer molecules comprising a diamine functional group to form a mixture;
- passing the mixture through a surface of a substrate to form a nascent membrane on the surface of the substrate; and
- heating the nascent membrane to form a graphene oxide-based membrane.

9. The method according to claim 8, wherein the dispersing comprises ultrasonicating the dispersion.

10. The method according to claim 8 or 9, wherein the diamine functional group comprised in the spacer molecules comprise methanediamine, ethylenediamine (EDA), p-phenylenediamine, or mixtures thereof.

11. The method according to any of claims 8 to 10, wherein the passing comprises vacuum filtering the mixture through the surface of the substrate.

12. The method according to any of claims 8 to 11, wherein the substrate is supported on a filter.

13. The method according to claim 12, wherein the method further comprises removing the filter after the passing.

14. An electrocapacitive unit comprising a graphene oxide-based membrane according to any of claims 1 to 7.

15. The electrocapacitive unit according to claim 14, further comprising an anode and a cathode such that the graphene oxide-based membrane is between the anode and the cathode.

16. The electrocapacitive unit according to claim 15, wherein each of the anode and the cathode comprise porous carbon-based material.

17. The electrocapacitive unit according to any of claims 14 to 16, wherein the electrocapacitive unit is comprised in an electrocapacitive module.

18. The electrocapacitive unit according to claim 17, wherein the electrocapacitive module comprises two or more electrocapacitive units arranged in a parallel configuration.

19. The electrocapacitive unit according to claim 18, wherein the electrocapacitive module comprises two or more electrocapacitive units arranged in a series configuration.

20. The electrocapacitive unit according to any of claims 14 to 19, wherein the electrocapacitive unit is comprised in a regenerative dialysis system for regenerating dialysate.

21. The electrocapacitive unit according to claim 20, wherein the graphene oxide-based membrane enables removal of excess ions from spent dialysate passing through the regenerative dialysis system.