

Claims

1. A graphene oxide-based membrane comprising:
 - a 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 $\leq 10 \text{ \AA}$.
2. The membrane according to claim 1, wherein the interlayer spacing between two adjacent layers of single-layered graphene oxide is $5.5\text{-}7 \text{ \AA}$.
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 substrate is a porous conductive substrate.
6. The membrane according to claim 5, wherein the porous conductive substrate comprises a porous carbon-based conductive substrate.
7. The membrane according to claim 5 or 6, wherein the porous conductive substrate comprises a carbon fibre substrate.
8. 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.

9. A method of forming a graphene oxide-based membrane according to any of preceding claim, the method comprising:

- dispersing graphene oxide flakes in a solvent to form a single-layered graphene oxide dispersion;
- 5 - 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
- 10 - heating the nascent membrane to form a graphene oxide-based membrane.

10. The method according to claim 9, wherein the dispersing comprises ultrasonication of the dispersion.

15 11. The method according to claim 9 or 10, wherein the diamine functional group comprised in the spacer molecules comprise methanedi-amine, ethylenedi-amine (EDA), p-phenylenedi-amine, or mixtures thereof.

12. The method according to any of claims 9 to 11, wherein the passing comprises
20 vacuum filtering the mixture through the surface of the substrate.

13. The method according to any of claims 9 to 12, wherein the substrate is supported on a filter.

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

15. An electrocapacitive unit comprising a graphene oxide-based membrane according to any of claims 1 to 8.

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

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

18. The electrocapacitive unit according to any of claims 15 to 17, wherein the
5 electrocapacitive unit is comprised in an electrocapacitive module.

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

15 21. The electrocapacitive unit according to any of claims 15 to 20, wherein the electrocapacitive unit is comprised in a regenerative dialysis system for regenerating dialysate.

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