CLAIMS

1. The use of a reduced graphene oxide laminate membrane as a barrier material, wherein the reduced graphene oxide laminate membrane is formed from the reduction of a graphene oxide laminate membrane with a reducing agent which does not generate significant amounts of CO_2 or CO as a major component when it reduces graphene oxide and /or wherein reduction of the graphene oxide with the reducing agent leads to the oxygen originating from the graphene oxide which is displaced being substantially or exclusively expelled as water.

2. The use of claim 1, wherein the reducing agent is selected from one or more of: HI, HBr and ascorbic acid (vitamin C).

3. The use of claim 1 or claim 2, wherein the reduced graphene oxide laminate membrane is supported on a substrate.

4. The use of any one of claims 1 to 3 wherein a cross-linking agent is interspersed throughout the reduced graphene oxide laminate.

5. The use of claim 4, wherein the cross-linking agent is a polymer.

6. The use of claim 5, wherein the polymer is PVA.

7. The use of any one of claims 4 to 6, wherein the amount of rGO in the laminate is from 30 weight% to 98 weight%.

8. The use of any one of claims 1 to 7, wherein an adhesion promoter is situated between the reduced graphene oxide laminate and the substrate.

9. The use of any one of claims 1 to 8, wherein the substrate is PET.

10. The use of claim 8, wherein the substrate is a metal substrate and the adhesion promoter is selected from phytic acid, poly(methyl methacrylate) (PMMA) and polystyrene.

11. The use of claim 8, wherein the substrate is a glass or silicon based substrate and the adhesion promoter is sodium metasilicate.

12. A method of making a barrier material, the method comprising the step of reducing a graphene oxide laminate to form reduced graphene oxide laminate with a reducing agent which does not generate CO_2 or CO as a major component when it reduces graphene oxide; wherein the method comprises the following steps:

A) supporting a graphene oxide laminate membrane on a substrate; and

B) reducing the graphene oxide to form a reduced graphene oxide laminate membrane supported on the substrate;

and the method also comprises

Ai) mixing a suspension of GO with a solution or suspension of a polymer to form a GO/polymer mixture;

Aii) depositing the mixture onto the substrate to form a graphene oxide polymer composite laminate membrane supported on the substrate; and

B) reducing the graphene oxide to form a reduced graphene oxide polymer composite laminate membrane supported on the substrate.

13. The method of claim 12, wherein the reducing agent is selected from one or more of: HI, HBr and ascorbic acid (vitamin C).

14. The method of claim 12, wherein the polymer is PVA.

15. The method of claim 12, wherein the method comprises:

Ai) mixing a suspension of GO with a solution or suspension of a cross-linking agent to form a GO/crosslinking agent mixture;

Aii) depositing the mixture onto the substrate to form a cross-linked graphene oxide composite laminate membrane supported on the substrate; and

B) reducing the graphene oxide to form a reduced graphene oxide composite laminate membrane supported on the substrate.

16. The method of any one of claims 12 to 14, wherein the method comprises, before the GO membrane is supported on the substrate, the step of modifying the substrate to increase the strength of the association between the substrate and the GO and/or rGO laminate membrane.

17. The method of claim 16, wherein modifying the substrate comprises coating the surface of the substrate with an adhesion promoter.

18. The method of claim 16, wherein the substrate is a polymer substrate and the step of modifying the substrate comprises oxidising the surface of the substrate by exposing it to ozone and/or oxygen plasma to form an oxidised polymer substrate.

19. The method of claim 18, wherein the polymer substrate is PET.

20. The method of any one of claims 12 to 17, wherein the substrate is a porous structure or material and the method is a method of reducing the porosity of a porous structure or material.

21. A barrier material comprising:

an oxidised polymer substrate; and

a reduced graphene oxide laminate membrane;

wherein the reduced graphene oxide laminate membrane is formed from the reduction of the corresponding graphene oxide laminate membrane with a reducing agent which does not generate CO_2 or CO when it reduces graphene oxide and/or wherein reduction of the corresponding graphene oxide laminate with the reducing agent leads to the oxygen originating from the graphene oxide being substantially or exclusively expelled as water;

wherein the oxidised polymer substrate has a higher oxygen content than a corresponding polymer that has not been oxidised.

22. The barrier material of claim 21, wherein the oxidised polymer is oxidised PET.

23. A reduced graphene oxide laminate membrane, wherein the reduced graphene oxide membrane is affixed to a metal substrate and an adhesion promoter is dispersed throughout the reduced graphene oxide laminate and/or or between the reduced graphene oxide laminate and the substrate and wherein the reduced graphene oxide laminate membrane is formed from the reduction of the corresponding graphene oxide laminate membrane with a reducing agent which does not generate CO_2 or CO when it reduces graphene oxide and/or wherein reduction of the corresponding graphene oxide laminate with the reducing agent leads to the oxygen originating from the graphene oxide being substantially or exclusively expelled as water.

24. A membrane of claim 23, wherein the adhesion promoter is a polymer.

25. A membrane of claim 24, wherein the polymer is PVA.

26. A membrane of claim 23, wherein the adhesion promoter is phytic acid. e.g. PMMA, PVA, polystyrene, poly(4-styrenesulfonate), Nafion, carboxymethyl cellulose, Chitosan, polyvinyl pyrrolidone, polyaniline.

27. A reduced graphene oxide laminate membrane, wherein the reduced graphene oxide membrane is affixed to a glass or silicon based substrate and an adhesion promoter is dispersed throughout the reduced graphene oxide laminate and/or or between the reduced graphene oxide laminate and the substrate and wherein the reduced graphene oxide laminate membrane is formed from the reduction of the corresponding graphene oxide laminate membrane with a reducing agent which does not generate CO_2 or CO when it reduces graphene oxide and/or wherein reduction of the corresponding graphene oxide laminate with the reducing agent leads to the oxygen originating from the graphene oxide being substantially or exclusively expelled as water.

28. A membrane of claim 27, wherein the adhesion promoter is sodium metasilicate.

29. A membrane or barrier material of any one of claims 21 to 28, wherein the reducing agent is selected from HI, HBr and ascorbic acid.