nanoplates, graphyne (C) nanoplates, borophene (B) nanoplates, phosphorene (P) nanoplates, or a 2D in-plane heterostructure of two or more of the aforesaid materials.

In some examples of the present disclosure, the 2D nano-materials comprise Layered 2D materials which comprise one or a mixture of graphite flakes in which the graphite flakes have one nanoscale dimension and 35 or less layers, multi-layered graphene (C) nanoplates, multi-layered graphene oxide nanoplates, multi-layered reduced graphene oxide nanoplates, multi-layered hexagonal boron nitride (hBN) nanoplates, multi-layered molybdenum disulphide (MoS_2) nanoplates, multi-layered tungsten diselenide (WSe_2) nanoplates, multi-layered silicene (Si) nanoplates, multi-layered germanene (Ge) nanoplates, multi-layered graphyne (C) nanoplates, multi-layered borophene (B) nanoplates, multi-layered phosphorene (P) nanoplates , or a 2D vertical heterostructure of two or more of the aforesaid materials.

In another aspect, there is provided an object at least partially constructed from a fibre and or fabric reinforced composite material characterised in that the object is comprised at least a first proof coating layer, a first or composite matrix, and one or more fibre and or fabric reinforcement materials in which fibre and or fabric reinforcement material and the composite matrix form a composite element, and the proof coating is comprised of a second matrix having dispersed therein 2D nanomaterial platelets, wherein the 2D nanomaterial platelets are graphene / graphitic platelets and have a D50 particle size of less than 45 µm, less than 30 µm, or less than 15 µm.

As discussed above, epoxy resins and other materials that are suitable for use as the composite matrix for the present invention will, after a relatively short period of exposure to water or humidity, become saturated with water which can exacerbate the effects of hydrolysis on composite materials. The mechanism of hydrolysis is well known and does not need to be discussed herein.

It has been found in general research on graphene that a graphene film can effectively decouple a metallic substrate on which the film is deposited from the environment. It has been shown that a single atomic and defect free film of graphene is impermeable to gas, water and dissolved gasses and ions in that water. It has however been estimated that in the presence of a defect density of $1um^{-2}$ water transportation through graphene can occur at speeds of >1 m/s. Such mass transport rates can account for the observed corrosion effects on metals.

Graphene has many forms and growth of a film by CVD (Chemical Vapor Deposition) is well understood and can give rise to graphene films of 1-3 atomic layers. Such films are used in most experimentation in connection with graphene. Such techniques have limited commercial applicability because they enable only

CLAIMS

1. A method of manufacture of an object from a fibre and or fabric reinforced composite material comprising at least a first layer of a proof coating, a first or composite matrix, and one or more fibre and or fabric reinforcement materials, characterised in that the manufacture steps comprise

a) forming a first layer of the proof coating, and

b) laying up a mixture of the fibre and or fabric reinforcement material and the composite matrix form a composite element,

in which

(i) step (a) is performed first with the first layer of the proof coating being applied to a mould or support, followed by step (b) with layup being performed on a surface of the first layer of the proof coating of step (a); or

(ii) step (b) is performed first with layup being performed on a mould or support, followed by step (a) with the first layer of the proof coating being applied to at least one surface of the composite element of step (b)

characterised in that the proof coating is comprised of a second matrix having dispersed therein 2D nanomaterial platelets, wherein the 2D nanomaterial platelets are graphene / graphitic platelets and have a D50 particle size of less than 45 µm, less than 30 µm, or less than 15 µm.

2. A method according to claim 1 in which the 2D nanomaterial platelets of the proof coating comprise one or a mixture of graphene nanoplates and graphite flakes in which the graphite flakes have one nanoscale dimension and 35 or less layers of atoms.

3. A method according to claim 1 or 2 in which the 2D nanomaterial platelets comprise one or a mixture of graphene (C) nanoplates, graphene oxide

nanoplates, reduced graphene oxide nanoplates, graphite flakes in which the graphite flakes have one nanoscale dimension and 35 or less layers, hexagonal boron nitride (hBN) nanoplates, molybdenum disulphide (MoS_2) nanoplates, tungsten diselenide (WSe_2) nanoplates, silicene (Si) nanoplates, germanene (Ge) nanoplates, graphyne (C) nanoplates, borophene (B) nanoplates, phosphorene (P) nanoplates, multi-layered graphene (C) nanoplates, multi-layered graphene oxide nanoplates, multi-layered reduced graphene oxide nanoplates, multi-layered hexagonal boron nitride (hBN) nanoplates, multi-layered molybdenum disulphide (MoS_2) nanoplates, multi-layered tungsten diselenide (WSe_2) nanoplates, multi-layered silicene (Si) nanoplates, multi-layered germanene (Ge) nanoplates, multi-layered graphyne (C) nanoplates, multi-layered borophene (B) nanoplates, multi-layered phosphorene (P) nanoplates , or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials.

4. A method according to any of claims 1 to 3 in which the manufacture steps further comprise

c) forming a layer of a gelcoat

in which

(iii) step (c) is performed first with the gelcoat being applied to a mould or support, followed by step (a) with the proof coating being formed on a surface of the gelcoat, followed by step (b) with layup being performed on a free surface of the proof coating; or

(iv) step (b) is performed first with layup being performed on a mould or support, followed by step (a) with the first layer of the proof coating being applied to at least one surface of the composite element of step (b), followed by step (c) with the gelcoat being applied to a free surface of the proof coating.

5. A method of manufacture according to any of claims 1 to 4 in which the manufacture steps further comprise forming at least two proof coating layers.

6. A method of manufacture according to claim 5 in which the manufacture steps further comprise at least two proof coating layers overlie different surfaces of the composite element.

7. A method of manufacture according to claim 5 or 6 in which the manufacture steps further comprise overlaying at least one proof coating layer with a further proof coating layer.

8. A method of manufacture according to any of claims 1 to 7 in which the layer of proof coating is created by brushing, spraying or printing.

9. A method of manufacture according to any of claims 1 to 8 in which the proof coating layer has a dried thickness in the range of 5 µm to 100 µm, 5 µm to 50 µm, 10 µm to 30 µm, 25 µm to 100 µm or 40 µm to 60 µm, 25 µm to 100 µm, of 40 µm to 60 µm.

10. A method of manufacture according to any of claims 1 to 9 in which the proof coating is comprised of 0.1 wt% to 0.5 wt% of 2D nanomaterial platelets.

11. A method of manufacture according to any of claims 1 to 10 in which the composite matrix is comprised of one or more thermoset matrices, an unsaturated polyester resin, an orthophthalic polyester resin, a terephthalic polyester resin, an Isophthalic polyester resin, a dicyclopentadiene polyester resin, a chlorendic polyester resin, a vinyl ester resin, an epoxy resin, a cyanate ester, a bismaleimide, a urethane acrylate, a phenolic, a furan or poly(furfuralalcohol), a polyimide, a benzoxazine and mixtures and combinations thereof.

12. A method of manufacture according to any of claims 1 to 11 in which the second matrix is comprised of one or more of crosslinkable resins, epoxy resin, a polyester resin, a vinyl ester resin, acrylics, aminoplasts, urethanes, carbamates, alkyds, silicones, polyureas, silicates, polydimethyl siloxanes, vinyl esters, unsaturated polyesters , an orthophthalic polyester resin, a terephthalic polyester resin, an Isophthalic polyester resin, a dicyclopentadiene polyester resin, a chlorendic

polyester resin, phenolics, furans or poly(furfurylalcohols), polyimides, bezoxazines and non-crosslinkable resins.

13. A method of manufacture according to any of claims 1 to 12 in which the proof coating further comprises a hardener.

14. An object at least partially constructed from a fibre and or fabric reinforced composite material characterised in that the object is comprised at least a first proof coating layer, a first or composite matrix, and one or more fibre and or fabric reinforcement materials in which fibre and or fabric reinforcement material and the composite matrix form a composite element, and the proof coating is comprised of a second matrix having dispersed therein 2D nanomaterial platelets, wherein the 2D nanomaterial platelets are graphene / graphitic platelets and have a D50 particle size of less than 45 µm, less than 30 µm, or less than 15 µm.

15. An object according to claim 14, wherein the proof coating comprises multiple layers of 2D nanomaterial platelets providing a labyrinthine path for the penetration of water and/or other liquids.

16. An object according to claims 14 or 15 in which the 2D nanomaterial platelets of the proof coating comprise one or a mixture of graphene nanoplates and graphite flakes in which the graphite flakes have one nanoscale dimension and 35 or less layers of atoms.

17. An object according to any of claims 14 to 16 in which the 2D nanomaterial platelets comprise one or a mixture of graphene (C) nanoplates, graphene oxide nanoplates, reduced graphene oxide nanoplates, graphite flakes in which the graphite flakes have one nanoscale dimension and 35 or less layers, hexagonal boron nitride (hBN) nanoplates, molybdenum disulphide (MoS_2) nanoplates, tungsten diselenide (WSe_2) nanoplates, silicene (Si) nanoplates, germanene (Ge) nanoplates, graphyne (C) nanoplates, borophene (B) nanoplates, phosphorene (P) nanoplates, multi-layered graphene (C) nanoplates, multi-layered graphene oxide nanoplates, multi-layered reduced graphene oxide nanoplates, multi-layered hexagonal boron nitride (hBN) nanoplates, multi-layered molybdenum disulphide

(MoS_2) nanoplates, multi-layered tungsten diselenide (WSe_2) nanoplates, multi-layered silicene (Si) nanoplates, multi-layered germanene (Ge) nanoplates, multi-layered graphyne (C) nanoplates, multi-layered borophene (B) nanoplates, multi-layered phosphorene (P) nanoplates , or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials.

18. An object according to any of claims 14 to 17 in which the object further comprises a layer of a gelcoat and in which a proof coating layer is between the gelcoat layer and the composite element.

19. An object according to any of claims 14 to 18 in which the object comprises at least two proof coating layers.

20. An object according to claim 19 in which at least two proof coating layers overlie different surfaces of the composite element.

21. An object according to claims 19 or 20 in which at least one proof coating layer is overlaid with a further proof coating layer.

22. An object according to any of claims 14 to 21 in which the proof coating layer has a dried thickness in the range of 5 µm to 100 µm, 5 µm to 50 µm, 10 µm to 30 µm, 25 µm to 100 µm or 40 µm to 60 µm.

23. An object according to any of claims 14 to 22 in which the proof coating is comprised of 0.1 wt% to 0.5 wt% of 2D nanomaterial platelets.

24. An object according to any of claims 14 to 23 in which the composite matrix is comprised of one or more thermoset matrices, an unsaturated polyester resin, an orthophthalic polyester resin, a terephthalic polyester resin, an Isophthalic polyester resin, a dicyclopentadiene polyester resin, a chlorendic polyester resin, a vinyl ester resin, an epoxy resin, a cyanate ester, a bismaleimide, a urethane acrylate, a phenolic, a furan or poly(furfuralalcohol), a polyimide, a benzoxazine and mixtures and combinations thereof.

25. An object according to any of claims 14 to 24 in which the second matrix is comprised of one or more of crosslinkable resins, epoxy resin, a polyester resin, a vinyl ester resin, acrylics, aminoplasts, urethanes, carbamates, alkyds, silicones, polyureas, silicates, polydimethyl siloxanes, vinyl esters, unsaturated polyesters, phenolics, furans or poly(furfurylalcohols), polyimides, bezoxazines and non-crosslinkable resins mixtures.

26. An object according to any of claims 14 to 25 in which the proof coating further comprises a hardener.

27. An object according to any of claims 14 to 26 in which the object is a mould for use in the making of objects from composite materials.