CLAIMS

1. A waterborne protective coating system that comprises at least one binder, water, and a dispersion of 2D material/graphitic nanoplatelets,

wherein the 2D material/graphitic platelets are comprised of one or more of graphene nanoplatelets, graphitic nanoplatelets, and 2D material nanoplatelets and in which the graphene nanoplatelets are comprised of one or more of graphene nanoplates, nanoplates, reduced graphene oxide nanoplates, bilayer graphene nanoplates, bilayer reduced graphene oxide nanoplates, trilayer graphene nanoplates, trilayer reduced graphene oxide nanoplates, few-layer graphene nanoplates, few-layer graphene oxide nanoplates, few-layer reduced graphene oxide nanoplates, and graphene nanoplates of 6 to 10 layers of carbon atoms, and the graphitic platelets are comprised of graphite flakes with at least 10 layers of carbon atoms, the graphitic nanoplatelets are comprised of one or more of graphite nanoplates with 10 to 20 layers of carbon atoms, graphite nanoplates with 10 to 14 layers of carbon atoms, graphite nanoplates with 10 to 35 layers of carbon atoms graphite nanoplates with 10 to 40 layers of carbon atoms, graphite nanoplates with 25 to 30 layers of carbon atoms, graphite nanoplates with 25 to 35 layers of carbon atoms, graphite nanoplates with 20 to 35 layers of carbon atoms, or graphite nanoplates with 20 to 40 layers of carbon atoms, and the 2D material platelets are comprised of one or more of hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2), tungsten diselenide (WSe_2), silicene (Si), germanene (Ge), Graphyne (C), borophene (B), phosphorene (P), or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials,

wherein the dispersion of 2D material/graphitic nanoplatelets comprises 2D material/graphitic nanoplatelets, water, at least one wetting agent, and at least one grinding media, wherein the at least one grinding media is water soluble or functionalised to be water soluble.

~~2. A waterborne protective coating system according to claim 1 in which the 2D material/graphitic platelets are comprised of one or more of graphene nanoplatelets, graphitic nanoplatelets, and 2D material nanoplatelets and in which~~

~~the graphene nanoplatelets are comprised of one or more of graphene nanoplates, nanoplates, reduced graphene oxide nanoplates, bilayer graphene nanoplates, bilayer reduced graphene oxide nanoplates, trilayer graphene nanoplates, trilayer reduced graphene oxide nanoplates, few-layer graphene nanoplates, few-layer graphene oxide nanoplates, few-layer reduced graphene oxide nanoplates, and graphene nanoplates of 6 to 10 layers of carbon atoms, and the graphitic platelets are comprised of graphite flakes with at least 10 layers of carbon atoms,~~

~~the graphitic nanoplatelets are comprised of one or more of graphite nanoplates with 10 to 20 layers of carbon atoms, graphite nanoplates with 10 to 14 layers of carbon atoms, graphite nanoplates with 10 to 35 layers of carbon atoms graphite nanoplates with 10 to 40 layers of carbon atoms, graphite nanoplates with 25 to 30 layers of carbon atoms, graphite nanoplates with 25 to 35 layers of carbon atoms, graphite nanoplates with 20 to 35 layers of carbon atoms, or graphite nanoplates with 20 to 40 layers of carbon atoms, and~~

~~the 2D material platelets are comprised of one or more of hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2), tungsten diselenide (WSe_2), silicene (Si), germanene (Ge), Graphyne (C), borophene (B), phosphorene (P), or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials.~~

2~~3~~. A waterborne protective coating system according to claim 1 ~~or 2~~ in which the 2D material/graphitic platelets comprises at least one 1D material.

3~~4~~. A waterborne protective coating system according to ~~any of~~ claim~~s~~ 1 ~~to~~or 2~~-3~~ in which the coating system further comprises an additive, the additive comprising one of or an mixture of two or more of a dispersing additive for grinding inorganic and organic pigments in water, a defoamer, a pigment, a rheology modifier, a resin or binder, a levelling agent, a substrate wetting agent, a flow additive, a skinning preventor, or a flash rust inhibitor.

~~5. A waterborne protective coating system according to any of claims 1 to 4 in which the dispersion of 2D material/graphitic nanoplatelets comprises 2D material/graphitic nanoplatelets, water, at least one wetting agent, and at least one grinding media.~~

~~6. A waterborne protective coating system according to any of claim 5 in which the at least one grinding media is water soluble or functionalised to be water soluble.~~

47. A waterborne protective coating system according to any of the preceding claims ~~5 or 6~~ in which the at least one wetting agent comprises one of a polymeric wetting agent, an ionic wetting agent, a polymeric non-ionic dispersing and wetting agent, a cationic wetting agent, an amphoteric wetting agent, a Gemini wetting agent, a highly molecular resin-like wetting and dispersing agent or a mixture of two or more of these wetting agents.

58. A waterborne protective coating system according to any of claims 1 to ~~7~~ 4 in which the at least one binder comprises one of an acrylic resin, an alkyd resin, an acrylic-alkyd hybrid resin, an epoxy resin, ~~–~~a polyester resin, a vinyl ester resin, a polyurethane resin, an aminoplast resin, a urethane resin, a polyamide resin, or a mixture of two or more of the aforesaid resins.

69. A waterborne protective coating system according to any of claims 1 to 57 in which the at least one binder comprises an acrylic-alkyd hybrid resin.

710. A waterborne protective coating system according to any of claims 1 to 57 in which the at least one binder comprises an epoxy resin.

811. A method of formulation of a waterborne protective coating system according to any of claims 1 to 710 comprising the steps of

(a) obtaining a liquid dispersion of 2D material/graphitic nanoplatelets, water, at least one wetting agent, and at least one grinding media in an aqueous solution, wherein the at least one grinding media is water soluble or functionalised to be water soluble, and

(b) mixing the liquid dispersion with at least one binder and water;~~.~~

wherein the 2D material/graphitic platelets are comprised of one or more of graphene nanoplatelets, graphitic nanoplatelets, and 2D material nanoplatelets and in which the graphene nanoplatelets are comprised of one or more of graphene nanoplates, nanoplates, reduced graphene oxide nanoplates, bilayer graphene nanoplates, bilayer reduced graphene oxide nanoplates, trilayer graphene

nanoplates, trilayer reduced graphene oxide nanoplates, few-layer graphene nanoplates, few-layer graphene oxide nanoplates, few-layer reduced graphene oxide nanoplates, and graphene nanoplates of 6 to 10 layers of carbon atoms, and the graphitic platelets are comprised of graphite flakes with at least 10 layers of carbon atoms, the graphitic nanoplatelets are comprised of one or more of graphite nanoplates with 10 to 20 layers of carbon atoms, graphite nanoplates with 10 to 14 layers of carbon atoms, graphite nanoplates with 10 to 35 layers of carbon atoms graphite nanoplates with 10 to 40 layers of carbon atoms, graphite nanoplates with 25 to 30 layers of carbon atoms, graphite nanoplates with 25 to 35 layers of carbon atoms, graphite nanoplates with 20 to 35 layers of carbon atoms, or graphite nanoplates with 20 to 40 layers of carbon atoms, and the 2D material platelets are comprised of one or more of hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2), tungsten diselenide (WSe_2), silicene (Si), germanene (Ge), Graphyne (C), borophene (B), phosphorene (P), or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials.

9~~12~~. A method according to claim 8~~10~~ in which the liquid dispersion of 2D material/graphitic nanoplatelets is obtained by the steps of

(i) creating a dispersing medium;

(ii) mixing 2D material/graphitic nanoplatelets into the dispersing medium; and

(iii) subjecting the 2D material/graphitic nanoplatelets to sufficient shear forces and or crushing forces to reduce the particle size of the 2D material/graphitic nanoplatelets,

~~characterised in that the 2D material/graphitic nanoplatelets and~~wherein the dispersing medium mixture comprises the 2D material/graphitic nanoplatelets, the at least one grinding media, water, and the at least one wetting agent~~, and that the at least one grinding media is water soluble or functionalised to be water soluble.~~.

10~~3~~. A method according to claim 9~~12~~ in which the step of subjecting the 2D material/graphitic nanoplatelets to sufficient shear forces and or crushing forces to reduce the particle size of the 2D material/graphitic nanoplatelets is performed using a grinding mill, a dissolver, a bead mill, or a three-roll mill.

114. A method according to claim 912 or 1013 in which the at least one wetting agent comprises one of a polymeric wetting agent, an ionic wetting agent, a polymeric non-ionic dispersing and wetting agent, a cationic wetting agent, an amphoteric wetting agent, a Gemini wetting agent, a highly molecular resin-like wetting and dispersing agent or a mixture of two or more of these wetting agents.

~~15. A method according to any of claims 10 to 13 in which the liquid dispersion of 2D material/graphitic nanoplatelets is an aqueous dispersion.~~

~~16. A method according to any of claims 11 to 15 in which the 2D material/graphitic nanoplatelets are comprised of one or more of graphene nanoplatelets, graphitic nanoplatelets, and 2D material nanoplatelets and in which~~
~~the graphene nanoplatelets are comprised of one or more of graphene nanoplates, reduced graphene oxide nanoplates, bilayer graphene nanoplates, bilayer reduced graphene oxide nanoplates, trilayer graphene nanoplates, trilayer reduced graphene oxide nanoplates, few-layer graphene nanoplates, few-layer graphene oxide nanoplates, few-layer reduced graphene oxide nanoplates, and graphene nanoplates of 6 to 10 layers of carbon atoms, and the graphitic platelets are comprised of graphite nanoplates with at least 10 layers of carbon atoms,~~
~~the graphitic platelets are comprised of one or more of graphite nanoplates with 10 to 20 layers of carbon atoms, graphite nanoplates with 10 to 14 layers of carbon atoms, graphite nanoplates with 10 to 35 layers of carbon atoms graphite nanoplates with 10 to 40 layers of carbon atoms, graphite nanoplates with 25 to 30 layers of carbon atoms, graphite nanoplates with 25 to 35 layers of carbon atoms, graphite nanoplates with 20 to 35 layers of carbon atoms, or graphite nanoplates with 20 to 40 layers of carbon atoms, and~~
~~the 2D material nanoplatelets are comprised of one or more of hexagonal boron nitride (hBN), molybdenum disulphide (MoS_2), tungsten diselenide (WSe_2), silicene (Si), germanene (Ge), Graphyne (C), borophene (B), phosphorene (P), or a 2D in-plane or vertical heterostructure of two or more of the aforesaid materials.~~

127. A method according to any of claims 811 to 116 in which the 2D material/graphitic nanoplatelets comprises at least one 1D material.