[0010] The present invention seeks to provide an edge-functionalised graphene platelet structure which substantially retains the beneficial properties of pure graphene but is also capable of being stored in higher concentrations than existing graphene structures.

Summary

[0011] In one aspect, the present disclosure provides a dispersible graphene platelet including: a base layer of graphene; at least one discontinuous graphene layer stacked on the base layer; wherein the at least one discontinuous layer has a smaller surface area than the base layer; and, wherein the edge regions of the base layer and the at least one discontinuous layer are at least partially functionalised.

[0012] In certain examples of the first aspect, the platelet is able to form a stable dispersion in water at concentrations up to 700 mg/mL.

[0013] In certain examples of the first aspect, the electrical conductivity of the platelet is approximately 900 S/cm.

[0014] In certain examples of the first aspect, the platelet is further functionalised by the addition of metal ions to at least one of the functionalised edges or the surface.

[0015] In certain examples of the first aspect, the metal ions are selected from Fe, Cu, Co, and Sn.

[0016] According to a second aspect, there is provided a polymer-matrix composite material comprising a polymer; and graphene platelets according to the first aspect.

[0017] In certain examples of the second aspect, the polymer is selected from alginate, chitosan, PVA, PEG, PU, PEI, PVDF, PDMS or PEDOT PSS.

[0018] According to a third aspect, there is provided an electrode for electrochemical processes comprising; graphene platelets according the first aspect; and a binder.

[0019] In certain examples of the third aspect, the binder is selected from Nafion and PVDF.

[0020] According to a fourth aspect, there is provided a method for producing an electrode according to the third aspect, comprising: creating a mixture containing graphene platelets according to the first aspect and a binder; and coating the mixture onto an electrode substrate.

[0021] According to a fifth aspect, there is provided a method for producing dispersible graphene platelets including the steps of:

a. suspending graphite or graphene in a solution containing an organic nitrile (such as acetonitrile), an ester (such as ethyl acetate) and water; and

b. reacting the solution containing suspended graphite or graphene with an oxidant (such as ruthenium tetroxide) to at least partially functionalise edge regions of the graphite or graphene.

[0022] In certain examples of the fifth aspect, the method further comprises the step of: cooling the resultant solution obtained in step b. in an ice bath.

[0023] In certain examples of the fifth aspect, the method further comprises the step of: homogenising the resultant solution obtained in step b.

[0024] In certain examples of the fifth aspect, the homogenisation is conducted at 20000 rpm up to 2 hours.

[0025] In certain examples of the fifth aspect, the method further comprises the step of: ultrasonicating the resultant solution obtained in step b.

[0026] In certain examples of the fifth aspect, the method further comprises the step of: filtering the resultant solution obtained in step b to produce a filtered solid.

[0027] In certain examples of the fifth aspect, the method further comprises the step of: washing the filtered solid.

[0028] In certain examples of the fifth aspect, washing includes washing the filtered solid with HCl and water.

[0029] In certain examples of the fifth aspect, the filtered solid is washed with HCl until a filtrate produced by washing the filtered solid is colourless and then with water until the filtrate is neutral.

[0030] In certain examples of the fifth aspect, the filtered solid is washed with an organic solvent such as ethanol or acetone.

[0031] In certain examples of the fifth aspect, the filtered solid is dried in vacuo to produce a dried powder.

[0032] In certain examples of the fifth aspect, the filtered solid is freeze dried to produce a dried powder.

[0033] In certain examples of the fifth aspect, the dried powder is dispersed in water and sonicated for up to 30 minutes, and a resulting mixture is allowed to settle for up to 48 hours to produce a solid and a supernatant, and decanting and filtering the supernatant to produce a graphene powder.

[0034] In certain examples of the fifth aspect, the graphene powder is washed with an organic solvent and dried.

[0035] In certain examples of the fifth aspect, the dried powder is dispersed in water and sonicated for up to 30 minutes, and a resulting mixture is centrifuged to produce a solid and a supernatant.

[0036] In certain examples of the fifth aspect, the oxidant is ruthenium tetroxide.

[0037] In certain examples of the fifth aspect, the ruthenium tetroxide is provided via the reaction of sodium periodate with ruthenium chloride added to the solution containing suspended graphene or graphite.

[0038] In certain examples of the fifth aspect, the graphene or graphite is provided in the form of expanded graphite with an increased interlayer spacing.

[0039] In certain examples of the fifth aspect, the filtered solid is then dispersed in a solution containing metal ions to bind metal ions to at least one of a surface or a functionalised edge of the platelet.

[0040] In certain examples of the fifth aspect, the metal ions are selected from Fe, Cu, Co, and Sn.

[0041] According to a sixth aspect, there is provided a dispersible graphene platelet according to the first aspect, produced by a method according to the fifth aspect.

[0041a] According to a seventh aspect, there is provided a method for producing dispersible graphene platelets including the steps of: suspending graphite or graphene in a solution; and, contacting the solution containing suspended graphite or graphene with an oxidant to at least partially functionalise edge regions of the graphite or graphene.

Brief Description of the Figures

[0042] FIGURE 1 shows a schematic representation of a dispersible graphene platelet.

[0043] FIGURE 2 shows a low magnification bright field TEM image of a single dispersible graphene platelet.

[0044] FIGURE 3 shows a high magnification bright field TEM image of the edge of a dispersible graphene platelet.

[0045] FIGURE 4 shows an SEM image of a dispersible graphene platelet at 5000x magnification.

[0046] FIGURE 5A shows a Raman spectrum for a sample of graphene platelets.

[0047] FIGURE 5B shows a Raman spectrum for 99.9999% graphite.

[0048] FIGURE 6A shows an expanded 2D band from the Raman spectrum of the edges of a dispersible graphene platelet.

[0049] FIGURE 6B shows an expanded 2D band from the Raman spectrum of the basal plane of a dispersible graphene platelet.

[0050] FIGURE 7A shows the XRD spectrum for a sample of graphene platelets.

[0051] FIGURE 7B shows the XRD spectrum for both 99.9999% graphite and graphene platelets.

[0052] FIGURE 8 shows an XPS spectrum for a sample of graphene platelets.

[0053] FIGURE 9 shows a graph of the titration of a dispersion of the graphene platelets.