WHAT IS CLAIMED IS:

~~1. A composition comprising:~~

~~dehydrogenated graphite comprising a plurality of flakes having~~

~~at least one flake in 10 having a size in excess of 10 square micrometers,~~

~~an average thickness of 10 atomic layers or less, and~~

~~a defect density characteristic of at least 50% of μ-Raman spectra of the de-hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters having a D/G area ratio below 0.5.~~

~~2. A composition comprising:~~

~~dehydrogenated graphite comprising a plurality of flakes having~~

~~at least one flake in 10 having a size in excess of 10 square micrometers,~~

~~a coefficient of determination value of 2D single peak fitting of μ-Raman spectra of the de-hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters larger than 0.99 for more than 50 % of the spectra, and~~

~~a defect density characteristic of at least 50% of μ-Raman spectra of the de-hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters having a D/G area ratio below 0.5.~~

~~3. The composition of either claim 1 or 2, wherein more than 60%, for example, more than 80%, or more than 85 % of μ-Raman spectra of the de-hydrogenated graphite have the coefficient of determination value larger than 0.99.~~

~~4. The composition of any one of claims 1 to 3, wherein more than 40%, for example, more than 50% or more than 65 % of the μ-Raman spectra of the de-hydrogenated graphite have the coefficient of determination value larger than 0.995.~~

~~5. The composition of any one of claims 1 to 4, wherein at least one flake in six has a size in excess of 10 square micrometers, for example, at least one flake in four.~~

~~6. The composition of any one of claims 1 to 5, wherein at least one flake in ten has a size in excess of 25 square micrometers, for example, at least two flakes in ten.~~

~~7. The composition of any one of claims 1 to 6, wherein the average thickness is seven atomic layers or less, for example, five atomic layers or less.~~

~~8. The composition of any one of claims 1 to 7, wherein the defect density is characteristic of at least 80% of the collected spectra having a D/G area ratio below 0.5, for example, at least 95% of the collected spectra having a D/G area ratio below 0.5.~~

~~9. The composition of any one of claims 1 to 8, wherein the defect density is characteristic of at least 80% of the collected spectra having a D/G area ratio below 0.5, for example, at least 95% of the collected spectra having a D/G area ratio below 0.5.~~

~~10. The composition of any one of claims 1 to 9, wherein the defect density is characteristic of at least 50% of the collected spectra having a D/G area ratio below 0.2, for example, at least 70% of the collected spectra having a D/G area ratio below 0.2.~~

~~11. The composition of any one of claims 1 to 10, wherein the defect density is characteristic of at the average D/G area ratio being below 0.8, for example, below 0.5 or below 0.2.~~

~~12. The composition of any one of claims 1 to 11, wherein the composition is a particulate powder of dehydrogenated graphite flakes, for example, a black particulate powder of dehydrogenated graphite flakes.~~

~~13. The composition of any one of claims 1 to 12, wherein the plurality of the flakes of the dehydrogenated graphite are wrinkled, crumpled, or folded, for example, wherein the plurality of the flakes are assembled into a 3-dimensional structure.~~

~~14. The composition of any one of claims 1 to 13, wherein the full width half maximum of the G peak in μ-Raman spectra of the de-hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters is larger than 20 reciprocal centimeters, for example, larger than 25 reciprocal centimeters or larger than 30 reciprocal centimeters.~~

~~15. The composition of any one of claims 1 to 14, wherein the μ-Raman spectra of the de-hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters show a broad peak in the range between 1000 and 1800 reciprocal centimeters with a full width half maximum of more than 200 reciprocal centimeters, for example more than 400 reciprocal centimeters.~~

~~16. The composition of any one of claims 1 to 15, wherein more than 1%, for example, more than 5% or more than 10% of the flakes are of a thickness of more than 10 atomic layers.~~

~~17. The composition of any one of claims 1 to 16, wherein the composition is a composite, for example, wherein the composite further includes activated carbon or wherein the composite further includes a polymer.~~

~~18. The composition of any of claims 1 to 17, wherein the composition is a composite and at least 30%, for example, at least 50% or at least 70% of sp3 hybridized carbon sites of the composition are one or more of:~~

~~a) functionalized with a non-hydrogen chemical group,~~

~~b) cross-linked with sp3 hybridized carbon sites of another flakes, or~~

~~c) otherwise chemically modified.~~

~~19. An electrode comprising the composition of any one of claims 1 to 18.~~

~~20. A battery or an electrochemical capacitor comprising the electrode of claim 19, for example, wherein the battery is a lithium battery, a lithium-ion battery, a silicon anode battery, or a lithium sulfur battery.~~

~~21.~~1. An electrode comprising a composition, the composition comprising:

hydrogenated graphite comprising a plurality of flakes having

at least one flake in 10 having a size in excess of 10 square micrometers,

an average thickness of 10 atomic layers or less, and

a defect density characteristic of μ-Raman spectra of the hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters and an excitation power below 2 mW at the focus of an 100X objective having an average D/G area ratio being between 0.2 and 4, wherein the majority of the defects are reversible hydrogenation of sp3-hybridized carbon sites away from the edges of the flakes.

~~22.~~2. An electrode comprising a composition comprising:

a reversibly hydrogenated graphite comprising a plurality of flakes having

at least one flake in 10 having a size in excess of 10 square micrometers,

a coefficient of determination value of 2D single peak fitting of μ-Raman spectra of the graphite after thermal treatment in inert atmosphere at 2 mbar and 800 °C, collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters, of larger than 0.99 for more than 50 % of the spectra, and

a defect density characteristic of μ-Raman spectra of the hydrogenated graphite collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters and an excitation power below 2 mW at the focus of an 100X objective having an average D/G area ratio being between 0.2 and 4, wherein the majority of the defects are reversible hydrogenation of sp3-hybridized carbon sites away from the edges of the flakes.

~~23.~~3. The electrode~~composition~~ of either claim ~~21~~1 or ~~22~~ 2, wherein more than 60%, for example, more than 80%, or more than 85 % of μ-Raman spectra of the graphite have the coefficient of determination value larger than 0.99.

~~24.~~4. The electrode~~composition~~ of any one of claims 1~~21~~ to ~~23~~ 3, wherein more than 40%, for example, more than 50% or more than 65 % of the µ-Raman spectra of the graphite have the coefficient of determination value larger than 0.995.

~~25.~~5. The electrode~~composition~~ of claim 1~~21~~ to ~~24~~ 4, wherein at least one flake in six has a size in excess of 10 square micrometers, for example, at least one flake in four.

~~26.~~6. The electrode~~composition~~ of any of claims 1~~21~~ to ~~25~~ 5, wherein at least one flake in ten has a size in excess of 25 square micrometers, for example, at least two flakes in ten.

~~27.~~7. The electrode~~composition~~ of any of claims 1~~21~~ to ~~26~~ 6, wherein the average thickness is seven atomic layers or less, for example, five atomic layers or less.

~~28.~~8. The electrode~~composition~~ of any of claims 1~~21~~ to ~~27~~ 7, wherein the defect density is characteristic of at least 50% of the µ-Raman spectra collected at 532 nm excitation with a resolution better than 1.8 reciprocal centimeters and an excitation power below 2 mW at the focus of an 100X objective having a D/G area ratio above 0.5, for example, at least 80% or at least 95% of the collected spectra having a D/G area ratio above 0.5.

~~29.~~9. The electrode~~composition~~ of any of claims 1~~21~~ to ~~28~~ 8, wherein the defect density is characteristic of at least 50% of the collected spectra having a D/G area ratio above 0.8, for example, at least 60% or at least 90% of the collected spectra having a D/G area ratio above 0.8.

~~30.~~10. The electrode~~composition~~ of any of claims 1~~21~~ to ~~29~~ 9, wherein the defect density is characteristic of the average D/G area ratio being between 0.4 and 2, for example, between being 0.8 and 1.5.

~~31.~~11. The electrode~~composition~~ of any of claims 1~~21~~ to~~30~~ 10, wherein at least 60%, for example, at least 75% of the defects are reversible hydrogenation of sp3-hybridized carbon sites away from the edges of the flakes.

~~32.~~12. The electrode~~composition~~ of any of claims 1~~21~~ to~~31~~ 11, wherein the composition is a composite and at least 5%, for example, at least 10%, of sp3 hybridized carbon sites of the composition are one or more of:

a) functionalized with a non-hydrogen chemical group,

b) cross-linked with sp3 hybridized carbon sites of another flakes, or

c) otherwise chemically modified.

13. A battery or an electrochemical capacitor comprising the electrode of any one of claims 1 to 12, for example, wherein the battery is a lithium battery, a lithium-ion battery, a silicon anode battery, or a lithium sulfur battery.

~~33. An apparatus (1) for the expansion of the graphite (2) to graphene (7) with at least one container (10) provided for receiving an electrolyte, at least one anode (4) and at least one cathode (3), characterized in that the cathode (3) contains diamond or consists thereof.~~

~~34. The apparatus of claim 33, further comprising a separator (5) which separates the anode (4) from the cathode (3).~~

~~35. The apparatus according to claim 33 or 34, characterized in that the separator (5) is in contact with the surface of the anode (4) or that the separator (5) is diamond and/or polytetrafluoroethylene and/or Al2O3 and/or ceramic and/or quartz and/or glass contains or consists thereof.~~

~~36. The apparatus according to one of claims 33 to 35, further comprising a drive means with which the separator (5), and optionally the anode (4), are rotatable.~~

~~37. The apparatus according to one of claims 33 to 36, characterized in that the separator (5), and optionally the anode (4) are displaceably mounted, so that the~~

~~distance between the cathode (3) and the separator (5) is changeable in operation of the apparatus (1).~~

~~38. The apparatus according to one of claims 33 to 37, further comprising an electric voltage supply set up to apply a DC voltage of from about 5 V to about 60 V between the anode and cathode, or from about 15 V to about 30 V, wherein the voltage is optionally pulsed.~~

~~39. The apparatus according to one of claims 33 to 38, further comprising a feed apparatus (11) by which electrolyte and graphite particles (2) can be fed as a dispersion into the at least one container (10) and/or further comprising a discharge apparatus (12) by which electrolyte and graphene flakes (7) are dischargable from the at least one container (10) as a dispersion.~~

~~40.~~14. A method comprising:

~~for the expansion~~expanding ~~of the~~ graphite ~~(2)~~ to graphene ~~(7)~~, wherein graphite particles ~~(2)~~ and at least one electrolyte are introduced into at least one container ~~(10)~~ and the graphite ~~(2)~~, through the application of an electrical voltage ~~(6)~~ to at least one anode ~~(4)~~ and at least one cathode ~~(3)~~ is expanded,

~~characterized in that~~wherein the cathode ~~(3)~~ contains or consists of diamond and hydrogen is produced at the cathode; and

thermally treating the graphene to yield a dried hydrogenated graphite material.

~~41.~~15. Method according to claim ~~40~~ 14, characterized in that hydrogen is intercalated in the graphite particles ~~(2)~~ and/or chemisorbed on the graphite particles ~~(2)~~, so that graphene flakes ~~(7)~~ are exfoliated from the graphite particles ~~(2)~~.

~~42.~~16. Method according to any one of claims 14~~40~~ or ~~41~~ 15, characterized in that the anode ~~(4)~~ is separated from the cathode ~~(3)~~ by a separator ~~(5)~~.

~~43.~~17. Method according to claim ~~42~~ 16, characterized in that the separator ~~(5)~~ contains or consists of diamond and/or polytetrafluoroethylene and/or Al2O3 and/or ceramic and/or quartz and/or glass.

~~44.~~18. Method according to one of claims ~~40~~14 to ~~43~~ 17, characterized in that ~~the separator (5), and optionally the anode (4) are set into rotation and/or in that~~ the separator is ~~(5), and optionally the anode (4) are~~ shifted so that the distance between the cathode ~~(3)~~ and the separator ~~(5)~~ changes during operation of the apparatus ~~(1)~~.

~~45.~~19. Method according to any one of claims ~~40~~14 to ~~44~~ 18, characterized in that ~~an electrical voltage from about 5 V to about 60 V, or an electrical voltage from about 10 V to about 50 V, or~~ an electrical voltage from about 12 V to about 45 V, or an electric voltage from about 15 V to about 30 V is applied between the anode ~~(4)~~ and cathode ~~(3)~~.

~~46.~~20. Method according to any one of claims ~~40~~14 to ~~45~~ 19, characterized in that graphite particles ~~(2)~~ are supplied continuously to the container ~~(10)~~ and/or that graphene flakes ~~(7)~~ are removed continuously from the container ~~(10)~~.

~~47.~~21. Method according to any one of claims 1427 to ~~46~~ 20, further comprising ~~the step of~~ photo-treating the graphene flakes ~~(7)~~ for dehydrogenation, for example, wherein the photo-treating including illuminating the graphene flakes ~~(7)~~ with visible light, UV, or microwaves, wherein more that 50% of hydrogenated sp3 hybridized carbon sites are de-hydrogenated.

~~48.~~22. Method according to any one of claims ~~40~~14 to ~~47~~ 21, further comprising ~~the step of:~~ subsequently thermally treating~~ment of~~ the graphene flakes ~~(7)~~ at a temperature ~~from about 100°C to about 800°C, or~~ from about 300°C to about 650°C, and for a period of ~~from about 1 min to about 60 min, or~~ from about 15 min to about 40 min.

~~49.~~23. Method according to one of claims ~~40~~14 to ~~48~~ 22, characterize~~d~~ in that the graphene flakes ~~(7)~~ have an average surface area of ~~more than 10 um2 or~~ more than 50 um2 or of more than 100 um2.

24. Method according to one of claims 14 to 23, further comprising subjecting the dried hydrogenated graphite material to a dehydrogenating thermal treatment that yields a dry dehydrogenated graphite material.