for treatments to repeat the steps of collecting and concentrating the supernatant, and there is a problem of inferior production efficiency of a graphene dispersion. As disclosed in Patent Literature 2, even by subjecting natural graphite to an ultrasonic treatment for a long time, only weak parts of the surface are exfoliated, other large parts do not contribute to the exfoliation, and it is considered as a problem that the amount of exfoliated graphene is small.

{0007}

The invention was completed focusing on such problem points, and a graphite-based carbon material, from which graphene is easily exfoliated by carrying out predetermined treatments to natural graphite, and which makes it possible to disperse graphene at a high concentration or to a high degree is called a graphene precursor. ~~Then, an object~~Embodiments of the invention ~~is~~ seek to provide a graphite-based carbon material useful as such a graphene precursor, as well as a method of producing the same.

{Solution to Problem}

{0008}

~~In order to solve the above-described problems, the~~An aspect of the present invention provides a graphite-based carbon material useful as a graphene precursor, ~~of the invention is characterized by~~ having a rhombohedral graphite layer (3R) and a hexagonal graphite layer (2H), wherein

a Rate (3R) of the rhombohedral graphite layer (3R) and the hexagonal graphite layer (2H), based on an X-ray diffraction method, which is defined by following Equation 1 is 31% or more:

$$\text{Rate (3R)} = P3/(P3+P4)\times 100 \quad \cdots\cdots \text{ Equation 1}$$

wherein

P3 is a peak intensity of a (101) plane of the rhombohedral graphite layer (3R) based on the X-ray diffraction method, and

P4 is a peak intensity of a (101) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method.

According to the features, since a large amount of the rhombohedral graphite layer (3R) from which a layer is easily exfoliated is included therein, a graphite-based carbon material useful as a graphene precursor, from which graphene is easily exfoliated when the graphite-based carbon material is useful as a precursor, and which makes it possible to disperse graphene at a high concentration or to a high degree can be obtained.

{0009}

The graphite-based carbon material useful as a graphene precursor in an embodiment of the invention is characterized in that the Rate (3R) is 40% or more.

According to the feature, as long as the Rate (3R) is 40% or more, a graphite-based carbon material useful as a graphene precursor from which graphene is more easily exfoliated,

compared with cases where the Rate (3R) is 31% or more and less than 40%, can easily be obtained.

{0010}

The graphite-based carbon material useful as a graphene precursor of an embodiment the invention is characterized in that the Rate (3R) is 50% or more.

According to the feature, as long as the Rate (3R) is 50% or more, a graphite-based carbon material useful as a graphene precursor from which graphene is more easily exfoliated, compared with cases where the Rate (3R) is 40% or more and less than 50%, can easily be obtained.

{0011}

The graphite-based carbon material useful as a graphene precursor of an embodiment the invention is characterized in that an intensity ratio P1/P2 of the hexagonal graphite layer (2H) based on the X-ray diffraction method is 0.01 or more, wherein

P1 is a peak intensity of a (100) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method, and

P2 is a peak intensity of a (002) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method.

According to the feature, when the intensity ratio P1/P2 of the hexagonal graphite layer (2H) is made 0.01 or more, the orientation disorder of crystal structure of carbon material will be higher, graphene is easily exfoliated, and the

graphite-based carbon material can be made to more effectively function as the precursor.

{0012}

The above-described graphite-based carbon material useful as a graphene precursor in an embodiment of the invention is characterized in that the graphite-based carbon material is produced by carrying out a radiowave-force-based treatment and a physical-force-based treatment in a vacuum or in the air.

According to the feature, by combining a treatment based on a radiowave force by microwaves, millimeter waves, plasma, electromagnetic induction heating (IH), magnetic fields or the like, and a treatment based on a physical force by a ball mill, jet mill, centrifugal force, supercriticality or the like, to a natural graphite material in a vacuum or in the air, a graphite-based carbon material including more rhombohedral graphite layers (3R) is obtained. In addition, since the treatments are carried out in a vacuum or in the air, aftertreatments are simple.

{0013}

A method of producing a graphite-based carbon material useful as a graphene precursor in an embodiment of the invention is characterized by including: carrying out a radiowave-force-based treatment and a physical-force-based treatment to a natural graphite material in a vacuum or in the air.

According to the feature, by combining a treatment based on a radiowave force by microwaves, millimeter waves, plasma, electromagnetic induction heating (IH), magnetic fields or the like, and a treatment based on a physical force by a ball mill, a jet mill, a centrifugal force, supercriticality or the like, a graphite-based carbon material useful as a graphene precursor, which more easily separates into graphene, compared with use of either one of the treatments, can be obtained in a short time.

{0014}

~~A~~ An aspect of the present invention provides a method of producing a graphite-based carbon material useful as a graphene precursor ~~of the invention is characterized in that the above-described natural graphite material~~ wherein the above-described natural graphite material has at least a hexagonal graphite layer (2H), and an intensity ratio P1/P2 of the hexagonal graphite layer (2H) based on the X-ray diffraction method is less than 0.01, wherein

P1 is a peak intensity of a (100) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method, and

P2 is a peak intensity of a (002) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method.

According to the features, the carbon material can be produced from easily-available natural graphite of which the orientation disorder of crystal structure of carbon material is lower and general.

{0015}

The graphite-based carbon material in an embodiment of the invention is characterized by having a rhombohedral graphite layer (3R) and a hexagonal graphite layer (2H), wherein a Rate (3R) of the rhombohedral graphite layer (3R) and the hexagonal graphite layer (2H), based on an X-ray diffraction method, which is defined by following Equation 1 is 31% or more:

$$\text{Rate (3R)} = P3/(P3+P4)\times 100 \cdots \text{Equation 1}$$

wherein

P3 is a peak intensity of a (101) plane of the rhombohedral graphite layer (3R) based on the X-ray diffraction method, and

P4 is a peak intensity of a (101) plane of the hexagonal graphite layer (2H) based on the X-ray diffraction method.

According to the features, a large amount of the rhombohedral graphite layer (3R) which is easily exfoliated to layers can be obtained.

Furthermore other aspects are following.

A graphene dispersion is characterized in that the graphene dispersion is obtained by carrying out a radiowave-force-based treatment and a physical-force-based treatment to the above-described graphite-based carbon material useful as a graphene precursor in a liquid.

According to the feature, in a liquid such as a solvent, heat acts on the graphite-based carbon material due to the radiowave force by microwaves, millimeter waves, plasma, electromagnetic induction heating (IH), magnetic fields or the

CLAIMS

Claim 1

A graphite-based carbon material useful as a graphene precursor, having a rhombohedral graphite layer ~~(3R)~~ and a hexagonal graphite layer ~~(2H)~~, wherein a Rate ~~(3R)~~ of the rhombohedral graphite layer ~~(3R)~~ and the hexagonal graphite layer ~~(2H)~~, based on an X-ray diffraction method, which is defined by following Equation 1 is 31% or more:

$$\text{Rate}_{(3R)} = P3/(P3+P4)\times 100 \cdots \text{Equation 1}$$

wherein

P3 is a peak intensity of a (101) plane of the rhombohedral graphite layer ~~(3R)~~ based on the X-ray diffraction method, and

P4 is a peak intensity of a (101) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method.

Claim 2

The graphite-based carbon material useful as a graphene precursor according to claim 1, wherein the Rate ~~(3R)~~ is 40% or more.

Claim 3

The graphite-based carbon material useful as a graphene precursor according to claim 1, wherein the Rate ~~(3R)~~ is 50% or more.

Claim 4

The graphite-based carbon material useful as a graphene precursor according to claim 1, wherein an intensity ratio P1/P2 of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method is 0.01 or more, wherein

P1 is a peak intensity of a (100) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method, and

P2 is a peak intensity of a (002) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method.

Claim 5

The graphite-based carbon material useful as a graphene precursor according to claim 1, wherein the graphite-based carbon material is produced by carrying out a radiowave-force-based treatment and a physical-force-based treatment in a vacuum or in the air.

Claim 6

A method of producing the graphite-based carbon material useful as a graphene precursor according to claim 1, comprising: carrying out a radiowave-force-based treatment and a physical-force-based treatment to a natural graphite material in a vacuum or in the air.

Claim 7

A method of producing a graphite-based carbon material useful as a graphene precursor, wherein the natural graphite material as set forth in claim 5 has at least a hexagonal graphite layer ~~(2H)~~, and an intensity ratio P1/P2 of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method is less than 0.01, wherein

P1 is a peak intensity of a (100) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method, and

P2 is a peak intensity of a (002) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method.

Claim 8.

A graphite-based carbon material, having a rhombohedral graphite layer ~~(3R)~~ and a hexagonal graphite layer ~~(2H)~~, wherein a Rate ~~(3R)~~ of the rhombohedral graphite layer ~~(3R)~~ and the hexagonal graphite layer ~~(2H)~~, based on an X-ray diffraction method, which is defined by following Equation 1 is 31% or more:

Rate ~~(3R)~~ = P3/(P3+P4)×100 ···· Equation 1

wherein

P3 is a peak intensity of a (101) plane of the rhombohedral graphite layer ~~(3R)~~ based on the X-ray diffraction method, and

P4 is a peak intensity of a (101) plane of the hexagonal graphite layer ~~(2H)~~ based on the X-ray diffraction method.