{DESCRIPTION}

{Title of Invention}

COMPOSITE LUBRICATING MATERIAL, ENGINE OIL, GREASE, AND LUBRICANT, AND METHOD OF PRODUCING A COMPOSITE LUBRICATING MATERIAL

{Technical Field}

{0001}

The present invention relates to a composite lubricating material, engine oil, grease, and lubricant, and method of producing a composite lubricating material.

{Background Art}

{0002}

In recent years, addition of various nanomaterials to a driving mechanism, such as an engine, and a transmission mechanism, such as a transmission gear and a reduction gear, has been studied for purposes of improving fuel consumption, reducing friction, and the like. In particular, for environmental or resource problems, carbon materials such as graphene, CNT (carbon nanotube) and fullerene have attracted attention as nonmetal nanomaterials.

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Taking engine oil as an example, addition of molybdenum disulfide (MoS_2) or flaky graphite having a layered crystal structure, which exhibit low shearing resistance, and the like has been known (Non Patent Literature 5). Further, a sliding

The invention has been completed focusing on such problems, and ~~an object~~embodiments of the invention ~~is~~ seek to provide a composite lubricating material, engine oil, grease, and lubricant, excellent in lubricity.

~~Another object~~ Embodiments of the invention also seek ~~is~~ to provide a composite lubricating material capable of exhibiting desired characteristics even though an amount of the graphene-like dispersed/added in a base material is small.

~~Yet another object~~ Embodiments of the invention seek ~~is~~ to provide a composite lubricating material excellent in lubricity by utilizing a conventional production process.

{Solution to Problem}

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~~In order to solve the above-described problems, a~~ A composite lubricating material according to a first aspect of the present invention comprises at least a graphite based carbon material and/or graphene-like graphite exfoliated from the graphite-based carbon material dispersed in a base material,

the graphite-based carbon material 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:

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, the graphene-like graphite being a mixed material containing the graphite-based carbon material to graphene, produced by exfoliating a part or whole of the graphite-based carbon material, and the graphene being a crystal of a mean size of 100 nm or more and formed in a flake-like or sheet-like shape having 10 layers or less.

A second aspect of the present invention provides a method of producing a composite lubricating material, comprising a step of kneading at least a graphite-based carbon material into a base material,

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

Rate = P3/(P3+P4)×100 ···· Equation 1

wherein

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

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

According to the features, the composite material is excellent in lubricity. This is because, it is speculated that, at least one of a graphite based carbon material and graphene-like graphite is dispersed in a base material, and as sliding is performed by a sliding part, the graphite based carbon material or the graphene-like graphite is further flaked, thereby increasing an absolute number of pieces of the graphene-like graphite. As a result, a density of the graphene-like graphite is increased over time and lubricity is improved.

It is noted that, in this specification, "a graphite-based carbon material and/or graphene-like graphite exfoliated from the graphite-based carbon material (are) dispersed" means that at least any one of a graphite-based carbon material and graphene-like graphite exfoliated from the graphite-based carbon material is dispersed.

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A weight ration of the graphite-based carbon material to the base material is characterized by being 1/10,000 or more to less than 1.

{CLAIMS}

{Claim 1}

A composite lubricating material comprising at least a graphite-based carbon material and/or graphene-like graphite exfoliated from the graphite-based carbon material dispersed in a base material,

the 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:

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

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,

the graphene-like graphite being a mixed material containing the graphite-based carbon material to graphene, produced by exfoliating a part or whole of the graphite-based carbon material, and

the graphene being a crystal of a mean size of 100 nm or more and formed in a flake-like or sheet-like shape having 10 layers or less.

{Claim 2}

The composite lubricating material according to claim 1, wherein a weight ratio of the graphite-based carbon material to the base material is 1/10,000 or more to less than 1.

{Claim 3}

The composite lubricating material according to claim 1, wherein the base material is at least one or more of base oil derived from mineral, synthesis, plants or animals.

{Claim 4}

The composite lubricating material according to claim 1, comprising one or more kinds of additives for a purpose of preventing oxidative deterioration.

{Claim 5}

The composite lubricating material according to claim 4, wherein the additive is a radioactive substance.

{Claim 6}

Engine oil for use in an internal combustion engine or the like, comprising the composite lubricating material according to claim 1.

{Claim 7}

Grease for use in a rolling bearing, a sliding part, or the like, comprising the composite lubricating material according to claim 1.

{Claim 8}

Lubricant for use in a fluid bearing, a gear, or the like, comprising the composite lubricating material according to claim 1.

{Claim 9}

A method of producing a composite lubricating material, comprising a step of kneading at least a graphite-based carbon material into a base material,

the graphite-based carbon material having a rhombohedral graphite layer and a hexagonal graphite layer, wherein a Rate

of the rhombohedral graphite layer and the hexagonal graphite layer, based on an X-ray diffraction method, which is defined by following Equation 1 is 31% or more:

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

wherein

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

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

{Claim 10}

The method of producing the composite lubricating material according to claim 9, wherein a weight ratio of the graphite-based carbon material to the base material is 1/10,000 or more to less than 1.

{Claim 11}

The method of producing the composite lubricating material according to claim 10, wherein the base material is at least one or more of base oil derived from mineral, synthesis, plants or animals.

{Claim 12}

The method of producing the composite lubricating material according to claim 11, wherein the composite lubricating material includes one or more kinds of additives for a purpose of preventing oxidative deterioration.