Claims

[Claim 1]

Heteroatom-doped nanodiamond particles, wherein

the heteroatom-doped nanodiamond particles being doped with at least one heteroatom, and the heteroatom-doped nanodiamond particles satisfying requirements (i) to (iv) below:

(i) a BET specific surface area being from 35 to 600 m^2/g,
(ii) an average size of primary particles being from 3 to 55 nm,
(iii) a carbon content being from 70 to 99 mass%, a hydrogen content being from 0.1 to 5 mass%, and a nitrogen content being from 0.1 to 5 mass%, and
(iv)a ratio (D/G) of a peak area (D) of diamond to a peak area (G) of graphite by Raman spectroscopy is from 0.2 to 9,

wherein the heteroatom-doped nanodiamond has a fluorescence emission peak originated from at least one heteroatom-vacancy center, and

wherein the heteroatom comprises at least one selected from the group consisting of Group 14 elements, nickel and boron.

[Claim 2]

The heteroatom-doped nanodiamond particles according to claim 1, wherein the heteroatom-doped nanodiamond emitting fluorescence is further doped with phosphorus and/or boron.

[Claim 3]

The heteroatom-doped nanodiamond particles according to claim 1 or 2, wherein the heteroatom-doped nanodiamond has the fluorescence emission peak at from 720 to 770 nm, and the heteroatom comprises silicon.

[Claim 4]

The heteroatom-doped nanodiamond particles according to claim 1 or 2, wherein the heteroatom-doped nanodiamond has the fluorescence emission peak at from 580 to 630 nm, and the heteroatom comprises germanium.

[Claim 5]

The heteroatom-doped nanodiamond particles according to claim 1or 2, wherein the heteroatom-doped nanodiamond has the fluorescence emission peak at from 590 to 650 nm, and the heteroatom comprises tin.

[Claim 6]

The heteroatom-doped nanodiamond particles according to claim 1 or 2, wherein the nanodiamond has a fluorescence emission peak at from 540 to 600 nm, and the heteroatom comprises lead.

[Claim 7]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 6, which produces fluorescence due to a nitrogen-vacancy (N-V) center.

[Claim 8]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 7, wherein a shape of the nanodiamond is spherical, ellipsoidal, or polyhedral.

[Claim 9]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 8, wherein a ratio (H/D) of a peak area (H) of a surface hydroxy group (OH) to a peak area (D) of diamond by Raman spectroscopy is from 0.1 to 5.

[Claim 10]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 9, wherein a ratio (C/D) of a peak area (C) of a surface carbonyl group (CO) to a peak area (D) of diamond by Raman spectroscopy is from 0.01 to 1.5.

[Claim 11]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 10, comprising at least one oxygen-containing functional group terminal and/or at least one hydrogen-containing functional group terminal.

[Claim 12]
The heteroatom-doped nanodiamond particles according to any one of claims 1 to 11, wherein a concentration of the at least one heteroatom-vacancy center is 1×10^{10} /cm^3 or greater.