CLAIMS

[Claim 1] A direct decomposition device for hydrocarbons for directly decomposing hydrocarbons into carbon and hydrogen, comprising

a rector containing a catalyst ~~including~~ which is a non-supported catalyst of an aggregate of a plurality of metal particles with an iron purity of 86% or more,

wherein the reactor is configured to be supplied with a raw material gas containing hydrocarbons, and

wherein a particle size range of the plurality of particles is between 2 μm and 3 mm and a crystallite size of iron constituting the plurality of particles is 2 nm or more and less than 60 nm.

~~[Claim 2] The direct decomposition device for hydrocarbons according to claim 1,~~

~~wherein a crystallite size of iron constituting the plurality of particles is 2 nm or more and less than 60 nm.~~

[Claim 2~~3~~] The direct decomposition device for hydrocarbons according to claim 1 ~~or 2~~,

wherein a specific surface area of the plurality of particles by BET method is 0.1 m^2/g or more and 10 m^2/g or less, or a pore specific surface area of the plurality of particles by mercury injection method is 0.01 m^2/g or more and 1 m^2/g or less.

[Claim 3~~4~~] The direct decomposition device for hydrocarbons according to ~~any one of~~ claim~~s~~ 1 or 2 ~~to 3~~,

wherein a pore volume of the plurality of particles is 0.01 cc/g or more and 1 cc/g or less.

~~[Claim 5] The direct decomposition device for hydrocarbons according to any one of claims 1 to 4,~~

~~wherein a particle size range of the plurality of particles is between 2 μm and 3 mm.~~

[Claim 46] The direct decomposition device for hydrocarbons according to any one of claims 1 to 35,

wherein a reaction of direct decomposition of hydrocarbons into carbon and hydrogen is performed in a temperature range between 600°C and 900°C.

[Claim 57] The direct decomposition device for hydrocarbons according to any one of claims 1 to 46,

wherein a partial pressure of hydrocarbons in the raw material gas is between 0.025 MPa and 0.1 MPa.

[Claim 68] The direct decomposition device for hydrocarbons according to any one of claims 1 to 57, further comprising a carbon removal device for removing carbon adhering to the catalyst from the catalyst.

[Claim 79] The direct decomposition device for hydrocarbons according to claim 68,

wherein the carbon removal device is a fluidized bed forming device for forming a fluidized bed of the catalyst contained in the reactor.

[Claim 810] The direct decomposition device for hydrocarbons according to claim 68 or 79,

wherein the carbon removal device includes:

a catalyst regeneration device for regenerating part of the catalyst in the reactor;

a catalyst supply line for supplying the catalyst from the reactor to the catalyst regeneration device; and

a catalyst return line for returning the catalyst from the catalyst regeneration device to the reactor.

[Claim 9~~11~~] The direct decomposition device for hydrocarbons according to any one of claims 1 to 8~~10~~, further comprising:

a reactant gas flow line through which a reactant gas containing hydrogen flows after flowing out of the reactor; and

a solid-gas separation device disposed in the reactant gas flow line to separate carbon from the reactant gas.

[Claim 10~~12~~] A direct decomposition method for hydrocarbons for directly decomposing hydrocarbons into carbon and hydrogen, comprising

a step of supplying a raw material gas containing hydrocarbons to a catalyst ~~including~~ which is a non-supported catalyst of an aggregate of a plurality of metal particles with an iron purity of 86% or more,

wherein a particle size range of the plurality of particles is between 2 μm and 3 mm and a crystallite size of iron constituting the plurality of particles is 2 nm or more and less than 60 nm.

[Claim 11~~13~~] The direct decomposition method for hydrocarbons according to claim 10~~12~~, further comprising a step of removing carbon adhering to the catalyst from the catalyst.