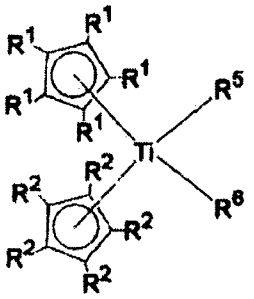
Claims

[Claim 1]

A catalyst composition for hydrogenation comprising (A), (B), (C), and (D) shown below,

wherein a mass ratio of the (D) to the (A) ((D)/(A)) is in a range of 0.01 to 2.00,

(A): a titanocene compound represented by following general formula (1),



... (1)

(wherein R^5 and R^6 represent any group selected from the group consisting of hydrogen, a hydrocarbon group having 1 to 12 carbon atoms, an aryloxy group, an alkoxy group, a halogen group, and a carbonyl group, R^5 and R^6 may be the same or different; and R^1 and R^2 represent any group selected from the group consisting of hydrogen and a hydrocarbon group having 1 to 12 carbon atoms, and R^1 and R^2 may be the same or different; provided that R^1 and R^2 are not all hydrogen atoms or all a hydrocarbon group having 1 to 12 carbon atoms),

(B): a compound containing one or more elements selected from the group consisting of elements Li, Na, K, Mg, Zn, Al, and Ca,

(C): an unsaturated polymer having a fraction of an olefinic unsaturated double bond content of side chains based on a total olefinic unsaturated double bond content of 0.25 to 1.0, and

(D): a polar compound.

[Claim 2]

The catalyst composition for hydrogenation according to claim 1, wherein a mass ratio of the (C) to the (A) ((C)/(A)) is in a range of 0.3 to 8.0.

[Claim 3]

The catalyst composition for hydrogenation according to claim 1 or 2, wherein the (C) is an unsaturated polymer having a fraction of the olefinic unsaturated double bond content of the side chains based on the total olefinic unsaturated double bond content of 0.40 to 1.0.

[Claim 4]

The catalyst composition for hydrogenation according to any one of claims 1 to 3, wherein a total olefinic unsaturated double bond of the side chains of the (C) based on 1 mol of the (A) is 0.3 mol or more to 30 mol or less.

~~[Claim 5]~~

The catalyst composition for hydrogenation according to any one of claims 1 to 4, wherein the (B) is an organic lithium compound.

[Claim 6]

A method for hydrogenation, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic solvent, in the presence of the catalyst composition according to any one of claims 1 to 5.

[Claim 7]

The method for hydrogenation according to claim 6, wherein the olefinic unsaturated double bond-containing compound is a conjugated diene polymer or a copolymer formed of a conjugated diene and a vinyl aromatic hydrocarbon.

Claims

[Claim 1]

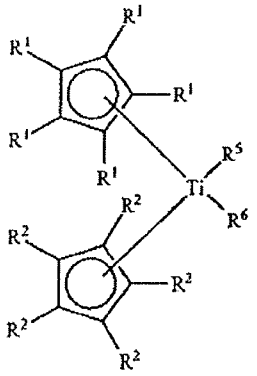
A catalyst composition comprising compounds (A), (B), (C), and (D) shown below,

wherein a mass ratio of the compound (D) to the compound (A) (the compound (D)/the compound (A)) is in a range of 0.01 to 2.00,

a mass ratio of the compound (C) to the compound (A) (the compound (C)/the compound (A)) is in a range of 0.3 to 8.0,

the compound (A) comprises a titanocene compound represented by following general formula (1),

(1)



(wherein R^5 and R^6 represent any group selected from the group consisting of hydrogen, a hydrocarbon group having 1 to 12 carbon atoms, an aryloxy group, an alkoxy group, a halogen group, and a carbonyl group, R^5 and R^6 may be the same or different; and R^1 and R^2 represent any group selected from the group consisting of hydrogen and a hydrocarbon group having 1 to 12 carbon atoms, and R^1 and R^2 may be the same or different; provided that R^1 and R^2 are not all hydrogen atoms or all hydrocarbon groups having 1 to 12 carbon atoms),

the compound (B) comprises a compound containing one or more elements selected from the group consisting of elements Li, Na, K, Mg, Zn, Al, and Ca,

the compound (C) comprises an unsaturated polymer having a fraction of an olefinic unsaturated double bond content of side chains based on a total olefinic unsaturated double bond content of 0.25 to 1.0, and

the compound (D) comprises a polar compound.

[Claim 2]

The catalyst composition according to claim 1, wherein the compound (C) is an unsaturated polymer having a fraction of the olefinic unsaturated double bond content of the side chains based on the total olefinic unsaturated double bond content of 0.40 to 1.0.

[Claim 3]

The catalyst composition according to claim 1, wherein a total olefinic unsaturated double bond of the side chains of the compound (C) based on 1 mol of the compound (A) is 0.3 mol or more to 30 mol or less.

[Claim 4]

The catalyst composition according to claim 1, wherein the compound (B) is an organic lithium compound.

[Claim 5]

The catalyst composition according to claim 1, wherein the compound (A) is selected from the group consisting of bis(η(5)-methylcyclopentadienyl)titanium dichloride, bis(η(5)-n-butylcyclopentadienyl)titanium dichloride, bis(η(5)-methylcyclopentadienyl)titanium diphenyl, bis(η(5)-n-butylcyclopentadienyl)titanium diphenyl, bis(η(5)-methylcyclopentadienyl)titanium di(p-tolyl) and bis(η(5)-n-butylcyclopentadienyl)titanium di(p-tolyl).

[Claim 6]

The catalyst composition according to claim 1, wherein the compound (A) is selected from the group consisting of bis(η(5)-cyclopentadienyl)titanium di(p-tolyl), bis(η(5)-cyclopentadienyl)titanium di(phenyl), bis(η(5)-cyclopentadienyl)titanium di(3,4-xylyl) and bis(η(5)-1,3-dimethylcyclopentadienyl)titanium dichloride.

[Claim 7]

The catalyst composition according to claim 1, wherein the compound (B) is triethylaluminum or sec-butyllithium.

[Claim 8]

The catalyst composition according to claim 1, wherein the compound (C) is polybutadiene, polyisoprene or a butadiene/isoprene copolymer.

[Claim 9]

The catalyst composition according to claim 1, wherein the compound (D) is an amine compound or an ether compound.

[Claim 10]

The catalyst composition according to claim 1, wherein the compound (D) is tetrahydrofuran, ethyl acetate or N,N,N',N'-Tetramethylethylenediamine.

[Claim 11]

The catalyst composition according to claim 5, wherein the compound (C) is an unsaturated polymer having a fraction of the olefinic unsaturated double bond content of the side chains based on the total olefinic unsaturated double bond content of 0.40 to 1.0.

[Claim 12]

The catalyst composition according to claim 11, wherein the compound (B) is an organic lithium compound.

[Claim 13]

A method of hydrogenating a compound, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic solvent, in the presence of the catalyst composition according to claim 5.

[Claim 14]

A method of hydrogenating a compound, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic solvent, in the presence of the catalyst composition according to claim 1.

[Claim 15]

The method according to claim 14, wherein the olefinic unsaturated double bond-containing compound is a conjugated diene polymer, or a copolymer formed of a conjugated diene and a vinyl aromatic hydrocarbon.

[Claim 16]

The method according to claim 14, wherein the olefinic unsaturated double bond-containing compound is styrene-butadiene-styrene block copolymer.

[Claim 17]

A method of hydrogenating a compound, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic solvent, in the presence of the catalyst composition according to claim 2.

[Claim 18]

A method of hydrogenating a compound, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic

solvent, in the presence of the catalyst composition according to claim 3.

[Claim 19]

A method of hydrogenating a compound, comprising bringing an olefinic unsaturated double bond-containing compound into contact with hydrogen in an inert organic solvent, in the presence of the catalyst composition according to claim 4.