[Patent Document 6] JP-A No. 1990-274703

[Patent Document 7] JP-A No. 2004-161957

[Patent Document 8] JP-A No. 1996-67713

[Patent Document 9] JP-A No. 1992-802147

[Patent Document 10] JP-A No. 1991-12439

[Patent Document 11] JP-A No. 1995-247387

[Patent Document 12] JP-A No. 1996-59916

[Patent Document 13] JP-A No. 2000-191852

[Patent Document 14] JP-A No. 2000-191858

[Non-Patent Document 1] Angew. Chem. Int. Ed. Engl., 24, 507 (1985)

[Non-Patent Document 2] J. Am. Chem. Soc., 110, 6255-6256 (1988)

SUMMARY

[0030a]

In a first aspect of the present disclosure, there is provided a method for producing a syndiotactic α-olefin polymer comprising polymerizing one or more monomers selected from α-olefins having 2 or more carbon atoms at a temperature within the range from 0 to 170°C in the presence of a catalyst (1) which comprises:

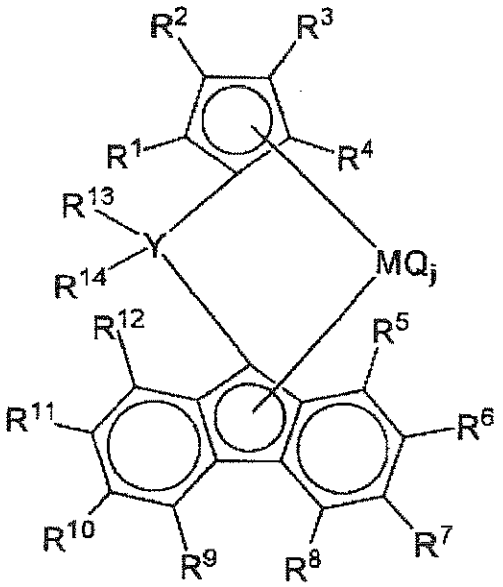
(a-1) a bridged metallocene compound represented by the following Formula [1-1]; and

(b) at least one compound selected from:

(b-1) an organoaluminum oxy compound,

(b-2) a compound which reacts with the bridged metallocene compound (a-1) to form an ion pair, and

(b-3) an organoaluminum compound;



... [1-1]

wherein each of R^1, R^2, R^3 and R^4 is a hydrogen atom;

R^5, R^8, R^9 and R^{12}, which may be identical to or different from each other, are each selected from hydrogen, hydrocarbon group and a silicon-containing group;

R^6, R^7, R^{10} and R^{11}, which may be identical to or different from each other, are each selected from a hydrocarbon group and a silicon-containing group;

in one or more pairs of adjacent groups selected from R^5 and R^6, R^7 and R^8, R^8 and R^9, R^9 and R^{10}, and R^{11} and R^{12}, the adjacent groups may be linked to each other to form

a ring;

R^{13} and R^{14}, which may be identical to or different from each other, are each an atom or a substituent selected from the group consisting of a hydrogen atom, a hydrocarbon group having 2 to 20 carbon atoms, and a silicon atom-containing group;

M is Ti, Zr or Hf;

Y is carbon; and

Q, which may be identical to or different from each other, is selected from a halogen, a hydrocarbon group, an anion ligand and a neutral ligand capable of coordination with a lone electron pair; and

j is an integer from 1 to 4.

DISCLOSURE OF THE INVENTION

[0031]

The problem to be solved by the present invention (1) is to provide a catalyst for olefin polymerization which, in the case of polymerizing an α-olefin such as propylene or the like, can give an α-olefin polymer having a high melting point and a sufficient molecular weight under high temperature conditions as well as normal temperature conditions, and also, in the case of polymerizing α-olefins including ethylene as the main component under high temperature conditions, can give with good

terpene-based resins and petroleum resins, based on 100 parts by weight of the sum of amounts of the syndiotactic propylene polymer (AA) and the propylene·α-olefin copolymer (B3).

[0090]

Examples of preferred embodiments of the composition (X3) and composition (X3i) include:

a propylene-based polymer composition (X3) in which the propylene·α-olefin copolymer (B3) is a copolymer of propylene, ethylene and α-olefin having 4 to 20 carbon atoms, comprising constituent units derived from propylene in an amount of 30 to 90 mol%, and constituent units derived from ethylene and constituent units derived from an α-olefin having 4 to 20 carbon atoms in a total amount of 10 to 70 mol% (the sum of amounts of the constituent units derived from propylene, the constituent units derived from ethylene and constituent units derived from the α-olefin having 4 to 20 carbon atoms is 100 mol%), and saitsfies $P_E \leq P_{HAO}$ when the proportion of the constituent units derived from ethylene is designated as P_E (mol%), and the proportion of the constituent units derived from the α-olefin is designated as P_{HAO} (mol%).

[0091]

Examples of a preferred embodiment of the propylene-based polymer composition (X3) of the present invention (6) include:

the propylene-based polymer composition ~~according to~~

~~claim 1~~

(hereinafter, this composition may be referred to as "composition (X3ii)"), further comprising 0.1 to 500 parts by weight of a non-crosslinked or partially crosslinked olefin-based thermoplastic elastomer (C2), based on 100 parts by weight of the sum of amounts of the syndiotactic propylene polymer (AA) and propylene·α-olefin copolymer (B3).

[0092]

In the composition (X3), it is preferable that the syndiotactic propylene polymer (AA) has an intrinsic viscosity [η] measured in decalin at 135°C in the range of 0.1 to 10 dL/g, and a heat of fusion (ΔH) determined by measurement of differential scanning calorimetry (DSC) of 40 mJ/mg or greater.

[0093]

In the composition (X3), it is preferable that the molecular weight distribution (Mw/Mn, Mn: number average molecular weight, Mw: weight average molecular weight) of the propylene·α-olefin polymer (B3) as measured by GPC is 3.5 or less.

[0094]

The molded product of the present invention (6) is formed ~~using the composition (X3).~~

mixture was placed in an NMR tube having an internal diameter of 10 mm. ^{13}C-NMR measurement was performed at 120°C. The accumulation times were 10,000 or more. The composition of ethylene, propylene and α-olefin was quantified using the ^{13}C-NMR spectrum obtained.

[1014]

Melting point (Tm), Heat of fusion (ΔH)

Using DSCPyris1 or DSC7 manufactured by PerkinElmer Inc., about 5 mg of a sample was heated to 200°C, maintained for 10 minutes, and then cooled to 30°C at 10°C/min, under a nitrogen atmosphere (20 ml/min). The temperature was maintained at 30°C for 5 minutes and then heated to 200°C at 10°C/min. The melting point was calculated from the apex of the crystal melting peak, and the heat of fusion was calculated from the integrated value of the peak.

[1015]

When two peaks were observed for the propylene-based polymer described in the Examples of the present invention, in the case that the peak on the lower temperature side was designated as Tm_1 and the peak on the higher temperature side was designated as Tm_2, Tm_2 was considered as the Tm defined in the requirements (1) [2-1] and [2-2] of Claim 1 of the present invention.

[1016]

terpene-based resins and petroleum resins, based on 100 parts by weight of the sum of amounts of the syndiotactic propylene polymer (AA) and the propylene·α-olefin copolymer (B3).

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Examples of preferred embodiments of the composition (X3) and composition (X3i) include:

a propylene-based polymer composition (X3) in which the propylene·α-olefin copolymer (B3) is a copolymer of propylene, ethylene and α-olefin having 4 to 20 carbon atoms, comprising constituent units derived from propylene in an amount of 30 to 90 mol%, and constituent units derived from ethylene and constituent units derived from an α-olefin having 4 to 20 carbon atoms in a total amount of 10 to 70 mol% (the sum of amounts of the constituent units derived from propylene, the constituent units derived from ethylene and constituent units derived from the α-olefin having 4 to 20 carbon atoms is 100 mol%), and saitsfies $P_E \leq P_{HAO}$ when the proportion of the constituent units derived from ethylene is designated as P_E (mol%), and the proportion of the constituent units derived from the α-olefin is designated as P_{HAO} (mol%).

[0091]

Examples of a preferred embodiment of the propylene-based polymer composition (X3) of the present invention (6) include:

the propylene-based polymer composition

(hereinafter, this composition may be referred to as "composition (X3ii)"), further comprising 0.1 to 500 parts by weight of a non-crosslinked or partially crosslinked olefin-based thermoplastic elastomer (C2), based on 100 parts by weight of the sum of amounts of the syndiotactic propylene polymer (AA) and propylene·α-olefin copolymer (B3).

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In the composition (X3), it is preferable that the syndiotactic propylene polymer (AA) has an intrinsic viscosity [η] measured in decalin at 135°C in the range of 0.1 to 10 dL/g, and a heat of fusion (ΔH) determined by measurement of differential scanning calorimetry (DSC) of 40 mJ/mg or greater.

[0093]

In the composition (X3), it is preferable that the molecular weight distribution (Mw/Mn, Mn: number average molecular weight, Mw: weight average molecular weight) of the propylene·α-olefin polymer (B3) as measured by GPC is 3.5 or less.

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The molded product of the present invention (6) is formed using the composition (X3).

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[1015]

When two peaks were observed for the propylene-based polymer described in the Examples of the present invention, in the case that the peak on the lower temperature side was designated as Tm_1 and the peak on the higher temperature side was designated as Tm_2, Tm_2 was considered as the Tm defined in the requirements [2-1] and [2-2] as defined herein.

[1016]