

**ELECTRON WITHDRAWING GROUP-CONTAINING METAL COMPOUND****BACKGROUND OF THE INVENTION**Field of the Invention

The present invention relates to an electron withdrawing group-containing metal compound. This compound is useful as component for addition polymerization.

Description of Related Arts

Since olefin polymers such as polypropylene and polyethylene are excellent in mechanical properties, chemical resistance and the like and excellent in balance between those properties and economical efficiency, they have been widely used for various molding fields. These olefin polymers have been conventionally produced by polymerizing an olefin using a conventional type solid catalyst (multi-site catalyst) which combines a solid catalyst component obtained by using a metal compound of Group IV such as titanium trichloride or titanium tetrachloride, with a metal compound of Group XIII represented by an organoaluminum compound.

A process for producing an addition polymer, which polymerizes an addition-polymerizable monomer using a

so-called single site catalyst prepared by combining a transition metal compound which is different from a solid catalyst component having been used from old (for example, a metallocene complex) with an aluminoxane or the like, is recently proposed. For example, JP-A-58-19309 reports a process using bis(cyclopentadienyl) zirconium dichloride and methyl aluminoxane. Further, it is reported that a specific boron compound and such transition metal compound are combined. For example, JP-A-1-50203 reports a process using bis(cyclopentadienyl)zirconium dimethyl and tri(n-butyl)ammonium tetrakis(pentafluorophenyl) borate. The olefin polymers obtained by using these single site catalysts have a narrower molecular weight distribution than that obtained by the conventional type solid catalyst (multi-site catalyst), and further, a comonomer is more homogeneously copolymerized in case of a copolymer. Accordingly, it is known that a more homogeneous copolymer than a case of using the conventional type solid catalyst is obtained.

The improvement of such catalyst component for addition polymerization has been intensively studied, and the kinds of metals used for main catalyst components are widely reported over the respective Groups of the Periodic Table. For example, in Angew. Chem. Int. Ed. 38 428 (1999), it reported that a metallocene complex of the Group III to the Group XIII and non-metallocene

compound are effective as the main catalyst components. On the other hand, as a co-catalyst component as an activator for combining with the metallocene complex or non-metallocene compound, an aluminoxane belonging to  
5 a compound of the Group XIII, a boron compound and the like have been mainly developed.

Further, when an addition polymer such as an olefin polymer is produced using a single-site catalyst, the molecular weight of the addition polymer obtained is  
10 usually low, and the improvement thereof has been desired. JP-A-6-329713 reports a catalyst component of polymerizing an olefin composed of an aluminum compound having an electron withdrawing group or a group containing an electron withdrawing group. An olefin  
15 polymer having a certain degree of high molecular weight can be obtained by using the aluminum compound. However, since it cannot be always said that the high molecular weight is adequately high, a novel catalyst component as an activator, which realizes the further improvement  
20 of high molecular weight, has been desired.

#### SUMMARY OF THE INVENTION

An object of the present invention is to provide a compound capable of forming a catalyst for addition  
25 polymerization which reveals a high polymerization activity by using as a catalyst aid component for activation and a production method thereof, a catalyst

component for addition polymerisation composed of a compound, capable of forming a catalyst for addition polymerisation which reveals a high polymerisation activity, a catalyst for addition polymerisation which is made by using the catalyst component and reveals a high polymerisation activity, and an efficient process for producing an addition polymer using the catalyst for addition polymerisation.

Namely, according to the present invention there is provided an electron withdrawing group-containing metal compound (I), (also referred to hereafter as compound [A]), obtained by a process comprising contacting (a), (b) and (c) described below in the presence of an ether compound as a solvent:

15

(a) a compound represented by the general formula [1],  

$$M^1L^1C \quad [1]$$

20

(b) a compound represented by the general formula [2],  

$$R^1_{p-1}T^1H \quad [2], \text{ and}$$

(c) a compound represented by the general formula [3],  

$$R^2_{q-2}J^1H_2 \quad [3]$$

25 wherein in each of the general formulae [1] to [3],  $M^1$  represents an atom of Group III to XII or the lanthanide series of the Periodic Table; c represents a valence of  $M^1$ ;  $L^1$  represents a hydrogen atom, a halogen atom or a

hydrocarbon group; when a plural number of  $L^1$ 's exist, they may be mutually the same or different;  $R^1$  represents a halogen atom-containing group;  $R^2$  represents a halogenated hydrocarbon group; when a plural number of  $R^2$ 's exist, they  
 5 may be mutually the same or different; each of  $T^1$  and  $J^1$  independently represents a nitrogen atom or an oxygen atom; and each of  $p$  and  $q$  represents a valence of  $T^1$  and  $J^1$ , respectively.

Further compounds recited below as [B] to [E] have been  
 10 investigated during the development of the present invention, but are not considered to form part of the invention of the present application:

[B] A compound obtained by contacting (d), (e) and (f) described below:

15

(d) a compound represented by the general formula [4],  

$$M^2L^2d \quad [4]$$

(e) a compound represented by the general formula [5],  
 20 
$$R^3_{r-1}T^2H \quad [5], \text{ and}$$

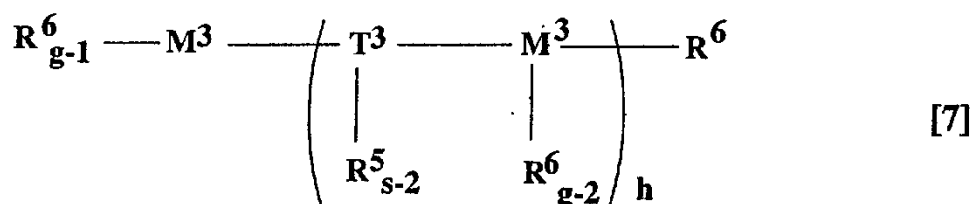
(f) a compound represented by the general formula [6],  

$$R^4(J^2H_{e-1})_f \quad [6]$$

25 (wherein in each of the general formulae [4] to [6],  $M^2$  represents an atom of Group III to Group XII or lanthanide series of the Periodic Table;  $d$  represents a valence of  $M^2$ ;  $L^2$  represents a hydrogen atom, a halogen atom or a

hydrocarbon group; when a plural number of  $L^2$ 's exist, they may be mutually the same or different;  $R^3$  represents an electron-withdrawing group or a group containing an electron-withdrawing group;  $R^4$  represents an organic group having a valence of  $f$ ; each of  $T^2$  and  $J^2$  independently represents an atom of the Group XV or Group XVI of the Periodic Table;  $r$  represents a valence of  $T^2$ ;  $e$  represents a valence of  $J^2$ ; and " $f$ " is an integer of 2 to 10.);

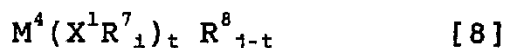
[C] A compound represented by the general formula [7]:



(wherein  $M^3$  represents an atom of the Group III to Group XII or lanthanide series of the Periodic Table; when a plural number of  $M^3$ 's exist, they may be mutually the same or different;  $T^3$  represents an atom of the Group XIV, Group XV or Group XVI of the Periodic Table; when a plural number of  $T^3$ 's exist, they may be mutually the same or different;  $R^5$  represents an electron-withdrawing group or a group containing an electron-withdrawing group; when a plural number of  $R^5$ 's exist, they may be mutually the same or different;  $R^6$  represents a hydrocarbon group; a plural number of  $R^6$ 's may be mutually the same or different; " $g$ " represents a valence

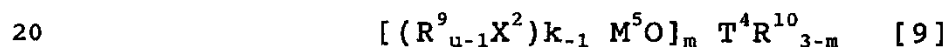
of  $M^3$ ; "s" represents a valence of  $T^3$ ; and "h" represents a numeral of 1 or more.);

[D] A compound represented by the general formula [8],



5 (wherein  $M^4$  represents an atom of the Group III to Group XII or lanthanide series of the Periodic Table;  $X^1$  represents an atom of the Group XIV, Group XV or Group XVI of the Periodic Table; when a plural number of  $X^1$ 's exist, they may be mutually the same or different;  $R^7$  represents an electron-withdrawing group or a group  
10 containing an electron-withdrawing group; when a plural number of  $R^7$ 's exist, they may be mutually the same or different;  $R^8$  represents a hydrogen atom, a halogen atom or a hydrocarbon group; a plural number of  $R^8$ 's may be  
15 mutually the same or different; "j" represents a valence of  $M^4$ ; "t" represents a numeral satisfying  $0 < t \leq j$ ; and "i" represents a numeral less by one than the valence of  $X^1$ .); and

[E] A compound represented by the general formula [9]:



(wherein  $M^5$  represents an atom of the Group III to Group XII or lanthanide series of the Periodic Table; when a plural number of  $M^5$ 's exist, they may be mutually the same or different;  $X^2$  represents an atom of the Group XIV, Group XV or Group XVI of the Periodic Table; when a plural  
25 number of  $X^2$ 's exist, they may be mutually the same or different;  $R^9$  represents an electron-withdrawing group

or a group containing an electron-withdrawing group; when a plural number of  $R^9$ 's exist, they may be mutually the same or different;  $T^4$  represents an atom of the Group XIII of the Periodic Table,  $R^{10}$  represents a hydrogen atom, a halogen atom or a hydrocarbon group; when a plural number of  $R^{10}$ 's exist, they may be mutually the same or different; "k" represents a valence of  $M^5$ ; "u" represents a valence of  $X^2$ ; and "m" represents a numeral satisfying  $1 \leq m \leq 3$ .)

Further, the present invention and alternative embodiments are illustrated in detail below.

#### DETAILED DESCRIPTION OF THE INVENTION

Respective  $M^1$  to  $M^5$  in the general formulae [1], [4], [7], [8] and [9] represent an atom of the Group III to the Group XII or lanthanide series of the Periodic Table of the Elements (Revised edition of IUPAC Inorganic Chemistry Nomenclature 1989). Specific examples thereof include a scandium atom, an yttrium atom, a titanium atom, a zirconium atom, a vanadium atom, a chromium atom, a molybdenum atom, a manganese atom, a rhenium atom, an iron atom, a ruthenium atom, a cobalt atom, a rhodium atom, a nickel atom, a palladium atom, a platinum atom, a copper atom, a silver atom, a gold atom, a zinc atom, a cadmium atom, a mercury atom, a samarium atom, an ytterbium atom and the like. As  $M^1$  to  $M^5$ , an atom of the Group XII is preferable in particular, and a zinc atom

is most preferable.

Respective c, d, g, j and k in the general formulae [1], [4], [7], [8] and [9] represent a valence of  $M^1$  to  $M^5$ , respectively, and for example, when  $M^1$  is a zinc atom, c is 2.

Respective  $L^1$  and  $L^2$  in the general formulae [1] and [4] represent a hydrogen atom, a halogen atom or a hydrocarbon group, and when a plural number of  $L^1$ 's and  $L^2$ 's exist, they may be mutually the same or different. Specific examples of the halogen atom in  $L^1$  and  $L^2$  include a fluorine atom, a chlorine atom, a bromine atom, and an iodine atom. As a hydrocarbon group in  $L^1$  and  $L^2$ , an alkyl group, an aryl group or an aralkyl group is preferable.

As the alkyl group, an alkyl group having 1 to 20 carbon atoms is preferable. Examples include thereof a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a sec-butyl group, a tert-butyl group, an isobutyl group, a n-pentyl group, a neopentyl group, a n-hexyl group, a n-octyl group, a n-decyl group, a n-dodecyl group, a n-pentadecyl group, a n-eicosyl group, and the like. A methyl group, an ethyl group, an isopropyl group, a tert-butyl group or an isobutyl group is more preferable.

Any one of these alkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom, or an iodine atom. Examples of the

alkyl group having 1 to 20 carbon atoms which is substituted with the halogen atom include a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a chloromethyl group, a dichloromethyl group, a trichloromethyl group, a bromomethyl group, a dibromomethyl group, a tribromomethyl group, an iodomethyl group, a diiodomethyl group, a triiodomethyl group, a fluoroethyl group, a difluoroethyl group, a trifluoroethyl group, a tetrafluoroethyl group, a pentafluoroethyl group, a chloroethyl group, a dichloroethyl group, a trichloroethyl group, a tetrachloroethyl group, a pentachloroethyl group, a bromoethyl group, a dibromoethyl group, a tribromoethyl group, a tetrabromoethyl group, a pentabromoethyl group, a perfluoropropyl group, a perfluorobutyl group, a perfluoropentyl group, a perfluorohexyl group, a perfluorooctyl group, a perfluorododecyl group, a perfluoropentadecyl group, a perfluoroeicosyl group, a perchloropropyl group, a perchlorobutyl group, a perchloropentyl group, a perchlorohexyl group, a perchlorooctyl group, a perchlorododecyl group, a perchloropentadecyl group, a perchloroeicosyl group, a perbromopropyl group, a perbromobutyl group, a perbromopentyl group, a perbromohexyl group, a perbromooctyl group, a perbromododecyl group, a perbromopentadecyl group, a perbromoeicosyl group and the like.

Further, these alkyl groups may be partially substituted with an alkoxy group such as a methoxy group, an ethoxy group or the like, an aryloxy group such as a phenoxy group or the like, or an aralkyloxy group such as a benzyloxy group or the like, etc.

As the aryl group, an aryl group having 6 to 20 carbon atoms is preferable. Examples thereof include a phenyl group, a 2-tolyl group, a 3-tolyl group, a 4-tolyl group, a 2,3-xylyl group, a 2,4-xylyl group, a 2,5-xylyl group, a 2,6-xylyl group, a 3,4-xylyl group, a 3,5-xylyl group, a 2,3,4-trimethylphenyl group, a 2,3,5-trimethylphenyl group, a 2,3,6-trimethylphenyl group, a 2,4,6-trimethylphenyl group, a 3,4,5-trimethylphenyl group, a 2,3,4,5-tetramethylphenyl group, a 2,3,4,6-tetramethylphenyl group, a 2,3,5,6-tetramethylphenyl group, a pentamethylphenyl group, an ethylphenyl group, a n-propylphenyl group, an isopropylphenyl group, a n-butylphenyl group, a sec-butylphenyl group, a tert-butylphenyl group, a n-pentylphenyl group, a neopentylphenyl group, a n-hexylphenyl group, a n-octylphenyl group, a n-decylphenyl group, a n-dodecylphenyl group, a n-tetradecylphenyl group, a naphthyl group, an anthracenyl group and the like, and a phenyl group is more preferable.

These aryl groups may be partially substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom, an alkoxy group such

as a methoxy group, an ethoxy group or the like, an aryloxy group such as a phenoxy group or the like, or an aralkyloxy group such as a benzyloxy group or the like, etc.

5           As the aralkyl group, an aralkyl group having 7 to 20 carbon atoms is preferable. Examples thereof include a benzyl group, a (2-methylphenyl)methyl group, a (3-methylphenyl)methyl group, a (4-methylphenyl)methyl group, a (2,3-dimethylphenyl)methyl group, a (2,4-

10 dimethylphenyl)methyl group, a (2,5-dimethylphenyl)methyl group, a (2,6-dimethylphenyl)methyl group, a (3,4-dimethylphenyl)methyl group, (3,5-

15 dimethylphenyl)methyl group, a (2,3,4-timethylphenyl)methyl group, a (2,3,5-timethylphenyl)methyl group, a (2,3,6-timethylphenyl)methyl group, a (3,4,5-

20 tetramethylphenyl)methyl group, a (2,3,4,6-tetramethylphenyl)methyl group, a (2,3,5,6-tetramethylphenyl)methyl group, a (pentamethylphenyl)methyl group, an (ethylphenyl)methyl group, a (n-propylphenyl)methyl

25 group, an (isopropylphenyl)methyl group, a (n-butylphenyl)methyl group, a (sec-butylphenyl)methyl group, a (tert-butylphenyl)methyl group, a (n-

pentylphenyl)methyl group, a (neopentylphenyl)methyl group, a (n-hexylphenyl)methyl group, a (n-octylphenyl)methyl group, a (n-decylphenyl)methyl group, a (n-dodecylphenyl)methyl group, a (n-tetradecylphenyl)methyl group, a naphthylmethyl group, an anthracenylmethyl group and the like, and a benzyl group is more preferable.

These aralkyl groups may be partially substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom, an iodine atom or the like, an alkoxy group such as a methoxy group, an ethoxy group or the like, an aryloxy group such as a phenoxy group or the like, or an aralkyloxy group such as a benzyloxy group or the like, etc.

Each of the above-mentioned  $L^1$  and  $L^2$  is preferably a hydrogen atom, an alkyl group or an aryl group, more preferably a hydrogen atom or an alkyl group, and preferably an alkyl group in particular.

Respective  $T^2$  and  $J^2$  in the above-mentioned general formulae [5] and [6] independently represent an atom of the Group XV or Group XVI of the Periodic Table of the Elements (Revised edition of IUPAC Inorganic Chemistry Nomenclature 1989), while each of  $T^1$  and  $J^1$  independently represents a nitrogen atom or an oxygen atom.  $T^1$  in the general formula [2] and  $J^1$  in the general formula [3] may be the same or different. Further,  $T^2$  in the general formula [5] and  $J^2$  in the general formula [6] may be the same or different. Specific examples of the atom of the Group XV include a nitrogen atom, a phosphorous atom, and the like, and specific examples of the atom of the Group XVI include an

oxygen atom, a sulfur atom, and the like. Respective  $T^2$  and  $J^2$  are preferably a nitrogen atom, or an oxygen atom, and more preferably an oxygen atom.

Respective  $p$ ,  $q$ ,  $r$  and  $e$  in the above-mentioned general  
5 formulae [2], [3], [5] and [6] represent a valence of  $T^1$ ,  $J^1$ ,  $T^2$  and  $J^2$ , respectively, and for example, when  $T^1$  is an atom of the Group XV,  $p$  is 3 and when  $T^1$  is an atom of the Group XVI,  $p$  is 2.

$R^1$  and  $R^3$  in the above-mentioned general formulae [2]  
10 and [5] represent a halogen atom-containing group and an electron-withdrawing group or a group containing an electron-withdrawing group respectively, and when a plural number of  $R^1$ 's or  $R^3$ 's exist, they may be mutually the same or different. As an index of the electron-withdrawing  
15 property, the substituent constant  $\sigma$  of the Hammett's rule and the like are known, and a functional group in which the substituent constant  $\sigma$  of the Hammett's rule is positive can be mentioned as an electron-withdrawing group.

Specific examples of the electron-withdrawing  
20 group include a fluorine atom, a chlorine atom, a bromine atom, an iodine atom, a cyano group, a nitro group, a carbonyl group, a sulfone group, a phenyl group and the like.

The group containing an electron-withdrawing group

preferably include a halogenated alkyl group, halogenated aryl, and a (halogenated alkyl)aryl group, cyanated aryl group and nitrated aryl group having up to 20 carbon atoms, an ester group (an alkoxycarbonyl group, aralkyloxycarbonyl group and aryloxycarbonyl group having up to 20 carbon atoms,) and the like.

Specific examples of the halogenated alkyl group include a fluoromethyl group, a chloromethyl group, a bromomethyl group, an iodomethyl group, a difluoromethyl group, a dichloromethyl group, a dibromomethyl group, a diiodomethyl group, a trifluoromethyl group, a trichloromethyl group, a tribromomethyl group, a triiodomethyl group, a 2,2,2-trifluoroethyl group, a 2,2,2-trichloroethyl group, a 2,2,2-tribromoethyl group, a 2,2,2-triiodoethyl group, a 2,2,3,3,3-pentafluoropropyl group, a 2,2,3,3,3-pentachloropropyl group, a 2,2,3,3,3-pentabromopropyl group, a 2,2,3,3,3-pentaiodopropyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 2,2,2-trichloro-1-trichloromethylethyl group, a 2,2,2-tribromo-1-tribromomethylethyl group, a 2,2,2-triiodo-1-triiodomethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl group, a 1,1-bis(trichloromethyl)-2,2,2-trichloroethyl group, a 1,1-bis(tribromomethyl)-2,2,2-tribromoethyl group, a 1,1-bis(triiodomethyl)-2,2,2-triiodoethyl group, and

the like.

Specific examples of the halogenated aryl group include a 2-fluorophenyl group, a 3-fluorophenyl group, a 4-fluorophenyl group, a 2-chlorophenyl group, a 3-chlorophenyl group, a 4-chlorophenyl group, a 2-bromophenyl group, a 3-bromophenyl group, a 4-bromophenyl group, a 2-iodophenyl group, a 3-iodophenyl group, a 4-iodophenyl group, a 2,6-difluorophenyl group, a 3,5-difluorophenyl group, a 3,4,5-trifluorophenyl group, a 2,6-dichlorophenyl group, a 3,5-dichlorophenyl group, a 2,6-dibromophenyl group, a 3,5-dibromophenyl group, a 2,6-diiodophenyl group, a 3,5-diiodophenyl group, a 2,4,6-trifluorophenyl group, a 2,4,6-trichlorophenyl group, a 2,4,6-tribromophenyl group, a 2,4,6-triiodophenyl group, a pentafluorophenyl group, a pentachlorophenyl group, a pentabromophenyl group, a pentaiodophenyl group, and the like.

Specific examples of the (halogenated alkyl)aryl group include a 2-(trifluoromethyl)phenyl group, a 3-(trifluoromethyl)phenyl group, a 4-(trifluoromethyl)phenyl group, a 2,6-bis(trifluoromethyl)phenyl group, a 3,5-bis(trifluoromethyl)phenyl group, a 2,4,6-tris(trifluoromethyl)phenyl group, and the like.

Specific examples of the cyanated aryl group include a 2-cyanophenyl group, a 3-cyanophenyl group, a 4-cyanophenyl group and the like.

Specific examples of the nitrated aryl group include a 2-nitrophenyl group, a 3-nitrophenyl group, a 4-nitrophenyl group and the like.

Specific examples of the ester group include a methoxycarbonyl group, an ethoxycarbonyl group, a n-propoxycarbonyl group, an isopropoxycarbonyl group, a phenoxycarbonyl group, a trifluoromethoxycarbonyl group, a pentafluorophenoxycarbonyl group, and the like.

$R^1$  and  $R^3$  are preferably the halogenated hydrocarbon group, and more preferably the halogenated alkyl group or halogenated aryl group having up to 20 carbon atoms. Further preferable is a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a 2,2,2-trifluoroethyl group, a 2,2,3,3,3-pentafluoropropyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl group, a 4-fluorophenyl group, a 2,6-difluorophenyl group, a 3,5-difluorophenyl group, a 3,4,5-trifluorophenyl group, a 2,4,6-trifluorophenyl group, a pentafluorophenyl group, a chloromethyl group, a dichloromethyl group, a trichloromethyl group, a 2,2,2-trichloroethyl group, a 2,2,3,3,3-pentachloropropyl group, a 2,2,2-trichloro-1-trichloromethylethyl group, a 1,1-bis(trichloromethyl)-2,2,2-trichloroethyl group, a

4-chlorophenyl group, a 2,6-dichlorophenyl group, a 3,5-dichlorophenyl group, a 2,4,6-trichlorophenyl group or a pentachlorophenyl group. A fluoroalkyl group or a fluoroaryl group is preferable in particular, and a  
5 trifluoromethyl group, a 2,2,2-trifluoro-1-trifluoromethylethyl group, a 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl group, a 3,4,5-trifluorophenyl group, or a pentafluorophenyl group is most preferable.

$R^2$  represents in the general formula [3] represents a  
10 halogenated hydrocarbon group, and when a plural number of  $R^2$ 's exist, they may be mutually the same or different. The halogenated hydrocarbon group in  $R^2$  includes a halogenated alkyl group, a halogenated aryl group, or (halogenated alkyl)aryl group having up to 20 carbon atoms, and the like,  
15 and the same halogenated alkyl group, halogenated aryl group, and (halogenated alkyl)aryl group as mentioned as specific examples of the electron-withdrawing group in  $R^1$  of the general formula [2] are used.

$R^2$  in the general formula [3] is a halogenated  
20 hydrocarbon group, and preferably

a fluorinated hydrocarbon group

$R^4$  in the general formula [6] represents an organic group having a valence of  $f$ , and is preferably a saturated aliphatic hydrocarbon group having a valence of  $f$  or an aromatic hydrocarbon group having a valence of  $f$ .

" $f$ " in the general formula [6] is a valence of  $R^4$ , and an integer of 2 to 10, preferably an integer of 2 to 6, more preferably an integer of 2 to 4, further more preferably an integer of 2 or 3, and most preferably 2.

Specific examples of the compounds (a) and (d) in the case in which each of  $M^1$  and  $M^2$  is a zinc atom, include dialkylzincs such as dimethylzinc, diethylzinc, dipropylzinc, di-*n*-butylzinc, di-isobutylzinc, di-*n*-hexylzinc, diallylzinc, bis(cyclopentadienyl)zinc and the like; diarylzincs such as diphenylzinc, dinaphthylzinc, bis(pentafluorophenyl)zinc and the like; alkylzinc halides such as methylzinc chloride, ethylzinc chloride, propylzinc chloride, *n*-butylzinc chloride, isobutylzinc chloride, *n*-hexylzinc chloride, methylzinc bromide, ethylzinc bromide, propylzinc bromide, *n*-butylzinc bromide, isobutylzinc bromide, *n*-hexylzinc bromide, methylzinc iodide, ethylzinc iodide, propylzinc iodide, *n*-butylzinc iodide, isobutylzinc iodide, *n*-hexylzinc iodide and the like; zinc halides such as zinc fluoride, zinc chloride, zinc bromide and zinc iodide; and the like.

The compounds (a) and (d) are preferably

dialkylzincs, further preferably dimethylzinc, diethylzinc, dipropylzinc, di-n-butylzinc, di-isobutylzinc, di-n-hexylzinc, diallylzinc or bis(cyclopentadienyl)zinc, and in particular, 5 dimethylzinc or diethylzinc is preferable.

Specific examples of the compounds (b) and (e) include amines such as difluoromethylamine, dichloromethylamine, dibromomethylamine, diiodomethylamine, bis(difluoromethyl)amine, 10 bis(dichloromethyl)amine, bis(dibromomethyl)amine, bis(diiodomethyl)amine, bis(trifluoromethyl)amine, bis(trichloromethyl)amine, bis(tribromomethyl)amine, bis(triiodomethyl)amine, bis (2,2,2-trifluoroethyl) amine, bis(2,2,2- trichloroethyl)amine, bis(2,2,2- 15 tribromoethyl)amine, bis(2,2,2-triiodoethyl)amine, bis(2,2,3,3,3-pentafluoropropyl)amine, bis(2,2,3,3,3-pentachloropropyl)amine, bis(2,2,3,3,3-pentabromopropyl)amine, bis(2,2,3,3,3-pentaiodopropyl)amine, bis(2,2,2-trifluoro-1- 20 trifluoromethylethyl)amine, bis(2,2,2-trichloro-1-trichloromethylethyl)amine, bis(2,2,2-tribromo-1-tribromomethylethyl)amine, bis(2,2,2-triiodo-1-triiodomethylethyl)amine, bis(1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl)amine, 25 bis(1,1-bis(trichloromethyl)-2,2,2-trichloroethyl)amine, bis(1,1-bis(tribromomethyl)-2,2,2-tribromoethyl)amine, bis(1,1-

bis(triiodomethyl)-2,2,2-triiodoethyl)amine, bis(2-fluorophenyl)amine, bis(3-fluorophenyl)amine, bis(4-fluorophenyl)amine, bis(2-chlorophenyl)amine, bis(3-chlorophenyl)amine, bis(4-chlorophenyl)amine, bis(2-bromophenyl)amine, bis(3-bromophenyl)amine, bis(4-bromophenyl)amine, bis(2-iodophenyl)amine, bis(3-iodophenyl)amine, bis(4-iodophenyl)amine, bis(2,6-difluorophenyl)amine, bis(3,5-difluorophenyl)amine, bis(2,6-dichlorophenyl)amine, bis(3,5-dichlorophenyl)amine, bis(2,6-dibromophenyl)amine, bis(3,5-dibromophenyl)amine, bis(2,6-diiodophenyl)amine, bis(3,5-diiodophenyl)amine, bis(2,4,6-trifluorophenyl)amine, bis(2,4,6-trichlorophenyl)amine, bis(2,4,6-tribromophenyl)amine, bis(2,4,6-triiodophenyl)amine, bis(pentafluorophenyl)amine, bis(pentachlorophenyl)amine, bis(pentabromophenyl)amine, bis(pentaiodophenyl)amine, bis(2-(trifluoromethyl)phenyl)amine, bis(3-(trifluoromethyl)phenyl)amine, bis(4-(trifluoromethyl)phenyl)amine, bis(2,6-di(trifluoromethyl)phenyl)amine, bis(3,5-di(trifluoromethyl)phenyl)amine, bis(2,4,6-tri(trifluoromethyl)phenyl)amine, bis(2-cyanophenyl)amine, bis(3-cyanophenyl)amine, bis(4-cyanophenyl)amine, bis(2-nitrophenyl)amine, bis(3-

nitrophenyl)amine, bis(4-nitrophenyl)amine and the like. Further, phosphine compounds in which a nitrogen atom is replaced with a phosphorus atom in the above-mentioned amine compounds, and the like are also exemplified.

When the compounds (b) and (e) are alcohols, specific examples thereof include fluoromethanol, chloromethanol, bromomethanol, iodomethanol, difluoromethanol, dichloromethanol, dibromomethanol, diiodomethanol, trifluoromethanol, trichloromethanol, tribromomethanol, triiodomethanol, 2,2,2-trifluoroethanol, 2,2,2-trichloroethanol, 2,2,2-tribromoethanol, 2,2,2-triiodoethanol, 2,2,3,3,3-pentafluoropropanol, 2,2,3,3,3-pentachloropropanol, 2,2,3,3,3-pentabromopropanol, 2,2,3,3,3-pentaiodopropanol, 2,2,2-trifluoro-1-trifluoromethylethanol, 2,2,2-trichloro-1-trichloromethylethanol, 2,2,2-tribromo-1-tribromomethylethanol, 2,2,2-triiodo-1-triiodomethylethanol, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanol, 1,1-bis(trichloromethyl)-2,2,2-trichloroethanol, 1,1-bis(tribromomethyl)-2,2,2-tribromoethanol, 1,1-bis(triiodomethyl)-2,2,2-triiodoethanol and the like. Further, thiol compounds in which an oxygen atom is replaced with a sulfur atom in the above-mentioned alcohol compounds, and the like are also exemplified.

When the compounds (b) and (e) are phenols, specific examples thereof include 2-fluorophenol, 3-fluorophenol, 4-fluorophenol, 2-chlorophenol, 3-chlorophenol, 4-chlorophenol, 2-bromophenol, 3-bromophenol, 4-bromophenol, 2-iodophenol, 3-iodophenol, 4-iodophenol, 2,6-difluorophenol, 3,5-difluorophenol, 3,4,5-trifluorophenol, 2,6-dichlorophenol, 3,5-dichlorophenol, 2,6-dibromophenol, 3,5-dibromophenol, 2,6-diiodophenol, 3,5-diiodophenol, 2,4,6-trifluorophenol, 2,4,6-trichlorophenol, 2,4,6-tribromophenol, 2,4,6-triiodophenol, pentafluorophenol, pentachlorophenol, pentabromophenol, pentaiodophenol, 2-(trifluoromethyl)phenol, 3-(trifluoromethyl)phenol, 4-(trifluoromethyl)phenol, 2,6-bis(trifluoromethyl)phenol, 3,5-bis(trifluoromethyl)phenol, 2-cyanophenol, 3-cyanophenol, 4-cyanophenol, 2-nitrophenol, 3-nitrophenol, 4-nitrophenol and the like. Further, thiophenol compounds in which an oxygen atom is replaced with a sulfur atom in the above-mentioned phenol compounds, and the like are also exemplified.

When the compounds (b) and (e) are carboxylic acids, specific examples thereof include 2-fluorobenzoic acid, 3-fluorobenzoic acid, 4-fluorobenzoic acid, 2,3-difluorobenzoic acid, 2,4-difluorobenzoic acid, 2,5-difluorobenzoic acid, 2,6-difluorobenzoic acid,

2,3,4-trifluorobenzoic acid, 2,3,5-trifluorobenzoic acid, 2,3,6-trifluorobenzoic acid, 2,4,5-trifluorobenzoic acid, 2,4,6-trifluorobenzoic acid, 2,3,4,5-tetrafluorobenzoic acid, 2,3,4,6-tetrafluorobenzoic acid, pentafluorobenzoic acid, fluoroacetic acid, difluoroacetic acid, trifluoroacetic acid, pentafluoropropanoic acid, heptafluorobutanoic acid, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanoic acid and the like.

10           When the compounds (b) and (e) are sulfonic acids, specific examples thereof include fluoromethanesulfonic acid, difluoromethanesulfonic acid, trifluoromethanesulfonic acid, pentafluoroethanesulfonic acid, 15 heptafluoropropanesulfonic acid, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethanesulfonic acid and the like.

          The compounds (b) and (e) are preferably, bis(trifluoromethyl)amine, bis(2,2,2-trifluoromethyl)amine, bis(2,2,3,3,3-pentafluoropropyl)amine, bis(2,2,2-trifluoro-1-trifluoromethylethyl)amine, bis(1,1-bis(trifluoromethyl)-2,2,2-trifluoroethyl)amine or 20 bis(pentafluorophenyl)amine as amines; trifluoromethanol, 2,2,2-trifluoroethanol, 2,2,3,3,3-pentafluoropropanol, 2,2,2-trifluoro-1-trifluoromethylethanol or 1,1-bis(trifluoromethyl)-

2,2,2-trifluoroethanol as alcohols; 2-fluorophenol,  
3-fluorophenol, 4-fluorophenol, 2,6-difluorophenol,  
3,5-difluorophenol, 3,4,5-trifluorophenol, 2,4,6-  
trifluorophenol, pentafluorophenol, 2-  
5 (trifluoromethyl)phenol, 3-(trifluoromethyl)phenol,  
4-(trifluoromethyl)phenol, 2,6-  
bis(trifluoromethyl)phenol, 3,5-  
bis(trifluoromethyl)phenol or 2,4,6-  
tris(trifluoromethyl)phenol as phenols;  
10 pentafluorobenzoic acid or trifluoroacetic acid as  
carboxylic acids; and trifluoromethanesulfonic acid as  
sulfonic acids.

The compounds (b) and (e) are more preferably,  
bis(trifluoromethyl)amine, bis(pentafluorophenyl)  
15 amine, trifluoromethanol, 2,2,2-trifluoro-1-  
trifluoromethylethanol, 1,1-bis(trifluoromethyl)-  
2,2,2-trifluoroethanol, 4-fluorophenol, 2,6-  
difluorophenol, 2,4,6-trifluorophenol, 3,4,5-  
trifluorophenol, pentafluorophenol, 4-  
20 (trifluoromethyl)phenol, 2,6-  
bis(trifluoromethyl)phenol or 2,4,6-  
tris(trifluoromethyl)phenol, and further preferably  
3,4,5-trifluorophenol, pentafluorophenol or 1,1-  
bis(trifluoromethyl)-2,2,2-trifluoroethanol.

25 The compounds (c) are preferably water, hydrogen  
disulfide, an alkylamine, arylamine, aralkylamine  
halogenated alkylamine, halogenated arylamine, and

(halogenated alkyl)arylamine having up to 20 carbon atoms, and specific examples thereof include water, hydrogen disulfide, methylamine, ethylamine, n-propylamine, isopropylamine, n-butylamine, sec-butylamine, tert-butylamine, isobutyl amine, n-pentylamine, neopentylamine, amyl amine, n-hexylamine, n-octylamine, n-decyl amine, n-dodecyl amine, n-eicosylamine, allylamine, cyclopentadienylamine, aniline, 2-tolylamine, 3-tolylamine, 4-tolylamine, 2,3-xylylamine, 2,4-xylylamine, 2,5-xylylamine, 2,6-xylylamine, 3,4-xylylamine, 3,5-xylylamine, 2,3,4-trimethylaniline, 2,3,5-trimethylaniline, 2,3,6-trimethylaniline, 2,4,6-trimethylaniline, 3,4,5-trimethylaniline, 2,3,4,5-tetramethylaniline, 2,3,4,6-tetramethylaniline, 2,3,5,6-tetramethylaniline, pentamethylaniline, ethylaniline, n-propylaniline, isopropylaniline, n-butylianiline, sec-butylianiline, tert-butylianiline, n-pentylianiline, neopentylianiline, n-hexylianiline, n-octylianiline, n-decylianiline, n-dodecylianiline, n-tetradecylianiline, naphthylamine, anthracenylamine, benzylamine, (2-methylphenyl)methylamine, (3-methylphenyl)methylamine, (4-methylphenyl)methylamine, (2,3-dimethylphenyl)methylamine, (2,4-dimethylphenyl)methylamine, (2,5-dimethylphenyl)methylamine, (2,6-

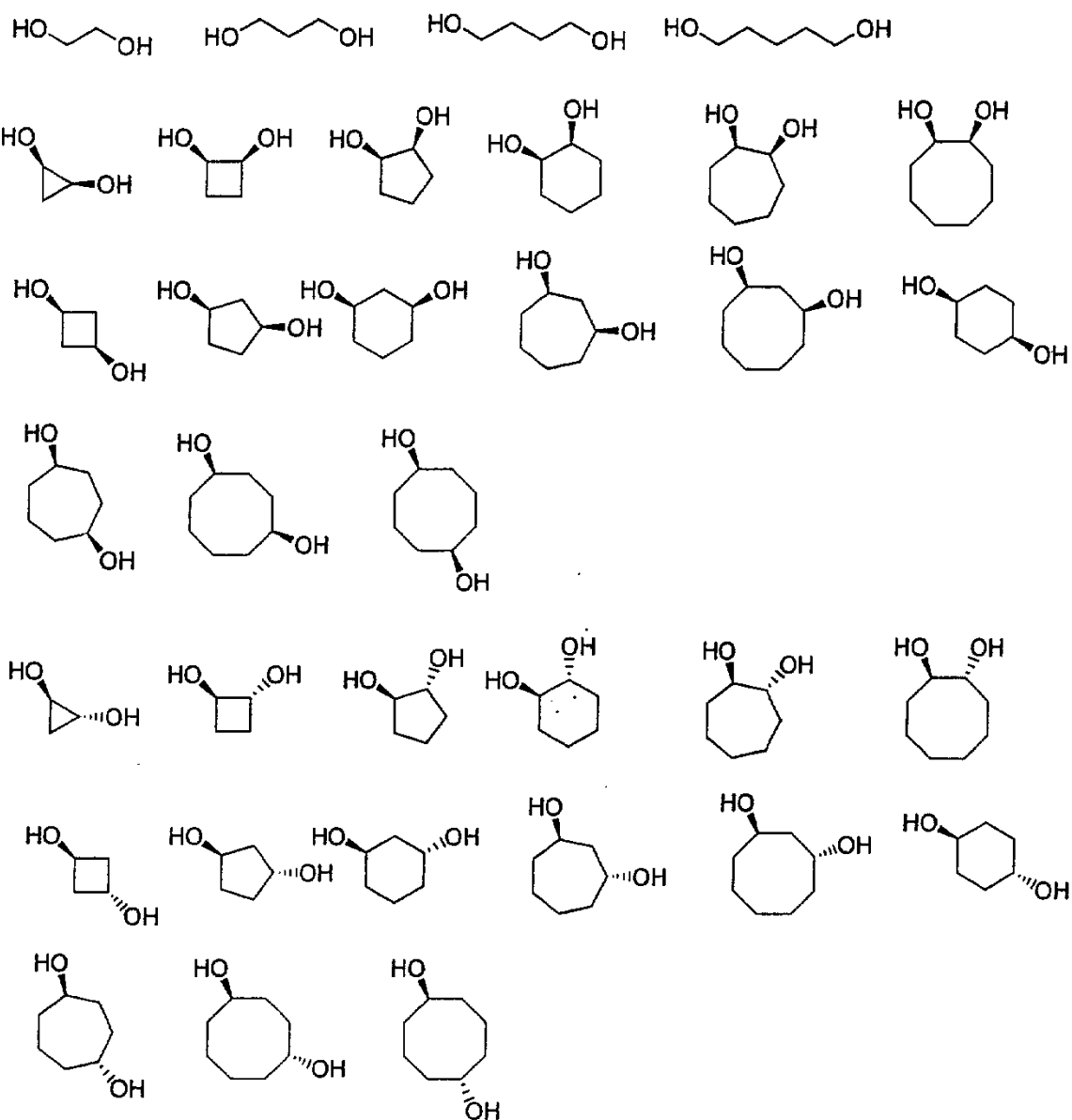
dimethylphenyl)methylamine, (3,4-  
dimethylphenyl)methylamine, (3,5-  
dimethylphenyl)methylamine, (2,3,4-  
trimethylphenyl)methylamine, (2,3,5-  
5 trimethylphenyl)methylamine, (2,3,6-  
trimethylphenyl)methylamine, (3,4,5-  
trimethylphenyl)methylamine, (2,4,6-  
trimethylphenyl)methylamine, (2,3,4,5-  
tetramethylphenyl)methylamine, (2,3,4,6-  
10 tetramethylphenyl)methylamine, (2,3,5,6-  
tetramethylphenyl)methylamine,  
(pentamethylphenyl)methylamine,  
(ethylphenyl)methylamine, (n-  
propylphenyl)methylamine,  
15 (isopropylphenyl)methylamine, (n-  
butylphenyl)methylamine, (sec-  
butylphenyl)methylamine, (tert-  
butylphenyl)methylamine, (n-pentylphenyl)methylamine,  
(neopentylphenyl)methylamine, (n-  
20 hexylphenyl)methylamine, (n-octylphenyl)methylamine,  
(n-decylphenyl)methylamine, (n-  
dodecylphenyl)methylamine, naphthylmethylamine,  
anthracenylmethylamine, fluoromethylamine,  
chloromethylamine, bromomethylamine, iodomethylamine,  
25 difluoromethylamine, dichloromethylamine,  
dibromomethylamine, diiodomethylamine,  
trifluoromethylamine, trichloromethylamine,

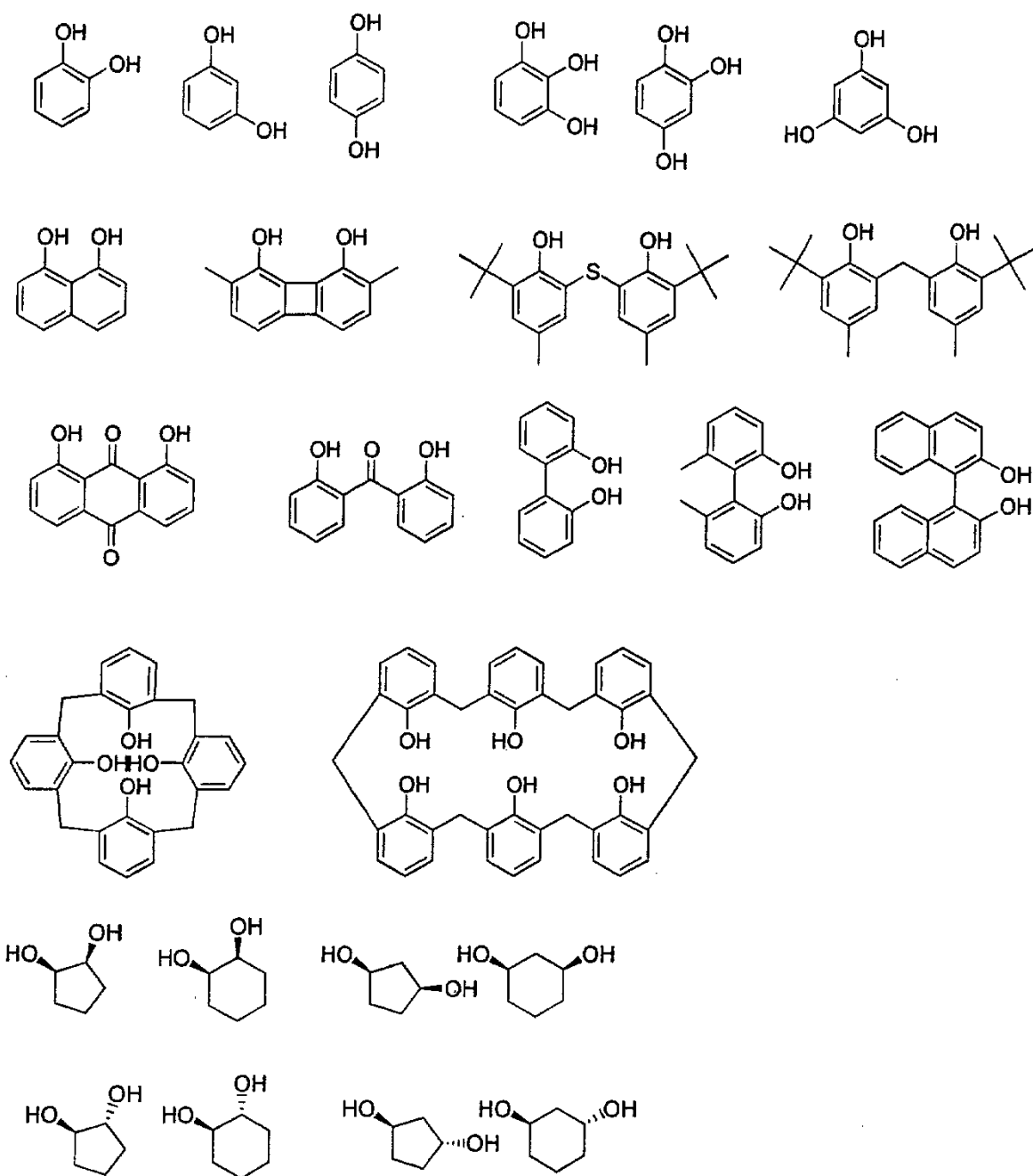
tribromomethylamine, triiodomethylamine, 2,2,2-trifluoroethylamine, 2,2,2-trichloroethylamine, 2,2,2-tribromoethylamine, 2,2,2-triiodoethylamine, 2,2,3,3,3-pentafluoropropylamine, 2,2,3,3,3-pentachloropropylamine, 2,2,3,3,3-pentabromopropylamine, 2,2,3,3,3-pentaiodopropylamine, 2,2,2-trifluoro-1-trifluoromethylethylamine, 2,2,2-trichloro-1-trichloromethylethylamine, 2,2,2-tribromo-1-tribromomethylethylamine, 2,2,2-triiodo-1-triiodomethylethylamine, 1,1-bis(trifluoromethyl)-2,2,2-trifluoroethylamine, 1,1-bis(trichloromethyl)-2,2,2-trichloroethylamine, 1,1-bis(tribromomethyl)-2,2,2-tribromoethylamine, 1,1-bis(triiodomethyl)-2,2,2-triiodoethylamine, 2-fluoroaniline, 3-fluoroaniline, 4-fluoroaniline, 2-chloroaniline, 3-chloroaniline, 4-chloroaniline, 2-bromoaniline, 3-bromoaniline, 4-bromoaniline, 2-iodoaniline, 3-iodoaniline, 4-iodoaniline, 2,6-difluoroaniline, 3,5-difluoroaniline, 2,6-dichloroaniline, 3,5-dichloroaniline, 2,6-dibromoaniline, 3,5-dibromoaniline, 2,6-diiodoaniline, 3,5-diiodoaniline, 2,4,6-trifluoroaniline, 2,4,6-trichloroaniline, 2,4,6-tribromoaniline, 2,4,6-triiodoaniline, pentafluoroaniline, pentachloroaniline, pentabromoaniline, pentaiodoaniline, 2-(trifluoromethyl)aniline, 3-(trifluoromethyl)aniline,

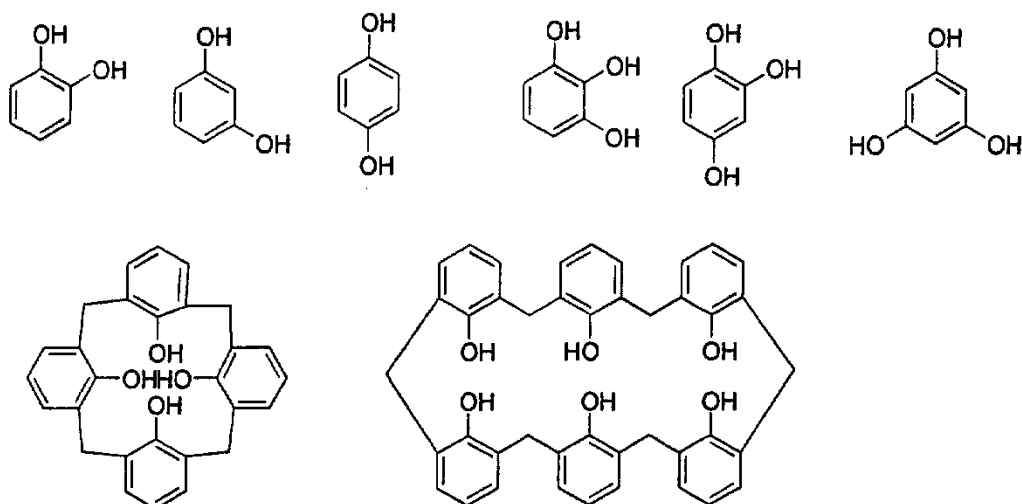
4-(trifluoromethyl)aniline, 2,6-  
di(trifluoromethyl)aniline, 3,5-  
di(trifluoromethyl)aniline and 2,4,6-  
tri(trifluoromethyl)aniline; more preferably water,  
5 hydrogen disulfide, methylamine, ethylamine, n-  
propylamine, isopropylamine, n-butylamine, sec-  
butylamine, tert-butylamine, isobutyl amine, n-  
octylamine, aniline, 2,6-xylylamine, 2,4,6-  
trimethylaniline, naphthylamine, anthracenylamine,  
10 benzylamine, trifluoromethylamine,  
pentafluoroethylamine, perfluoroproylamine,  
perfluorobutylamine, perfluoropentylamine,  
perfluorohexylamine, perfluorooctylamine,  
perfluorododecylamine, perfluoropentadecylamine,  
15 perfluoroeicosylamine, 2-fluoroaniline, 3-  
fluoroaniline, 4-fluoroaniline, 2,6-  
difluoroaniline, 3,5-difluoroaniline, 2,4,6-  
trifluoroaniline, pentafluoroaniline, 2-  
(trifluoromethyl)aniline, 3-(trifluoromethyl)aniline,  
20 4-(trifluoromethyl)aniline, 2,6-  
bis(trifluoromethyl)aniline, 3,5-  
bis(trifluoromethyl)aniline or 2,4,6-  
tris(trifluoromethyl)aniline; in particular,  
preferably water, trifluoromethylamine,  
25 perfluorobutylamine, perfluorooctylamine,  
perfluoropentadecylamine, 2-fluoroaniline, 3-  
fluoroaniline, 4-fluoroaniline, 2,6-difluoroaniline,

3,5-difluoroaniline, 2,4,6-trifluoroaniline,  
pentafluoroaniline, 2-(trifluoromethyl)aniline, 3-  
(trifluoromethyl)aniline, 4-(trifluoromethyl)aniline,  
2,6-bis(trifluoromethyl)aniline, 3,5-  
5 bis(trifluoromethyl)aniline and 2,4,6-  
tris(trifluoromethyl)aniline; and most preferably  
water and pentafluoroaniline.

Further, as the compound (f) used for preparation  
of the compound [B], the followings and the like are  
10 mentioned.







The compound [A] is a compound obtained by contacting the above-mentioned compounds (a), (b) and (c). The order of contacting the compounds (a), (b) and (c) is not specifically limited, and for example, the following order can be adopted.

- ① A method of contacting (c) after contacting (a) and (b).
- ② A method of contacting (b) after contacting (a) and (c).
- ③ A method of contacting (a) after contacting (b) and (c).

The contact order is preferably ① or ②. Namely, the compound [A] is preferably a compound obtained by contacting (c) with a contact product obtained by contacting (a) and (b), or a compound obtained by contacting (b) with a contact product obtained by contacting (a) and (c).

Further, the compound [B] is a compound obtained

by contacting the above-mentioned compounds (d), (e) and (f). The order of contacting the compounds (d), (e) and (f) is not specifically limited, and for example, the following order can be adopted.

5           ① ' A method of contacting (f) after contacting (d) and (e).

          ② ' A method of contacting (e) after contacting (d) and (f).

          ③ ' A method of contacting (d) after contacting (e) and (f).

          The contact order is preferably ① ' or ② '.  
Namely, the compound [B] is preferably a compound obtained by contacting (f) with a contact product obtained by contacting (d) and (e), or a compound  
15           obtained by contacting (e) with a contact product obtained by contacting (d) and (f).

          The contact treatment in the preparation of the above-mentioned compounds [A] and [B] is preferably carried out under an inert gas atmosphere. The treatment  
20           temperature is usually from  $-100^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ , and preferably from  $-80^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . The treatment time is usually from 1 minute to 36 hours, and preferably from 10 minutes to 24 hours. Further, the treatment may use a solvent, and these compounds may be directly treated  
25           without using it. The solvent used is inert to the raw material compounds (a), (b) and (c), or (d), (e) and (f).

          Either of a non-polar solvent such as an aliphatic

hydrocarbon solvent, an aromatic hydrocarbon solvent or the like, or a polar solvent such as an ethereal solvent or the like, can be used. Specific examples of the solvent include butane, hexane, heptane, octane, 2,2,4-  
5 trimethylpentane, cyclohexane, benzene, toluene, xylene, dimethyl ether, diethyl ether, diisopropyl ether, di-n-butyl ether, methyl tert-butyl ether, anisole, 1,4-dioxane, 1,2-dimethoxyethane, bis(2-methoxyethyl) ether, tetrahydrofuran, tetrahydropyran  
10 and the like.

In the present invention, a polar solvent is preferable among these solvents. As index representing the polarity of the solvent,  $E_T^N$  value (C. Reichardt, "Solvents and Solvents Effects in Organic Chemistry",  
15 2nd ed., VCH Verlag (1988)) and the like are known, and in particular, preferably, the polar solvent is a solvent which satisfies the expression:

$$E_T^N \text{ of } 0.5 \geq E_T^N \geq 0.1$$

Examples of the polar solvent include ethereal  
20 solvents such as dimethyl ether, diethyl ether, diisopropyl ether, di-n-butyl ether, methyl tert-butyl ether, anisole, 1,4-dioxane, 1,2-dimethoxyethane, bis(2-methoxyethyl) ether, tetrahydrofuran, tetrahydropyran and the like, and tetrahydrofuran is  
25 most preferable as the solvent.

The amounts used of the respective compounds in the preparation of the compound [A] are not specifically

limited. When the molar ratio of the amounts used of the respective compounds is defined as a molar ratio of  $(a):(b):(c) = 1:y^1:z^1$ , it is preferable that  $y^1$  and  $z^1$  satisfy substantially the expression (1):

$$c = y^1 + 2z^1 \quad (1)$$

(wherein c represents a valence of  $M^1$  in the expression (1))

$y^1$  in the expression (1) is preferably a numeral of from 0.01 to 1.99, more preferably a numeral of from 0.20 to 1.80, further preferably a numeral of from 0.25 to 1.50, and most preferably a numeral of from 0.50 to 1.00.  $z^1$  in the expression (1) is a numeral determined by c,  $y^1$  and the expression (1).

Further, the amount used of the respective compounds is not also specifically limited in the preparation of the compound [B]. When the molar ratio of the amounts used of the respective compounds is defined as a molar ratio of  $(d):(e):(f) = x^1:y^2:z^2$ , it is preferable that  $x^1$ ,  $y^2$  and  $z^2$  satisfy substantially the expression (2) when J in the general formula [6] is an atom of Group XVI, and the expression (3) when J in the general formula [6] is an atom of Group XV:

$$d \times x^1 = y^2 + f \times z^2 \quad (2)$$

$$y^2 + f \times z^2 \leq d \times x^1 \leq y^2 + 2 \times f \times z^2 \quad (3)$$

(wherein each of d and f in the expressions (2) and (3) is the same value as in the above-mentioned general formula [4] or [6], respectively.)

$y^2$  in the expressions (2) and (3) is preferably  
 a numeral of  $y^2/x^1$  of from 0.01 to 1.99, more preferably  
 a numeral of from 0.2 to 1.8, further preferably a numeral  
 of from 0.25 to 1.5, and most preferably a numeral of  
 5 from 0.5 to 1.0.  $z^2$  in the expressions (2) or (3) is a  
 numeral determined by  $d$ ,  $f$ ,  $x^1$ ,  $y^2$  and the above-  
 mentioned expression (2) or (3). Further,  $x^1$  is a numeral  
 being an arbitrary positive value.

Even if the use of the respective compounds are  
 10 really designed so as to perfectly satisfy the  
 above-mentioned expressions (1) to (3) in the contact  
 treatment of the above-mentioned compounds, the amounts  
 used may fluctuate finely, and it is usually carried out  
 to appropriately increase and decrease the amounts used  
 15 to a certain degree considering the amount of a compound  
 which remains while being unreacted. Herein, "satisfy  
 substantially" means that a case of designing to obtain  
 a compound obtained by contacting the respective  
 compounds at the molar ratio satisfying the above-  
 20 mentioned expressions is included even if the above-  
 mentioned expressions is not perfectly satisfied.

When the molar ratio of the amounts used of the  
 respective compounds is defined as a molar ratio of  
 (a):(b):(c) =  $1 : y^1 : z^1$  in the preparation of the  
 25 compound [A], it is preferable that  $y^1$  and  $z^1$  satisfy  
 the expression (4):

$$0 \leq |c - y^1 - 2z^1| \leq 0.2 \quad (4)$$

(c represents a valence of  $M^1$  in the expression (4))

Further, when the molar ratio of the amounts used of the respective compounds is defined as a molar ratio of  $(d):(e):(f) = x^1:y^2:z^2$  in the preparation of the compound [B], it is preferable that  $x^1$ ,  $y^2$  and  $z^2$  satisfy the expression (5) when J in the general formula [6] is an atom of Group XVI:

$$0 \leq |d - (y^2 + f \times z^2) \div x^1| \leq 0.2 \quad (5)$$

(each of d and f in the expression (5) is the same value as in the above-mentioned formula [4] or [6].)

As a result of the contact treatment, at least one of (a), (b) and (c) or at least one of (d), (e) and (f) which are raw materials may remain as unreacted matters concerning the compounds.

Further, it is preferable in the preparation of the compound [A] to distill the solvent from the product after the contact treatment and carry out drying at 25°C or more for one hour or more under reduced pressure. It is more preferable to carry out drying at 60 to 200°C for one to 24 hours and most preferable at 80 to 160°C for 4 to 18 hours.

Specific example of the production process of the compound [A] is shown below in detail when  $M^1$  is zinc atom, the compound (b) is pentafluorophenol, and the compound (c) is water. A process which include the following steps can be adopted:

Tetrahydrofuran is used as a solvent; a hexane solution

of diethylzinc is added thereto and cooled to 0°C;  
pentafluorophenol of the equimolar amount to  
diethylzinc is added dropwise thereto; after stirring  
at room temperature for 10 minutes to 24 hours, 0.5-  
5 fold molar amount of water to diethylzinc is further  
added dropwise; after stirring at room temperature for  
10 minutes to 24 hours, the solvent is removed by  
distillation; and drying is carried out at 120°C for 8  
hours under reduced pressure.

10 Of course, the compounds used in these treatments  
are not limited to pentafluorophenol and water, the  
compound as a raw material is not limited to a zinc  
compound, and the condition at drying is not limited to  
at 120°C for 8 hours.

15 Further, a specific example of the production  
process of the compound [B] is shown below in detail when  
M<sup>2</sup> is zinc atom, the compound (e) is pentafluorophenol,  
and the compound (f) is 1,3-cyclopentanediol(a mixture  
of cis-isomer and trans-isomer).

20 A process which include the following steps can be  
adopted:

A hexane solution of diethylzinc and toluene are  
charged in a flask whose atmosphere was replaced with  
argon and the mixture is stirred and cooled at -78°C;  
25 a hexane solution of pentafluorophenol which is an  
equimolar amount to diethylzinc is added thereto  
dropwise and the resultant was stirred at room

temperature for 1 hour; thereafter, 0.5-fold molar amount of 1,3-cyclopentanediol (a mixture of cis-isomer and trans-isomer) to diethylzinc is further added dropwise and stirring is carried out overnight; and then,  
5 a volatile material is removed by distillation and a solid prepared is dried at room temperature under reduced pressure.

Of course, the compound used in these treatments is not limited to pentafluorophenol and 1,3-cyclopentanediol (a mixture of cis-isomer and trans-isomer), and the metal compound as a raw material is not  
10 limited to a zinc compound.

Next, the compound [C] represented by the general formula [7] is illustrated.

15  $M^3$  has been already described.

$T^3$  in the general formula [7] represents an atom of the Group XIV, Group XV or Group XVI of the Periodic Table of the Elements (Revised edition of IUPAC Inorganic Chemistry Nomenclature 1989), and when a  
20 plural number of  $T^3$ 's exist, they may be mutually the same or different. Specific example of the atom of the Group XIV includes a carbon atom, a silicon atom and the like, specific example of the atom of the Group XV includes a nitrogen atom, a phosphorous atom and the like,  
25 and specific example of the atom of the Group XVI includes an oxygen atom, a sulfur atom and the like.  $T^3$  is preferably a carbon atom, a nitrogen atom or an oxygen

atom, further preferably a nitrogen atom or an oxygen atom, and in particular,  $T^3$  is preferably an oxygen atom.

"s" in the general formula [7] represents a valence of  $T^3$ . When  $T^3$  is the atom of the Group XIV, "s" is 4, when  $T^3$  is the atom of Group XV, "s" is 3, and when  $T^3$  is the atom of Group XVI, "s" is 2.

$R^5$  in the general formula [7] represents an electron-withdrawing group or a group containing an electron-withdrawing group, and when a plural number of  $R^5$ 's exist, they may be mutually the same or different. Examples of the electron-withdrawing group or the group containing an electron-withdrawing group are selected from those already described in the illustration of  $R^1$  and  $R^3$ , and the preferable group is the same group as in  $R^1$  and  $R^3$ .

Further,  $R^6$  represents a hydrocarbon group, and a plural number of  $R^6$ 's may be mutually the same or different. The hydrocarbon group in  $R^6$  is preferably an alkyl group, an aryl group or an aralkyl group.

As the alkyl group herein, an alkyl group having 1 to 20 carbon atoms is preferable. Examples include a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, a sec-butyl group, a tert-butyl group, an isobutyl group, a n-pentyl group, a neopentyl group, a n-hexyl group, a n-octyl group, a n-decyl group, a n-dodecyl group, a n-pentadecyl group, a n-eicosyl group, and the like. A methyl group, an ethyl

group, an isopropyl group, a tert-butyl group or an isobutyl group is more preferable.

Any one of these alkyl groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom. Examples of the alkyl group having 1 to 20 carbon atoms which is substituted with the halogen atom include a fluoromethyl group, a difluoromethyl group, a trifluoromethyl group, a chloromethyl group, a dichloromethyl group, a trichloromethyl group, a bromomethyl group, a dibromomethyl group, a tribromomethyl group, an iodomethyl group, a diiodomethyl group, a triiodomethyl group, a fluoroethyl group, a difluoroethyl group, a trifluoroethyl group, a tetrafluoroethyl group, a pentafluoroethyl group, a chloroethyl group, a dichloroethyl group, a trichloroethyl group, a tetrachloroethyl group, a pentachloroethyl group, a bromoethyl group, a dibromoethyl group, a tribromoethyl group, a tetrabromoethyl group, a pentabromoethyl group, a perfluoropropyl group, a perfluorobutyl group, a perfluoropentyl group, a perfluorohexyl group, a perfluorooctyl group, a perfluorododecyl group, a perfluoropentadecyl group, a perfluoroeicosyl group, a perchloropropyl group, a perchlorobutyl group, a perchloropentyl group, a perchlorohexyl group, a perchlorooctyl group, a perchlorododecyl group, a perchloropentadecyl group, a perchloroeicosyl group, a

perbromopropyl group, a perbromobutyl group, a  
perbromopentyl group, a perbromohexyl group, a  
perbromooctyl group, a perbromododecyl group, a  
perbromopentadecyl group, a perbromoeicosyl group and  
5 the like.

Further, any one of these alkyl groups may be  
partially substituted with an alkoxy group such as a  
methoxy group, an ethoxy group or the like, an aryloxy  
group such as a phenoxy group or the like, or an  
10 aralkyloxy group such as a benzyloxy group or the like,  
etc.

As the aryl group, an aryl group having 6 to 20 carbon  
atoms is preferable. Examples thereof include a phenyl  
group, a 2-tolyl group, a 3-tolyl group, a 4-tolyl group,  
15 a 2,3-xylyl group, a 2,4-xylyl group, a 2,5-xylyl group,  
a 2,6-xylyl group, a 3,4-xylyl group, a 3,5-xylyl group,  
a 2,3,4-trimethylphenyl group, a 2,3,5-trimethylphenyl  
group, a 2,3,6-trimethylphenyl group, a 2,4,6-  
trimethylphenyl group, a 3,4,5-trimethylphenyl group,  
20 a 2,3,4,5-tetramethylphenyl group, a 2,3,4,6-  
tetramethylphenyl group, a 2,3,5,6-tetramethylphenyl  
group, a pentamethylphenyl group, an ethylphenyl group,  
a n-propylphenyl group, an isopropylphenyl group, a  
n-butylphenyl group, a sec-butylphenyl group, a  
25 tert-butylphenyl group, a n-pentylphenyl group, a  
neopentylphenyl group, a n-hexylphenyl group, a n-  
octylphenyl group, a n-decylphenyl group, a n-

dodecylphenyl group, a n-tetradecylphenyl group, a naphthyl group, an anthracenyl group and the like, and a phenyl group is more preferable.

Any one of these aryl groups may be partially substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom, an alkoxy group such as a methoxy group, an ethoxy group or the like, an aryloxy group such as a phenoxy group or the like, or an aralkyloxy group such as a benzyloxy group or the like, etc.

As the aralkyl group, an aralkyl group having 7 to 20 carbon atoms is preferable. Examples include a benzyl group, a (2-methylphenyl)methyl group, a (3-methylphenyl)methyl group, a (4-methylphenyl)methyl group, a (2,3-dimethylphenyl)methyl group, a (2,4-dimethylphenyl)methyl group, a (2,5-dimethylphenyl)methyl group, a (2,6-dimethylphenyl)methyl group, a (3,4-dimethylphenyl)methyl group, a (3,5-dimethylphenyl)methyl group, a (2,3,4-trimethylphenyl)methyl group, a (2,3,5-trimethylphenyl)methyl group, a (2,3,6-trimethylphenyl)methyl group, a (3,4,5-trimethylphenyl)methyl group, a (2,4,6-trimethylphenyl)methyl group, a (2,3,4,5-tetramethylphenyl)methyl group, a (2,3,4,6-tetramethylphenyl)methyl group, a (2,3,5,6-

tetramethylphenyl)methyl group, a  
(pentamethylphenyl)methyl group, an  
(ethylphenyl)methyl group, a (n-propylphenyl)methyl  
group, an (isopropylphenyl)methyl group, a (n-  
5 butylphenyl)methyl group, a (sec-butylphenyl)methyl  
group, a (tert-butylphenyl)methyl group, a (n-  
pentylphenyl)methyl group, a (neopentylphenyl)methyl  
group, a (n-hexylphenyl)methyl group, a (n-  
octylphenyl)methyl group, a (n-decylphenyl)methyl  
10 group, a (n-dodecylphenyl)methyl group, a (n-  
tetradecylphenyl)methyl group, a naphthylmethyl group,  
an anthracenylmethyl group and the like, and a benzyl  
group is more preferable.

Any one of these aryl groups may be partially  
15 substituted with a halogen atom such as a fluorine atom,  
a chlorine atom, a bromine atom or an iodine atom, an  
alkoxy group such as a methoxy group, an ethoxy group  
or the like, an aryloxy group such as a phenoxy group  
or the like, or an aralkyloxy group such as a benzyloxy  
20 group or the like, etc.

$R^6$  in the general formula [7] is preferably an aryl  
group or an alkyl group.

"h" in the general formula [7] represents a numeral  
of 1 or more, and usually an integer. "h" is preferably  
25 an integer of 1 to 5, and in particular, 1.

The compound represented by the general formula [7]  
is preferably a  $\mu$ -oxo-bis(alkylzinc) or  $\mu$ -oxo-

bis(arylzinc), in particular.

Two or more of molecules of the compound represented by the general formula [7] may be associated.

5       The production process of the compound represented by the general formula [7] is not specifically limited, and for example, a process of treating an organometallic compound such as an alkylmetal, a halogenated alkylmetal or the like with a compound  
10       selected from a gem-dihalogenohydrocarbon, a silane, a germane, an amine, a phosphine, water, a hydrate of metal salt, hydrogen disulfide and the like, is mentioned.

      The treatment is preferably carried out under inert gas atmosphere. The treatment temperature is usually  
15       from  $-100^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ , and preferably from  $-80^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . The treatment time is usually from 1 minute to 36 hours, and preferably from 10 minutes to 24 hours. Further, the treatment may use a solvent, and these compounds may be directly treated without using it. The solvent used is  
20       preferably an aliphatic hydrocarbon solvent, an aromatic hydrocarbon solvent or an ethereal solvent which is inert to an organometallic compound such as an alkylmetal, a halogenated alkylmetal or the like and a compound selected from a gem-dihalogenohydrocarbon, a  
25       silane, a germane, an amine, a phosphine, water, a hydrate of metal salt, hydrogen disulfide and the like. Specific examples of the solvent include butane, hexane,

heptane, octane, benzene, toluene, diethyl ether, di-n-butyl ether, tetrahydrofuran and the like.

Further, in the treatment, the order of dropwise addition of the compound selected from a gem-

5 dihalogenohydrocarbon, a silane, a germane, an amine, a phosphine, water, a hydrate of metal salt, hydrogen disulfide and the like is not specifically limited, it may be successively dropwise added, may be simultaneously dropwise added, and 2 or more of solvents

10 may be dropwise added after mixing. Arbitrary amounts of  $R^5$  and  $R^6$  can be introduced by adjusting the molar number of the compound selected from a gem-

dihalogenohydrocarbon, a silane, a germane, an amine, a phosphine, water, a hydrate of metal salt, hydrogen

15 disulfide and the like to the organometallic compound.

Further, as a result of the treatment, the organometallic compound being a raw material and the compound selected from a gem-dihalogenohydrocarbon, a silane, a germane, an amine, a phosphine, water, a

20 hydrate of metal salt, hydrogen disulfide and the like may remain as an unreacted matter. The compound represented by the general formula [7] which was obtained by the treatment can be used as a catalyst component for addition polymerization after separation

25 and purification such as recrystallization or the like, but the reacted solution can be also used as a catalyst component for addition polymerization. The solvent is

preferably removed by distillation from the reacted solution, and drying is preferably carried out at a temperature of 25°C or more for 1 hour or more under reduced pressure. It is more preferable to carry out  
5 drying at 60 to 200°C for one to 24 hours, and most preferable at 80 to 160°C for 4 to 18 hours.

Specific example of the production process of the compound represented by the general formula [7] is further shown below in detail when  $M^3$  is zinc atom and  
10 a treating agent is water.

A process that toluene is a solvent, a hexane solution of a dialkylzinc (for example, diethylzinc) is added thereto and cooled at 0 °C, water of an equimolar amount to the dialkylzinc is added dropwise, and the  
15 mixture is stirred at room temperature for 10 minutes to 24 hours, can be adopted. Of course, those used in these treatments are not limited to the dialkylzinc and water.

Then, the compound [D] represented by the general  
20 formula [8] is illustrated.

$M^4$  has been already described.

As  $X^1$ , specific examples of the atom of the Group XIV as  $X^1$  include a carbon atom, a silicon atom and the like, specific examples of the atom of Group the XV  
25 include a nitrogen atom, a phosphorous atom and the like, and specific examples of the atom of the Group XVI include an oxygen atom, a sulfur atom and the like.  $X^1$  is

preferably a carbon atom, a nitrogen atom or an oxygen atom, further preferably a nitrogen atom or an oxygen atom, and in particular,  $X^1$  is preferably an oxygen atom.

"i" in the general formula [8] represents a numeral  
5 by 1 smaller than a valence of  $X^1$ . When  $X^1$  is the atom of the Group XIV, "i" is 3, when  $X^1$  is the atom of the Group XV, "i" is 2, and when  $X^1$  is the atom of the Group XIV, "i" is 1.

$R^7$  in the general formula [8] represents an  
10 electron-withdrawing group or a group containing an electron-withdrawing group, and when a plural number of  $R^7$ 's exist, they may be mutually the same or different. The examples of the electron-withdrawing group or the group containing an electron-withdrawing group are  
15 selected from those already described in the illustration of  $R^1$  and  $R^3$ , and the preferable group is the same group as in  $R^1$  and  $R^3$ .

Specific examples of  $X^1R^7i$  which is a combination of  $X^1$  and  $R^7$  when  $X^1$  is a carbon atom, include a  
20 tri(fluoromethyl)methyl group, a tri(chloromethyl)methyl group, a tri(bromomethyl)methyl group, a tri(iodomethyl)methyl group, a tri(difluoromethyl)methyl group, a tri(dichloromethyl)methyl group, a  
25 tri(dibromomethyl)methyl group, a tri(diiodomethyl)methyl group, a tri(trifluoromethyl)methyl group, a

tri(trichloromethyl)methyl group, a  
tri(tribromomethyl)methyl group, a  
tri(triiodomethyl)methyl group, a tri(2,2,2-  
trifluoromethyl)methyl group, a tri(2,2,2-  
5 trichloromethyl)methyl group, a tri(2,2,2-  
tribromomethyl)methyl group, a tri(2,2,2-  
triiodomethyl)methyl group, a tri(2,2,3,3,3-  
pentafluoropropyl)methyl group, a tri(2,2,3,3,3-  
pentachloropropyl)methyl group, a tri(2,2,3,3,3-  
10 pentabromopropyl)methyl group, a tri(2,2,3,3,3-  
pentaiodopropyl)methyl group, a tri(2,2,2-trifluoro-  
1- trifluoromethylethyl)methyl group, a tri(2,2,2-  
trichloro-1- trichloromethylethyl)methyl group, a  
tri(2,2,2-tribromo-1- tribromomethylethyl)methyl  
15 group, a tri(2,2,2-triiodo-1-  
triiodomethylethyl)methyl group, a tri(1,1-  
di(trifluoromethyl)-2,2,2- trifluoroethyl)methyl  
group, a tri(1,1-di(trichloromethyl)-2,2,2-  
trichloroethyl)methyl group, a tri(1,1-  
20 di(tribromomethyl)-2,2,2- tribromoethyl)methyl group,  
a tri(1,1-di(triiodomethyl)-2,2,2-  
triiodoethyl)methyl group, a tri(2-fluorophenyl)methyl  
group, a tri(3-fluorophenyl)methyl group, a tri(4-  
fluorophenyl)methyl group, a tri(2-chlorophenyl)methyl  
25 group, a tri(3-chlorophenyl)methyl group, a tri(4-  
chlorophenyl)methyl group, a tri(2-  
bromophenyl)methyl group, a tri(3-bromophenyl)methyl

group, a tri(4-bromophenyl)methyl group, a tri(2-iodophenyl)methyl group, a tri(3-iodophenyl)methyl group, a tri(4-iodophenyl)methyl group, a tri(2,6-difluorophenyl)methyl group, a tri(3,5-difluorophenyl)methyl group, a tri(2,6-dichlorophenyl)methyl group, a tri(3,5-dichlorophenyl)methyl group, a tri(2,6-dibromophenyl)methyl group, a tri(3,5-dibromophenyl)methyl group, a tri(2,6-diiodophenyl)methyl group, a tri(3,5-diiodophenyl)methyl group, a tri(2,4,6-trifluorophenyl)methyl group, a tri(2,4,6-trichlorophenyl)methyl group, a tri(2,4,6-tribromophenyl)methyl group, a tri(2,4,6-triiodophenyl)methyl group, a tri(pentafluorophenyl)methyl group, a tri(pentachlorophenyl)methyl group, a tri(pentabromophenyl)methyl group, a tri(pentaiodophenyl)methyl group, a tri(3-(trifluoromethyl)phenyl)methyl group, a tri(4-(trifluoromethyl)phenyl)methyl group, a tri(2,6-di(trifluoromethyl)phenyl)methyl group, a tri(3,5-di(trifluoromethyl)phenyl)methyl group, a tri(2,4,6-tri(trifluoromethyl)phenyl)methyl group, a tri(2-cyanophenyl)methyl group, a tri(3-cyanophenyl)methyl group, a tri(4-cyanophenyl)methyl group, a tri(2-nitrophenyl)methyl group, a tri(3-nitrophenyl)methyl

group, a tri(4-nitrophenyl)methyl group and the like. Further, functional groups obtained by substituting X from carbon atom to silicon atom, and functional groups represented by replacing a methyl group in the  
5 above-mentioned specific examples with a silyl group, can be also exemplified.

Similarly, specific examples of  $X^1R^7i$  when  $X^1$  is a nitrogen atom, include a di(fluoromethyl)amino group, a di(chloromethyl)amino group, a di(bromomethyl)amino  
10 group, a di(iodomethyl)amino group, a di(difluoromethyl)amino group, a di(dichloromethyl)amino group, a di(dibromomethyl)amino group, a di(diiodomethyl)amino group, a di(trifluoromethyl)amino group, a  
15 di(trichloromethyl)amino group, a di(tribromomethyl)amino group, a di(triiodomethyl)amino group, a di(2,2,2-trifluoroethyl)amino group, a di(2,2,2-trichloroethyl)amino group, a di(2,2,2-tribromoethyl)amino group, a di(2,2,2-triiodoethyl)amino group, a di(2,2,3,3,3-pentafluoropropyl)amino group, a di(2,2,3,3,3-pentachloropropyl)amino group, a di(2,2,3,3,3-pentabromopropyl)amino group, a di(2,2,3,3,3-pentaiodopropyl)amino group, a di(2,2,2-trifluoro-1-  
25 trifluoromethylethyl)amino group, a di(2,2,2-trichloro-1-trichloromethylethyl)amino group, a

di(2,2,2-tribromo-1-tribromomethylethyl)amino group,  
a di(2,2,2-triiodo-1-triiodomethylethyl)amino group, a  
di(1,1-bis(trifluoromethyl)-2,2,2-  
trifluoroethyl)amino group, a di(1,1-  
5 di(trichloromethyl)-2,2,2-trichloroethyl)amino group,  
a di(1,1-di(tribromomethyl)-2,2,2-  
tribromoethyl)amino group, a di(1,1-  
di(triiodomethyl)-2,2,2-triiodoethyl)amino group, a  
di(2-fluorophenyl)amino group, a di(3-  
10 fluorophenyl)amino group, a di(4-fluorophenyl)amino  
group, a di(2-chlorophenyl)amino group, a di(3-  
chlorophenyl)amine, a di(4-chlorophenyl)amino group, a  
di(2-bromophenyl)amino group, a di(3-bromophenyl)amino  
group, a di(4-bromophenyl)amino group, a di(2-  
15 iodophenyl)amino group, a di(3-iodophenyl)amino group,  
a di(4-iodophenyl)amino group, a di(2,6-  
difluorophenyl)amino group, a di(3,5-  
difluorophenyl)amino group, a di(2,6-  
dichlorophenyl)amino group, a di(3,5-  
20 dichlorophenyl)amino group, a di(2,6-  
dibromophenyl)amino group, a di(3,5-  
dibromophenyl)amino group, a di(2,6-  
diiodophenyl)amino group, a di(3,5-diiodophenyl)amino  
group, a di(2,4,6-trifluorophenyl)amino group, a  
25 di(2,4,6-trichlorophenyl)amino group, a di(2,4,6-  
tribromophenyl)amino group, a di(2,4,6-  
triiodophenyl)amino group, a

di(pentafluorophenyl)amino group, a  
di(pentachlorophenyl)amino group, a  
di(pentabromophenyl)amino group, a  
di(pentaiodophenyl)amino group, a di(2-  
5 (trifluoromethyl)phenyl)amino group, a di(3-  
(trifluoromethyl)phenyl)amino group, a di(4-  
(trifluoromethyl)phenyl)amino group, a di(2,6-  
di(trifluoromethyl)phenyl)amino group, a di(3,5-  
di(trifluoromethyl)phenyl)amino group, a di(2,4,6-  
10 tri(trifluoromethyl)phenyl)amino group, a di(2-  
cyanophenyl)amino group, a di(3-cyanophenyl)amino  
group, a di(4-cyanophenyl)amino group, a di(2-  
nitrophenyl)amino group, a di(3-nitrophenyl)amino  
group, a di(4-nitrophenyl)amino group, and the like.

15 Further, a functional group obtained by  
substituting X from nitrogen atom to phosphorous atom,  
and a functional group represented by replacing an amino  
group in the above-mentioned specific example with a  
phosphino group can be also exemplified.

20 Further, specific examples, when X<sup>1</sup> is an oxygen  
atom, include a fluoromethoxy group, a chloromethoxy  
group, a bromomethoxy group, an iodomethoxy group, a  
difluoromethoxy group, a dichloromethoxy group, a  
dibromomethoxy group, a diiodomethoxy group, a  
25 trifluoromethoxy group, a trichloromethoxy group, a  
tribromomethoxy group, a triiodomethoxy group, a  
2,2,2-trifluoroethoxy group, a 2,2,2-trichloroethoxy

group, a 2,2,2-tribromoethoxy group, a 2,2,2-triiodoethoxy group, a 2,2,3,3,3-pentafluoropropoxy group, a 2,2,3,3,3-pentachloropropoxy group, a 2,2,3,3,3-pentabromopropoxy group, a 2,2,3,3,3-pentaiodopropoxy group, a 2,2,2-trifluoro-1-trifluoromethylethoxy group, a 2,2,2-trichloro-1-trichloromethylethoxy group, a 2,2,2-tribromo-1-tribromomethylethoxy group, a 2,2,2-triiodo-1-triiodomethylethoxy group, a 1,1-di(trifluoromethyl)-2,2,2-trifluoroethoxy group, a 1,1-di(trichloromethyl)-2,2,2-trichloroethoxy group, a 1,1-di(tribromomethyl)-2,2,2-tribromoethoxy group, a 1,1-di(triiodomethyl)-2,2,2-triiodoethoxy group, a 2-fluorophenoxy group, a 3-fluorophenoxy group, a 4-fluorophenoxy group, a 2-chlorophenoxy group, a 3-chlorophenoxy group, a 4-chlorophenoxy group, a 2-bromophenoxy group, a 3-bromophenoxy group, a 4-bromophenoxy group, a 2-iodophenoxy group, a 3-iodophenoxy group, a 4-iodophenoxy group, a 2,6-difluorophenoxy group, a 3,5-difluorophenoxy group, a 3,4,5-trifluorophenoxy group, a 2,6-dichlorophenoxy group, a 3,5-dichlorophenoxy group, a 2,6-dibromophenoxy group, a 3,5-dibromophenoxy group, a 2,6-diiodophenoxy group, a 3,5-diiodophenoxy group, a 2,4,6-trifluorophenoxy group, a 2,4,6-trichlorophenoxy group, a 2,4,6-tribromophenoxy group, a 2,4,6-triiodophenoxy group, a pentafluorophenoxy group, a

pentachlorophenoxy group, a pentabromophenoxy group, a  
pentaiodophenoxy group, a 2-(trifluoromethyl)phenoxy  
group, a 3-(trifluoromethyl)phenoxy group, a 4-  
(trifluoromethyl)phenoxy group, a 2,6-  
5 di(trifluoromethyl)phenoxy group, a 3,5-  
di(trifluoromethyl)phenoxy group, a 2,4,6-tri  
(trifluoromethyl)phenoxy group, a 2-cyanophenoxy group,  
a 3-cyanophenoxy group, a 4-cyanophenoxy group, a 2-  
nitrophenoxy group, a 3-nitrophenoxy group, a 4-  
10 nitrophenoxy group and the like. Further, a functional  
group obtained by substituting X from oxygen atom to  
sulfur atom, and a functional group represented by  
replacing an oxy group in the above-mentioned specific  
example with a thioxy group can be also exemplified.  
15  $X^iR^j$  is preferably a tri(fluoroalkyl)methyl  
group, a tri(fluoroaryl)methyl group, a  
di(fluoroalkyl)amino group, a di(fluoroaryl)amino  
group, a fluoroalkyloxy group or a fluoroaryloxy group,  
such as a tri(fluoromethyl)methyl group, a  
20 tri(pentafluorophenyl)methyl group, a  
di(fluoromethyl)amino group, a di(pentafluorophenyl)  
amino group, a trifluoromethoxy group, a 2,2,2-  
trifluoro-1-trifluoromethylethoxy group, a 1,1-  
di(trifluoromethyl)-2,2,2-trifluoroethoxy group, a  
25 3,4,5-trifluorophenoxy group, or a pentafluorophenoxy  
group, more preferably a fluoroalkyloxy group or a  
fluoroaryloxy group such as a 2,2,2-trifluoro-1-

trifluoromethylethoxy group, a 1,1-di(trifluoromethyl)-2,2,2-trifluoroethoxy group, a 3,4,5-trifluorophenoxy group, or a pentafluorophenoxy group.

5         $R^8$  in the general formula [8] represents a hydrogen atom, a halogen atom or a hydrocarbon group. Specific examples of the halogen atom in  $R^8$  include a fluorine atom, a chlorine atom, a bromine atom and an iodine atom. As a hydrocarbon group in  $R^8$ , an alkyl group, an aryl  
10        group or an aralkyl group is preferable. Specific examples thereof include the same compounds as in  $R^6$  in the general formula [7] as described above.

$R^8$  in the general formula [8] is preferably an alkyl group or an aryl group, and more preferably an alkyl group,  
15        and "t" represents a numeral satisfying  $0 < t \leq j$ . "t" is preferably the same numeral as "j".

      Two or more of molecules of the compound represented by the general formula [8] may be associated.

      Among the compound represented by the general  
20        formula [8], specific examples of a case in which M is a zinc atom, include  
trifluoromethoxy(trimethylsiloxy)zinc,  
trifluoromethoxy(triethylsiloxy)zinc,  
trifluoromethoxy(triphenylsiloxy)zinc, 2,2,2-  
25        trifluoroethoxy(trimethylsiloxy)zinc, 2,2,2-  
trifluoroethoxy(triethylsiloxy)zinc, 2,2,2-  
trifluoroethoxy(triphenylsiloxy)zinc, 1,1-

di(trifluoromethyl)-2,2,2-  
trifluoroethoxy(trimethylsiloxy)zinc, 1,1-  
di(trifluoromethyl)-2,2,2-  
trifluoroethoxy(triethylsiloxy)zinc, 1,1-  
5 di(trifluoromethyl)-2,2,2-  
trifluoroethoxy(triphenylsiloxy)zinc, 2,2,2-  
trifluoro-1-  
trifluoromethylethoxy(trimethylsiloxy)zinc, 2,2,2-  
trifluoro-1-  
10 trifluoromethylethoxy(triethylsiloxy)zinc, 2,2,2-  
trifluoro-1-  
trifluoromethylethoxy(triphenylsiloxy)zinc,  
2,2,2,3,3,3-pentafluoropropoxy(trimethylsiloxy)zinc,  
2,2,2,3,3,3-pentafluoropropoxy(triethylsiloxy)zinc,  
15 2,2,2,3,3,3-pentafluoropropoxy(triphenylsiloxy)zinc,  
2,4,6-trifluorophenoxy(trimethylsiloxy)zinc, 2,4,6-  
trifluorophenoxy(triethylsiloxy)zinc, 2,4,6-  
trifluorophenoxy(triphenylsiloxy)zinc, 3,4,5-  
trifluorophenoxy(trimethylsiloxy)zinc, 3,4,5-  
20 trifluorophenoxy(triethylsiloxy)zinc, 3,4,5-  
trifluorophenoxy(triphenylsiloxy)zinc,  
pentafluorophenoxy(trimethylsiloxy)zinc,  
pentafluorophenoxy(triethylsiloxy)zinc,  
pentafluorophenoxy(triphenylsiloxy)zinc, 4-  
25 trifluoromethylphenoxy(trimethylsiloxy)zinc, 4-  
trifluoromethylphenoxy(triethylsiloxy)zinc, 4-  
trifluoromethylphenoxy(triphenylsiloxy)zinc,

trifluoromethylamido(trimethylsiloxy)zinc,  
trifluoromethylamido(triethylsiloxy)zinc,  
trifluoromethylamido(triphenylsiloxy)zinc, 2,2,2-  
trifluoroethylamido(trimethylsiloxy)zinc, 2,2,2-  
5 trifluoroethylamido(triethylsiloxy)zinc, 2,2,2-  
trifluoroethylamido(triphenylsiloxy)zinc,  
pentafluoroanilido(trimethylsiloxy)zinc,  
pentafluoroanilido(triethylsiloxy)zinc,  
pentafluoroanilido(triphenylsiloxy)zinc, N-  
10 trifluoromethylanilido(trimethylsiloxy)zinc, N-  
trifluoromethylanilido(triethylsiloxy)zinc, N-  
trifluoromethylanilido(triphenylsiloxy)zinc,  
trichloromethoxy(trimethylsiloxy)zinc,  
trichloromethoxy(triethylsiloxy)zinc,  
15 trichloromethoxy(triphenylsiloxy)zinc, 2,2,2-  
trichloroethoxy(trimethylsiloxy)zinc, 2,2,2-  
trichloroethoxy(triethylsiloxy)zinc, 2,2,2-  
trichloroethoxy(triphenylsiloxy)zinc, 1,1-  
di(trichloromethyl)-2,2,2-  
20 trichloroethoxy(trimethylsiloxy)zinc, 1,1-  
di(trichloromethyl)-2,2,2-  
trichloroethoxy(triethylsiloxy)zinc, 1,1-  
di(trichloromethyl)-2,2,2-  
trichloroethoxy(triphenylsiloxy)zinc, 2,2,2-  
25 trichloro-1-  
trichloromethylethoxy(trimethylsiloxy)zinc, 2,2,2-  
trichloro-1-

trichloromethylethoxy(triethylsiloxyl)zinc, 2,2,2-  
trichloro-1-  
trichloromethylethoxy(triphenylsiloxyl)zinc,  
2,2,3,3,3-pentachloropropoxy(trimethylsiloxyl)zinc,  
5 2,2,3,3,3-pentachloropropoxy(triethylsiloxyl)zinc,  
2,2,3,3,3-pentachloropropoxy(triphenylsiloxyl)zinc,  
2,4,6-trichlorophenoxy(trimethylsiloxyl)zinc, 2,4,6-  
trichlorophenoxy(triethylsiloxyl)zinc, 2,4,6-  
trichlorophenoxy(triphenylsiloxyl)zinc,  
10 pentachlorophenoxy(trimethylsiloxyl)zinc,  
pentachlorophenoxy(triethylsiloxyl)zinc,  
pentachlorophenoxy(triphenylsiloxyl)zinc, 4-  
trichloromethylphenoxy(trimethylsiloxyl)zinc, 4-  
trichloromethylphenoxy(triethylsiloxyl)zinc, 4-  
15 trichloromethylphenoxy(triphenylsiloxyl)zinc,  
trichloromethylamido(trimethylsiloxyl)zinc,  
trichloromethylamido(triethylsiloxyl)zinc,  
trichloromethylamido(triphenylsiloxyl)zinc, 2,2,2-  
trichloroethylamido(trimethylsiloxyl)zinc, 2,2,2-  
20 trichloroethylamido(triethylsiloxyl)zinc, 2,2,2-  
trichloroethylamido(triphenylsiloxyl)zinc,  
pentachloroanilido(trimethylsiloxyl)zinc,  
pentachloroanilido(triethylsiloxyl)zinc,  
pentachloroanilido(triphenylsiloxyl)zinc, N-  
25 trichloromethylanilido(trimethylsiloxyl)zinc, N-  
trichloromethylanilido(triethylsiloxyl)zinc, N-  
trichloromethylanilido(triphenylsiloxyl)zinc,

bis(trifluoromethoxy)zinc, bis(2,2,2-trifluoroethoxy)zinc, bis(1,1-di(trifluoromethyl)-2,2,2-trifluoroethoxy)zinc, bis(2,2,2-trifluoro-1-trifluoromethylethoxy)zinc, bis(2,2,3,3,3-pentafluoropropoxy)zinc, bis(2,4,6-trifluorophenoxy)zinc, bis(3,4,5-trifluorophenoxy)zinc, bis(pentafluorophenoxy)zinc, bis(4-trifluoromethylphenoxy)zinc, bis(trifluoromethylamido)zinc, bis(pentafluoroanilido)zinc, bis(N-trifluoromethylanilido)zinc, trifluoromethoxyzinc methyl, 2,2,2-trifluoroethoxyzinc methyl, 1,1-di(trifluoromethyl)-2,2,2-trifluoroethoxyzinc methyl, 2,2,2-trifluoro-1-trifluoromethylethoxyzinc methyl, 2,2,3,3,3-pentafluoropropoxyzinc methyl, 2,4,6-trifluorophenoxyzinc methyl, 3,4,5-trifluorophenoxyzinc methyl, pentafluorophenoxyzinc methyl, 4-trifluoromethylphenoxyzinc methyl, 4-trifluoromethylamidozinc methyl, 2,2,2-trifluoroethylamidozinc methyl, pentafluoroanilidozinc methyl, N-trifluoromethylanilidozinc methyl, trifluoromethoxyzinc ethyl, 2,2,2-trifluoroethoxyzinc ethyl, 1,1-di(trifluoromethyl)-2,2,2-trifluoroethoxyzinc ethyl, 2,2,2-trifluoro-1-trifluoromethylethoxyzinc ethyl, 2,2,3,3,3-pentafluoropropoxyzinc ethyl, 2,4,6-

trifluorophenoxyzinc ethyl, 3,4,5-  
trifluorophenoxyzinc ethyl, pentafluorophenoxyzinc  
ethyl, 4-trifluoromethylphenoxyzinc ethyl, 4-  
trifluoromethylamidozinc ethyl, 2,2,2-  
5 trifluoroethylamidozinc ethyl, pentafluoroanilidozinc  
ethyl, N-trifluoromethylanilidozinc ethyl and the like.

In particular, the compound represented by the  
general formula [8] is preferably a  
bis(fluoroalkyloxy)zinc or a bis(fluoroaryloxy)zinc,  
10 and most preferably bis(2,2,2-trifluoro-1-  
trifluoromethylethoxy)zinc, bis(3,4,5-  
trifluorophenoxy)zinc, bis(pentafluorophenoxy)zinc or  
bis(1,1-di(trifluoromethyl)-2,2,2-  
trifluoroethoxy)zinc.

15 The production process of the compound represented  
by the above-mentioned general formula [8] is not  
specifically limited, and for example, a process of  
treating an organometallic compound such as an  
alkylmetal, a halogenated alkylmetal or the like with  
20 a compound represented by  $\text{LiX}^1\text{R}^7\text{i}$  such as an  
alkyloxylithium compound having an electron-  
withdrawing substituent, an aryloxylithium compound  
having an electron-withdrawing substituent, an  
aminolithium compound having an electron-withdrawing  
25 substituent or the like, or a compound represented by  
 $\text{HX}^1\text{R}^7\text{i}$  such as an alcohol having an electron-withdrawing  
substituent, a phenol having an electron-withdrawing

substituent, an amine having an electron-withdrawing substituent or the like, is mentioned.

The treatment is preferably carried out under inert gas atmosphere. The treatment temperature is usually  
5 from  $-80^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ , and preferably from  $-50^{\circ}\text{C}$  to  $120^{\circ}\text{C}$ . The treatment time is usually from 1 minute to 36 hours, and preferably from 10 minutes to 24 hours. Further, the treatment may use a solvent, and these compounds may be directly treated without using it. The solvent used is  
10 preferably an aliphatic hydrocarbon solvent, an aromatic hydrocarbon solvent or an ethereal solvent which is inert to the organometallic compound, the compound represented by  $\text{LiX}^1\text{R}^7\text{i}$ , the compound represented by  $\text{HX}^1\text{R}^7\text{i}$  and the like.

15 Specific examples of the solvent is the same examples as specifically mentioned in the item of the compound [A].

Further, in the treatment, the order of dropwise addition of the organometallic compound, the compound  
20 represented by  $\text{LiX}^1\text{R}^7\text{i}$  and the compound represented by  $\text{HX}^1\text{R}^7\text{i}$  is not specifically limited, it may be successively dropwise added, may be simultaneously dropwise added, and 2 or more of solvents may be dropwise added after mixing. Arbitrary amounts of  $(\text{X}^1\text{R}^7\text{i})$  and  $\text{R}^8$   
25 can be introduced by adjusting the molar number of the compound represented by  $\text{LiX}^1\text{R}^7\text{i}$  and the compound represented by  $\text{HX}^1\text{R}^7\text{i}$  to the organometallic compound.

Further, as a result of the treatment, the organometallic compound being a raw material, the compound represented by  $\text{LiX}^1\text{R}^7\text{i}$ , the compound represented by  $\text{HX}^1\text{R}^7\text{i}$  and the like, may remain as unreacted matters. The compound represented by the general formula [8], which was obtained by the treatment can be used as a catalyst for addition polymerization after separation and purification such as recrystallization or the like, but the reacted solution can be also used as a catalyst component for addition polymerization. The solvent is preferably removed by distillation from the reacted solution, and drying is preferably carried out at a temperature of  $25^\circ\text{C}$  or more for 1 hour or more under reduced pressure. It is more preferable to carry out drying at 60 to  $200^\circ\text{C}$  for one to 24 hours, and most preferable at 80 to  $160^\circ\text{C}$  for 4 to 18 hours.

Specific example of the production process of the compound represented by the general formula [8] is further shown below in detail when  $\text{M}^4$  is a zinc atom and the treating agent is a phenol, include the following steps: hexane is used as a solvent; a hexane solution of a dialkylzinc (for example, diethylzinc) is added thereto and cooled at  $-78^\circ\text{C}$ ; a hydrocarbon solution of the phenol which are 2-fold molar amount to the dialkylzinc is added dropwise; and the resulting mixture is stirred at room temperature for 10 minutes to 24 hours.

Of course, those used in these treatments are not limited to the dialkylzinc and phenol.

Then, the compound [E] represented by the above-mentioned general formula [9] is illustrated.

5         $M^5$  has been already illustrated.

$X^2$  in the general formula [9] is the same as  $X^1$  in the general formula [8] which has been already illustrated, and preferable elements are also the same as in  $X^1$ .

10        Further, "u" in the above-mentioned general formula [9] represents a valence of  $X^2$ , when  $X^2$  is an atom of the Group XIV, "u" is 4, when  $X^2$  is an atom of the Group XV, "u" is 3, and when  $X^2$  is an atom of Group XVI, "u" is 2.

15         $R^9$  in the general formula [9] represents an electron-withdrawing group or a group containing an electron-withdrawing group, and when a plural number of  $R^9$ 's exist, they may be mutually the same or different. The exemplification of the electron-withdrawing group or the group containing an electron-withdrawing group  
20        is selected from those already described in the illustration of  $R^1$  and  $R^3$ , and the preferable group is the same group as in  $R^1$  and  $R^3$ . Specific example of  $X^2R^9_{u-1}$  which is a combination of  $X^2$  and  $R^9$  and preferable specific example thereof are the same as the specific example  $X^1R^7_1$   
25        which is previously illustrated when  $X^2$  is a carbon atom, a nitrogen atom or an oxygen atom.

$R^{10}$  in the general formula [9] represents a hydrogen

atom, a halogen atom or a hydrocarbon group, and when a plural number of  $R^{10}$ 's exist, they may be mutually the same or different.

Specific example and preferable specific example  
5 of  $R^{10}$  are also the same as in  $R^8$  in the general formula [8] which is previously described.

$T^4$  in the general formula [9] represents an atom of Group XIII of the Periodic Table. Specific examples thereof include a boron atom, an aluminum atom, a gallium  
10 atom and the like, and in particular, a boron atom is preferable. "m" in the general formula [9] represents a numeral satisfying  $1 \leq m \leq 3$ , and "m" is preferably 2. Two or more of molecules of the compound represented by the general formula [9] may be associated.

15 Among the compound represented by the general formula [9], specific examples of a case in which  $M^5$  is a zinc atom include  
bis(fluoroalkyloxyzincoxy)alkylborane such as  
bis(trifluoromethoxyzincoxy)methylborane,  
20 bis(1,1,3,3,3-pentafluoro-2-trifluoromethylpropoxyzincoxy)methylborane and  
bis(2,2,2-trifluoro-1-trifluoromethylmethoxyzincoxy)methylborane;  
bis(fluoroalkyloxyzincoxy)alkylborane such as  
25 bis(2,2,2-trifluoroethoxyzincoxy)methylborane and  
bis(2,2,3,3,3-pentafluoropropoxyzincoxy)methylborane;

bis(fluoroaryloxyzincoxy)alkylborane such as  
bis(2,4,6-trifluorophenoxyzincoxy)methylborane,  
bis(3,4,5-trifluorophenoxyzincoxy)methylborane and  
bis(pentafluorophenoxyzincoxy)methylborane; and  
5 bis(4-trifluoromethylphenoxyzincoxy)methylborane,  
bis(trifluoromethylamidozincoxy)methylborane,  
bis(2,2,2-trifluoroethylamidozincoxy)methylborane,  
bis(pentafluoroanilidozincoxy)methylborane, bis(N-  
trifluoromethylanilidozincoxy)methylborane and the  
10 like.

In particular, the compound represented by the  
general formula [9] is preferably a  
bis(fluoroalkyloxyzincoxy)alkylborane or a  
bis(fluoroaryloxyzincoxy)alkylborane, and further  
15 preferably bis(2,2,2-trifluoro-1-  
trifluoromethylethoxyzincoxy)methylborane,  
bis(3,4,5-trifluorophenoxyzincoxy)methylborane,  
bis(pentafluorophenoxyzincoxy)methylborane or  
bis(1,1,3,3,3-pentafluoro-2-  
20 trifluoromethylpropoxyzincoxy)methylborane.

The production process of the compound represented  
by the general formula [9] is not specifically limited,  
and for example, a process of treating the  
organometallic compound such as an alkylmetal, a  
25 halogenated alkylmetal or the like with an inorganic  
acid such as an alkylboric acid or the like, and  
thereafter, with the compound represented by  $\text{LiX}^2\text{R}_{u-1}^9$

such as an alkyloxylithium compound, aryloxylithium compound or aminolithium compound having an electron-withdrawing substituent, or the compound represented by  $HX^2R_{u-1}^9$  such as an alcohol, phenol or amine having an electron-withdrawing substituent or the like, is mentioned. A process of treating the organometallic compound such as an alkylmetal, a halogenated alkylmetal or the like with the compound selected from an alcohol, phenol or amine having an electron-withdrawing substituent, is preferable.

The treatment is preferably carried out under inert gas atmosphere. The treatment temperature is usually from  $-100^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ , and preferably from  $-80^{\circ}\text{C}$  to  $150^{\circ}\text{C}$ . The treatment time is usually from 1 minute to 36 hours, and preferably from 10 minutes to 24 hours. Further, the treatment may use a solvent, and these compounds may be directly treated without using it. The solvent used is preferably an aliphatic hydrocarbon solvent, an aromatic hydrocarbon solvent or an ether-based compound which is inert to the organometallic compound, the compound represented by  $LiX^2R_{u-1}^9$ , the compound represented by  $HX^2R_{u-1}^9$  and the like. Specific examples of the solvent is the same examples specifically mentioned in the item of the compound [A].

Further, in the treatment, the order of dropwise addition of the organometallic compound, the compound represented by  $LiX^2R_{u-1}^9$  and the compound represented by

$\text{HX}^2\text{R}_{u-1}^9$  is not specifically limited, it may be successively dropwise added, may be simultaneously dropwise added, and 2 or more of solvents may be dropwise added after mixing. Arbitrary amounts of  $(\text{X}^2\text{R}_{u-1}^9)$  and  $\text{R}^{10}$  can be introduced by adjusting the molar number of the compound represented by  $\text{LiX}^2\text{R}_{u-1}^9$  and the compound represented by  $\text{HX}^2\text{R}_{u-1}^9$  to the organometallic compound. Further, as a result of the treatment, the organometallic compound being a raw material, the compound represented by  $\text{LiX}^2\text{R}_{u-1}^9$ , the compound represented by  $\text{HX}^2\text{R}_{u-1}^9$  and the like may remain as unreacted matters. The compound represented by the general formula [9] which was obtained by the treatment can be used as a catalyst component for addition polymerization after carrying out separation and purification such as recrystallization or the like, but the reacted solution can be also used as a catalyst component for addition polymerization. The solvent is preferably removed by distillation from the reacted solution, and drying is preferably carried out at a temperature of  $25^\circ\text{C}$  or more for 1 hour or more under reduced pressure. It is more preferable to carry out drying at  $60$  to  $200^\circ\text{C}$  for one to 24 hours, and most preferable at  $80$  to  $160^\circ\text{C}$  for 4 to 18 hours.

Specific example of the production process of the compound represented by the general formula [9] is further shown below in detail when  $\text{M}^5$  is a zinc atom,

an inorganic acid is an alkylboric acid and the treating agent is a phenol. A process that a toluene slurry of the alkylboric acid is cooled to  $-78^{\circ}\text{C}$ , a prescribed amount of a hexane solution of a dialkylzinc is added dropwise while vigorously stirring the slurry, the temperature of the mixture is gradually raised to room temperature after completion of dropwise addition, further stirring is carried out for a fixed time, a prescribed amount of phenols is gradually added dropwise, and further stirring is carried out for a fixed time, can be adopted.

Of course, compounds used in these treatments are not limited to the alkylboric acid, the dialkylzinc and the phenol.

The compounds [A] to [E] which are described above in detail are useful as the catalyst component for addition polymerization (particularly, catalyst component for olefin polymerization). Specific examples of the catalyst for addition polymerization of the present invention include a catalyst for addition polymerization obtained by contacting the compound (I) selected from the above-mentioned compounds [A] to [E] as a catalyst component for addition polymerization with the compound with a metal compound (II) of the Group III to the Group XII or lanthanide series, and a catalyst for addition polymerization obtained by contacting the catalyst component for addition polymerization (I), a

metal compound (II) of the Group III to the Group XII or lanthanide series, and an organoaluminum compound (III).

Next, a catalyst for addition polymerization is  
5 described in detail below.

(II) Metal compound of the Groups III to XIII or Lanthanide Series

As the metal compound (II) of the Groups III to XII or Lanthanide Series used for addition polymerization  
10 catalyst of the present invention, a metal compound which is different from the above-described compound(I) is used, and it is not specifically limited so far as it is a metal compound of the Groups III to XIII or Lanthanide Series of the Periodic Table exhibiting an addition  
15 polymerization activity by using together with the compound(I), or compound(I) and an organoaluminum compound, as an activating co-catalyst component. Examples of the metal compound(II) includes metal compounds indicated by the general formula [10] described  
20 below,  $\mu$ -oxo type metal compounds and the like.



(wherein M is a metal atom of the Group 3 to Group 13 or Lanthanide Series of the Periodic Table of the Elements; L is a group having a cyclopentadienyl type  
25 anion skeleton or a group containing a hetero-atom, a plurality of L groups may be the same or different, and a plurality of L groups may be optionally linked in direct,

or through a group containing a carbon atom, a silicone atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom; X is a halogen atom or a hydrocarbon group having 1 to 20 carbon atoms; a represents a numeral  
5 satisfying an expression of  $0 < a \leq 8$ ; b represents a numeral satisfying an expression of  $0 < b \leq 8$ .)

In the general formula [10] representing the metal compound, M is a metal atom of the Group 3 to Group 13 of the Periodic Table (IUPAC 1985) or Lanthanide Series.  
10 Specific examples of the metal atom include a scandium atom, yttrium atom, titanium atom, zirconium atom, hafnium atom, vanadium atom, niobium atom, tantalum atom, chromium atom, iron atom, ruthenium atom, cobalt atom, rhodium atom, nickel atom, palladium atom, samarium atom,  
15 ytterbium atom, aluminum atom, boron atom and the like.

As the metal compound, M is preferably a transition metal compound, more preferably a titanium atom, zirconium atom or hafnium atom.

In the general formula [10], L is a group having a  
20 cyclopentadienyl type anion skeleton or a group containing a hetero-atom, and a plurality of L groups may be the same or different. Further, L groups may be optionally linked in direct, or through a group containing a carbon atom, a silicone atom, a nitrogen  
25 atom, an oxygen atom, a sulfur atom or a phosphorus atom.

A cyclopentadienyl type anion skeleton in L includes a cyclopentadienyl group, a substituted

cyclopentadienyl group, an indenyl group, a substituted indenyl group, a fluorenyl group, a substituted fluorenyl group and the like. Examples of the group having a cyclopentadiene type anion skeleton include an

5  $\eta^5$ -(substituted)cyclopentadienyl group, an  $\eta^5$ -(substituted)indenyl group, an  $\eta^5$ -(substituted)fluorenyl group and the like. Specific examples include an  $\eta^5$ -cyclopentadienyl group, an  $\eta^5$ -methylcyclopentadienyl group, an  $\eta^5$ -tert-

10 butylcyclopentadienyl group, an  $\eta^5$ -1,2-dimethylcyclopentadienyl group, an  $\eta^5$ -1,3-dimethylcyclopentadienyl group, an  $\eta^5$ -1-tert-butyl-2-methylcyclopentadienyl group, an  $\eta^5$ -1-tert-butyl-3-methylcyclopentadienyl group, an  $\eta^5$ -1-methyl-2-

15 isopropylcyclopentadienyl group, an  $\eta^5$ -1-methyl-3-isopropylcyclopentadienyl group, an  $\eta^5$ -1,2,3-trimethylcyclopentadienyl group, an  $\eta^5$ -1,2,4-trimethylcyclopentadienyl group, an  $\eta^5$ -tetramethylcyclopentadienyl group, an  $\eta^5$ -

20 pentamethylcyclopentadienyl group, an  $\eta^5$ -indenyl group, an  $\eta^5$ -4,5,6,7-tetrahydroindenyl group, an  $\eta^5$ -2-methylindenyl group, an  $\eta^5$ -3-methylindenyl group, an  $\eta^5$ -4-methylindenyl group, an  $\eta^5$ -5-methylindenyl group, an  $\eta^5$ -6-methylindenyl group, an  $\eta^5$ -7-methylindenyl

25 group, an  $\eta^5$ -2-tert-butylindenyl group, an  $\eta^5$ -3-tert-butylindenyl group, an  $\eta^5$ -4-tert-butylindenyl group, an  $\eta^5$ -5-tert-butylindenyl group, an  $\eta^5$ -6-

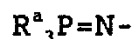
tert-butylindenyl group, an  $\eta^5$ -7-tert-butylindenyl group, an  $\eta^5$ -2,3-dimethylindenyl group, an  $\eta^5$ -4,7-dimethylindenyl group, an  $\eta^5$ -2,4,7-trimethylindenyl group, an  $\eta^5$ -2-methyl-4-isopropylindenyl group, an  $\eta^5$ -4,5-benzindenyl group, an  $\eta^5$ -2-methyl-4,5-benzindenyl group, an  $\eta^5$ -4-phenylindenyl group, an  $\eta^5$ -2-methyl-5-phenylindenyl group, an  $\eta^5$ -2-methyl-4-phenylindenyl group, an  $\eta^5$ -2-methyl-4-naphthylindenyl group, an  $\eta^5$ -fluorenyl group, an  $\eta^5$ -2,7-dimethylfluorenyl group, an  $\eta^5$ -2,7-di-tert-butylfluorenyl group (herein-after,  $\eta^5$  may be omitted for simplifying), and substitution products thereof, etc.

The hetero-atom in the group containing a hetero-atom includes an oxygen atom, a sulfur atom, a nitrogen atom, a phosphorus atom and the like, and examples thereof include an alkoxy group, an aryloxy group, a thioalkoxy group, a thioaryloxy group, an alkylamino group, an arylamino group, an alkylphosphino group, an arylphosphino group, or an aromatic or aliphatic heterocyclic group having an oxygen atom, a sulfur atom, a nitrogen atom and/or a phosphorus atom within the ring, and a chelating ligand.

Specific examples of the group containing a hetero-atom include a methoxy group, an ethoxy group, a n- or iso-propoxy group, a n-, sec-, iso- or tert-butoxy group, a phenoxy group, a 2-methylphenoxy group,

a 2,6-dimethylphenoxy group, a 2,4,6-trimethylphenoxy group, a 2-ethylphenoxy group, a 4-n-propylphenoxy group, a 2-isopropylphenoxy group, a 2,6-diisopropylphenoxy group, a 4-sec-butylphenoxy group, a 4-tert-butylphenoxy group, a 2,6-di-sec-butylphenoxy group, a 4-tert-butyl-4-methylphenoxy group, a 2,6-di-tert-butylphenoxy group, a 4-methoxyphenoxy group, a 2,6-dimethoxyphenoxy group, a 3,5-dimethoxyphenoxy group, a 2-chlorophenoxy group, a 4-nitrosophenoxy group, a 4-nitrophenoxy group, a 2-aminophenoxy group, a 3-aminophenoxy group, a 4-aminothiophenoxy group, a 2,3,6-trichlorophenoxy group, a 2,4,6-trifluorophenoxy group, a thiomethoxy group, a dimethylamino group, a diethylamino group, a di-n- or iso-propylamino group, a diphenylamino group, an isopropylamino group, a tert-butylamino group, a pyrrolyl group, a dimethylphosphino group, a 2-(2-oxy-1-propyl)phenoxy group, catechol, resorcinol, 4-isopropylcatechol, 3-methoxycatechol, a 1,8-dihydroxynaphthyl group, a 1,2-dihydroxynaphthyl group, a 2,2'-biphenyldiol group, a 1,1'-bi-2-naphthol group, a 2,2'-dihydroxy-6,6'-dimethylbiphenyl group, a 4,4',6,6'-tetra-tert-butyl-2,2'-methylenediphenoxy group, a 4,4',6,6'-tetramethyl-2,2'-isobutylidenediphenoxy group and the like.

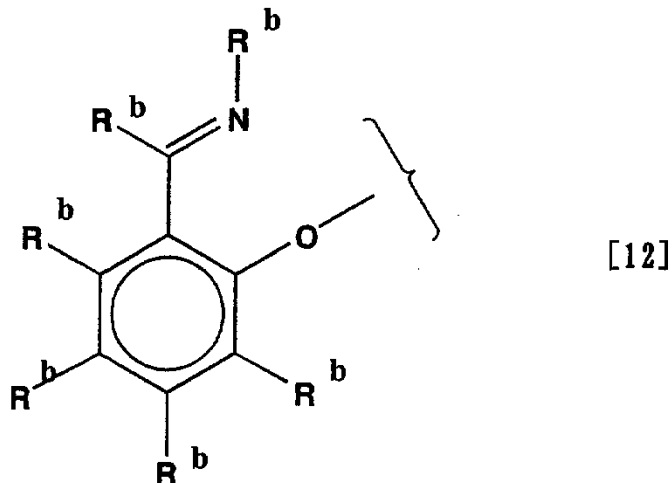
Further, the hetero atom-containing group includes a group represented by the formula[11]:



(wherein  $R^a$  represents a hydrogen atom, halogen atom or hydrocarbon group,  $R^a$  groups may be the same or different, and two of them may be bonded mutually and may form a ring.)

Specific Examples of  $R^a$  include a hydrogen atom, fluorine atom, chlorine atom, bromine atom, iodine atom, methyl group, ethyl group, n-propyl group, isopropyl group, n-butyl group, tert-butyl group, cyclohexyl group, phenyl group, 1-naphtyl group, benzyl group and the like, but are not limited thereto.

Further, the hetero atom-containing group also includes a group represented by the general formula [12]:



(wherein respective  $R^b$  groups independently represent a hydrogen atom, halogen atom, hydrocarbon group, halogenated hydrocarbon group, hydrocarbon oxy group, silyl group or amino group, they may be the same or different, and two or more of them may be bonded mutually

and may form a ring.)

Specific Examples of  $R^b$  in the general formula [12] include a hydrogen atom, fluorine atom, chlorine atom, bromine atom, iodine atom, phenyl group, 1-naphtyl group, 2-naphtyl group, tert-butyl group, 2,6-dimethylphenyl group, 2-fluorenyl group, 2-methylphenyl group, 4-trifluoromethylphenyl group, 4-methoxyphenyl group, 4-pyridyl group, cyclohexyl group, 2-isopropylphenyl group, benzyl group, methyl group, triethylsilyl group, diphenylmethylsilyl group, 1-methy-1-phenylethyl group, 1,1-dimethyl propyl group, 2-chlorophenyl group and the like, but are not limited thereto.

Further, the chelating ligand means a ligand having a plural number of coordinating positions, and specific examples thereof include an acetylacetonate, diimine, oxazoline, bisoxazoline, terpyridine, acylhydrazone, diethylenetriamine, triethylenetetramine, porphyrin, crown ether, cryptate and the like.

The mutual groups having the cyclopentadienyl type anion skeleton, the group having a cyclopentadienyl type anion skeleton and the group containing a hetero-atom, or the mutual groups containing a hetero-atom may be directly linked, or may be linked through a group containing a carbon atom, a silicone atom, a nitrogen atom, an oxygen atom, a sulfur atom or a phosphorus atom, respectively. Examples of the group include alkylene groups such as an ethylene group, a

propylene group and the like, substituted alkylene groups such as a dimethylmethylene group, a diphenylmethylene group and the like, or a silylene group, substituted silylene groups such as a  
5 dimethylsilylene group, a diphenylsilylene group, a tetramethyldisilylene group and the like, or hetero-atoms such as a nitrogen atom, an oxygen atom, a sulfur atom and/or a phosphorus atom and the like, etc.

X in the general formula [10] representing the  
10 transition metal compound is a halogen atom or a hydrocarbon group having 1 to 24 carbon atoms. Specific examples of X include a halogen atom such as a fluorine atom, chlorine atom, bromine atom, and iodine atom and hydrocarbon group having 1 to 24 carbon atoms such as  
15 a methyl group, ethyl group, n-propyl group, isopropyl group, n-butyl group, phenyl group, benzyl group and the like, and preferably include a halogen atom, alkyl group having 1 to 24 carbon atoms and aralkyl group having 7 to 24 carbon atoms.

20 In the general formula [10], "a" represents a numeral satisfying an expression of  $0 < a \leq 8$ , "b" represents a numeral satisfying an expression of  $0 < b \leq 8$ , and "a" and "b" are properly selected depending on the valency of M.

25 Among the metal compounds(II), specific examples of the compound in which a metal atom is a titanium atom include bis(cyclopentadienyl)titanium dichloride,

bis(methylcyclopentadienyl)titanium dichloride,  
bis(n-butylcyclopentadienyl)titanium dichloride,  
bis(dimethylcyclopentadienyl)titanium dichloride,  
bis(ethylmethylcyclopentadienyl)titanium dichloride,  
5 bis(trimethylcyclopentadienyl)titanium dichloride,  
bis(tetramethylcyclopentadienyl)titanium dichloride,  
bis(pentamethylcyclopentadienyl)titanium dichloride,  
bis(indenyl)titanium dichloride, bis(4,5,6,7-  
tetrahydroindenyl)titanium dichloride,  
10 bis(fluorenyl)titanium dichloride,  
cyclopentadienyl(pentamethylcyclopentadienyl)  
titanium dichloride, cyclopentadienyl(indenyl)  
titanium dichloride, cyclopentadienyl(fluorenyl)  
titanium dichloride, indenyl(fluorenyl)titanium  
15 dichloride, pentamethylcyclopentadienyl  
(indenyl)titanium dichloride,  
pentamethylcyclopentadienyl(fluorenyl)titanium  
dichloride, ethylenebis(cyclopentadienyl)titanium  
dichloride, ethylenebis(2-  
20 methylcyclopentadienyl)titanium dichloride,  
ethylenebis(3-methylcyclopentadienyl)titanium  
dichloride, ethylenebis(2-n-  
butylcyclopentadienyl)titanium dichloride,  
ethylenebis(3-n-butylcyclopentadienyl)titanium  
25 dichloride, ethylenebis(2,3-  
dimethylcyclopentadienyl)titanium dichloride,  
ethylenebis(2,4-dimethylcyclopentadienyl)titanium

dichloride, ethylenebis(2,5-  
dimethylcyclopentadienyl)titanium dichloride,  
ethylenebis(3,4-dimethylcyclopentadienyl)titanium  
dichloride, ethylenebis(2,3-  
5 ethylmethylcyclopentadienyl)titanium dichloride,  
ethylenebis(2,4-ethylmethylcyclopentadienyl)titanium  
dichloride, ethylenebis(2,5-  
ethylmethylcyclopentadienyl)titanium dichloride,  
ethylenebis(3,5-ethylmethylcyclopentadienyl)titanium  
10 dichloride, ethylenebis(2,3,4-  
trimethylcyclopentadienyl)titanium dichloride,  
ethylenebis(2,3,5-trimethylcyclopentadienyl)titanium  
dichloride, ethylenebis(tetramethylcyclopentadienyl)  
titanium dichloride, ethylenebis(indenyl)titanium  
15 dichloride, ethylenebis(4,5,6,7-  
tetrahydroindenyl)titanium dichloride,  
ethylenebis(2-phenylindenyl)titanium dichloride,  
ethylenebis(2-methylindenyl)titanium dichloride,  
ethylenebis(2-methyl-4-phenylindenyl)titanium  
20 dichloride, ethylenebis(2-methyl-4-  
naphthylindenyl)titanium dichloride, ethylenebis(2-  
methyl-4,5-benzoindenyl)titanium dichloride,  
ethylenebis(fluorenyl)titanium dichloride,  
ethylene(cyclopentadienyl)  
25 (pentamethylcyclopentadienyl)titanium dichloride,  
ethylene(cyclopentadienyl)(indenyl)titanium  
dichloride, ethylene(methylcyclopentadienyl)

(indenyl)titanium dichloride, ethylene(n-butylcyclopentadienyl)(indenyl)titanium dichloride, ethylene(tetramethylcyclopentadienyl) (indenyl)titanium dichloride,  
5 ethylene(cyclopentadienyl)(fluorenyl)titanium dichloride, ethylene(methylcyclopentadienyl) (fluorenyl)titanium dichloride, ethylene (pentamethylcyclopentadienyl)(fluorenyl)titanium dichloride, ethylene(n-butylcyclopentadienyl)  
10 (fluorenyl)titanium dichloride, ethylene (tetramethylpentadienyl)(fluorenyl)titanium dichloride, ethylene(indenyl)(fluorenyl)titanium dichloride, isopropylidenebis(cyclopentadienyl) titanium dichloride, isopropylidenebis(2-  
15 methylcyclopentadienyl)titanium dichloride, isopropylidenebis(3-methylcyclopentadienyl)titanium dichloride, isopropylidenebis(2-n-butylcyclopentadienyl)titanium dichloride, isopropylidenebis(3-n-butylcyclopentadienyl)titanium  
20 dichloride, isopropylidenebis(2,3-dimethylcyclopentadienyl)titanium dichloride, isopropylidenebis(2,4-dimethylcyclopentadienyl)titanium dichloride, isopropylidenebis(2,5-  
25 dimethylcyclopentadienyl)titanium dichloride, isopropylidenebis(3,4-dimethylcyclopentadienyl)titanium dichloride,

isopropylidenebis(2,3-  
ethylmethylcyclopentadienyl)titanium dichloride,  
isopropylidenebis(2,4-  
ethylmethylcyclopentadienyl)titanium dichloride,  
5 isopropylidenebis(2,5-  
ethylmethylcyclopentadienyl)titanium dichloride,  
isopropylidenebis(3,5-  
ethylmethylcyclopentadienyl)titanium dichloride,  
isopropylidenebis(2,3,4-  
10 trimethylcyclopentadienyl)titanium dichloride,  
isopropylidenebis(2,3,5-  
trimethylcyclopentadienyl)titanium dichloride,  
isopropylidenebis(tetramethylcyclopentadienyl)-  
titanium dichloride, isopropylidenebis(indenyl)  
15 titanium dichloride, isopropylidenebis(4,5,6,7-  
tetrahydroindenyl)titanium dichloride,  
isopropylidenebis(2-phenylindenyl)titanium  
dichloride, isopropylidenebis(2-  
methylindenyl)titanium dichloride,  
20 isopropylidenebis(2-methyl-4-phenylindenyl)titanium  
dichloride, isopropylidenebis(2-methyl-4-  
naphthylindenyl)titanium dichloride,  
isopropylidenebis(2-methyl-4,5-benzoindenyl)titanium  
dichloride, isopropylidenebis(fluorenyl)titanium  
25 dichloride, isopropylidene(cyclopentadienyl)  
(tetramethylcyclopentadienyl)titanium dichloride,  
isopropylidene(cyclopentadienyl)(indenyl)titanium

dichloride, isopropylidene(methylcyclopentadienyl)  
(indenyl)titanium dichloride, isopropylidene(n-  
butylcyclopentadienyl)(indenyl)titanium dichloride,  
isopropylidene(tetramethylcyclopentadienyl)  
5 (indenyl)titanium dichloride, isopropylidene  
(cyclopentadienyl)(fluorenyl)titanium dichloride,  
isopropylidene(methylcyclopentadienyl)(fluorenyl)tit  
anium dichloride, isopropylidene(n-  
butylcyclopentadienyl)(fluorenyl)titanium dichloride,  
10 isopropylidene (tetramethylcyclopentadienyl)  
(fluorenyl)titanium dichloride, isopropylidene  
(indenyl)(fluorenyl)titanium dichloride,  
dimethylsilylenebis(cyclopentadienyl)titanium  
dichloride, dimethylsilylenebis(2-  
15 methylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(3-  
methylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2-n-  
butylcyclopentadienyl)titanium dichloride,  
20 dimethylsilylenebis(3-n-  
butylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,3-  
dimethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,4-  
25 dimethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,5-  
dimethylcyclopentadienyl)titanium dichloride,

dimethylsilylenebis(3,4-  
dimethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,3-  
ethylmethylcyclopentadienyl)titanium dichloride,  
5 dimethylsilylenebis(2,4-  
ethylmethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,5-  
ethylmethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(3,5-  
10 ethylmethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,3,4-  
trimethylcyclopentadienyl)titanium dichloride,  
dimethylsilylenebis(2,3,5-  
trimethylcyclopentadienyl)titanium dichloride,  
15 dimethylsilylenebis(tetramethylcyclopentadienyl)-  
titanium dichloride,  
dimethylsilylenebis(indenyl)titanium dichloride,  
dimethylsilylenebis(4,5,6,7-  
tetrahydroindenyl)titanium dichloride,  
20 dimethylsilylenebis(2-methylindenyl)titanium  
dichloride, dimethylsilylenebis(2-methyl-4-  
phenylindenyl)titanium dichloride,  
dimethylsilylenebis(2-methyl-4-  
naphthylindenyl)titanium dichloride,  
25 dimethylsilylenebis(2-methyl-4,5-  
benzoindenyl)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(indenyl)titanium

dichloride, dimethylsilylene(methylcyclopentadienyl)  
(indenyl)titanium dichloride, dimethylsilylene(n-  
butylcyclopentadienyl)(indenyl)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)  
5 (indenyl)titanium dichloride, dimethylsilylene  
(cyclopentadienyl)(fluorenyl)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(fluorenyl)  
titanium dichloride, dimethylsilylene(n-  
butylcyclopentadienyl)(fluorenyl)titanium dichloride,  
10 dimethylsilylene-(tetramethylcyclopentadienyl)  
(indenyl)titanium dichloride, dimethylsilylene-  
(indenyl)(fluorenyl)titanium dichloride,  
cyclopentadienyltitanium trichloride,  
pentamethylcyclopentadienyltitanium trichloride,  
15 cyclopentadienyl(dimethylamido)titanium dichloride,  
cyclopentadienyl(phenoxy)titanium dichloride,  
cyclopentadienyl(2,6-dimethylphenyl)titanium  
dichloride, cyclopentadienyl(2,6-  
diisopropylphenyl)titanium dichloride,  
20 cyclopentadienyl(2,6-di-tert-butylphenyl)titanium  
dichloride, pentamethylcyclopentadienyl(2,6-  
dimethylphenyl)titanium dichloride,  
pentamethylcyclopentadienyl(2,6-  
diisopropylphenyl)titanium dichloride,  
25 pentamethylcyclopentadienyl(2,6-di-tert-  
butylphenyl)titanium dichloride, indenyl(2,6-  
diisopropylphenyl)titanium dichloride, fluorenyl-

(2,6-diisopropylphenyl)titanium dichloride,  
methylene(cyclopentadienyl)(3,5-dimethyl-2-  
phenoxy)titanium dichloride,  
methylene(cyclopentadienyl)(3-tert-butyl-2-  
5 phenoxy)titanium dichloride,  
methylene(cyclopentadienyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride,  
methylene(cyclopentadienyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
10 methylene(cyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, methylene(cyclopentadienyl)(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, methylene(cyclopentadienyl)(3-tert-  
15 butyl-5-methoxy-2-phenoxy)titanium dichloride,  
methylene(cyclopentadienyl)(3-tert-butyl-5-chloro-2-  
phenoxy)titanium dichloride,  
methylene(methylcyclopentadienyl)(3,5-dimethyl-2-  
phenoxy)titanium dichloride,  
20 methylene(methylcyclopentadienyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
methylene(methylcyclopentadienyl)(3-tert-butyl-5-  
methyl-2-phenoxy)titanium dichloride,  
methylene(methylcyclopentadienyl)(3-phenyl-2-  
25 phenoxy)titanium dichloride,  
methylene(methylcyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium

dichloride, methylene(methylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, methylene(methylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
5 methylene(methylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
methylene(tert-butylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride, methylene(tert-butylcyclopentadienyl)(3-tert-butyl-2-  
10 phenoxy)titanium dichloride, methylene(tert-butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride, methylene(tert-butylcyclopentadienyl)(3-phenyl-2-phenoxy)titanium  
dichloride, methylene(tert-butylcyclopentadienyl)(3-tert-butyl-  
15 tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, methylene(tert-butylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, methylene(tert-butylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
20 methylene(tert-butylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
methylene(tetramethylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride,  
methylene(tetramethylcyclopentadienyl)(3-tert-butyl-  
25 2-phenoxy)titanium dichloride,  
methylene(tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,

methylene(tetramethylcyclopentadienyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
methylene(tetramethylcyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
5 dichloride, methylene(tetramethylcyclopentadienyl)  
(3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, methylene(tetramethylcyclopentadienyl)  
(3-tert-butyl-5-methoxy-2-phenoxy)titanium  
dichloride, methylene(tetramethylcyclopentadienyl)  
10 (3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3-tert-  
butyl-2-phenoxy)titanium dichloride,  
15 methylene(trimethylsilylcyclopentadienyl)(3-tert-  
butyl-5-methyl-2-phenoxy)titanium dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3-phenyl-  
2-phenoxy)titanium dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3-tert-  
20 butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
25 methylene(trimethylsilylcyclopentadienyl)(3-tert-  
butyl-5-methoxy-2-phenoxy)titanium dichloride,  
methylene(trimethylsilylcyclopentadienyl)(3-tert-

butyl-5-chloro-2-phenoxy)titanium dichloride,  
methylene(fluorenyl)(3,5-dimethyl-2-  
phenoxy)titanium dichloride, methylene(fluorenyl)(3-  
tert-butyl-2-phenoxy)titanium dichloride,  
5 methylene(fluorenyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride, methylene(fluorenyl)(3-  
phenyl-2-phenoxy)titanium dichloride,  
methylene(fluorenyl)(3-tert-butyldimethylsilyl-5-  
methyl-2-phenoxy)titanium dichloride,  
10 methylene(fluorenyl)(3-trimethylsilyl-5-methyl-2-  
phenoxy)titanium dichloride, methylene(fluorenyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
methylene(fluorenyl)(3-tert-butyl-5-chloro-2-  
phenoxy)titanium dichloride,  
15 isopropylidene(cyclopentadienyl)(3,5-dimethyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(cyclopentadienyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(cyclopentadienyl)(3-tert-butyl-5-  
20 methyl-2-phenoxy)titanium dichloride,  
isopropylidene(cyclopentadienyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(cyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
25 dichloride, isopropylidene(cyclopentadienyl)(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, isopropylidene(cyclopentadienyl)(3-tert-

butyl-5-methoxy-2-phenoxy)titanium dichloride,  
isopropylidene(cyclopentadienyl)(3-tert-butyl-5-  
chloro-2-phenoxy)titanium dichloride,  
isopropylidene(methylcyclopentadienyl)(3,5-dimethyl-  
5 2-phenoxy)titanium dichloride,  
isopropylidene(methylcyclopentadienyl)(3-tert-butyl-  
2-phenoxy)titanium dichloride,  
isopropylidene(methylcyclopentadienyl)(3-tert-butyl-  
5-methyl-2-phenoxy)titanium dichloride,  
10 isopropylidene(methylcyclopentadienyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(methylcyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, isopropylidene(methylcyclopentadienyl)  
15 (3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, isopropylidene(methylcyclopentadienyl)  
(3-tert-butyl-5-methoxy-2-phenoxy)titanium  
dichloride, isopropylidene(methylcyclopentadienyl)  
(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
20 isopropylidene(tert-butylcyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
isopropylidene(tert-butylcyclopentadienyl)(3-tert-  
butyl-2-phenoxy)titanium dichloride,  
isopropylidene(tert-butylcyclopentadienyl)(3-tert-  
25 butyl-5-methyl-2-phenoxy)titanium dichloride,  
isopropylidene(tert-butylcyclopentadienyl)(3-phenyl-  
2-phenoxy)titanium dichloride, isopropylidene(tert-

butylcyclopentadienyl)(3-tert-butyltrimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,  
isopropylidene(tert-butylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
5 dichloride, isopropylidene(tert-butylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, isopropylidene(tert-butylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
10 isopropylidene(tetramethylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride,  
isopropylidene(tetramethylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride,  
isopropylidene(tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
15 isopropylidene(tetramethylcyclopentadienyl)(3-phenyl-2-phenoxy)titanium dichloride,  
isopropylidene(tetramethylcyclopentadienyl)(3-tert-butyltrimethylsilyl-5-methyl-2-phenoxy)titanium  
20 dichloride,  
isopropylidene(tetramethylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,  
isopropylidene(tetramethylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
25 isopropylidene(tetramethylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,

isopropylidene(trimethylsilylcyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
isopropylidene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-2-phenoxy)titanium dichloride,  
5 isopropylidene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
isopropylidene(trimethylsilylcyclopentadienyl)(3-  
phenyl-2-phenoxy)titanium dichloride,  
isopropylidene(trimethylsilylcyclopentadienyl)(3-  
10 tert-butyltrimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
isopropylidene(trimethylsilylcyclopentadienyl)(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
15 isopropylidene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
isopropylidene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3,5-dimethyl-2-  
20 phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride,  
25 isopropylidene(fluorenyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-tert-butyltrimethylsilyl-

5-methyl-2-phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-trimethylsilyl-5-methyl-  
2-phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-tert-butyl-5-methoxy-2-  
5 phenoxy)titanium dichloride,  
isopropylidene(fluorenyl)(3-tert-butyl-5-chloro-2-  
phenoxy)titanium dichloride,  
diphenylmethylenecyclopentadienyl(3,5-dimethyl-2-  
phenoxy)titanium dichloride,  
10 diphenylmethylenecyclopentadienyl(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
diphenylmethylenecyclopentadienyl(3-tert-butyl-5-  
methyl-2-phenoxy)titanium dichloride,  
diphenylmethylenecyclopentadienyl(3-phenyl-2-  
15 phenoxy)titanium dichloride,  
diphenylmethylenecyclopentadienyl(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, diphenylmethylenecyclopentadienyl(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
20 dichloride, diphenylmethylenecyclopentadienyl(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
diphenylmethylenecyclopentadienyl(3-tert-butyl-5-  
chloro-2-phenoxy)titanium dichloride,  
diphenylmethylenemethylcyclopentadienyl(3,5-  
25 dimethyl-2-phenoxy)titanium dichloride,  
diphenylmethylenemethylcyclopentadienyl(3-tert-  
butyl-2-phenoxy)titanium dichloride,

diphenylmethylene(methylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(methylcyclopentadienyl)(3-phenyl-2-phenoxy)titanium dichloride,  
5 diphenylmethylene(methylcyclopentadienyl)(3-tert-butyl-5-dimethylsilyl-5-methyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(methylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium  
10 dichloride,  
diphenylmethylene(methylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
diphenylmethylene(methylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
15 diphenylmethylene(tert-butylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(tert-butylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(tert-butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
20 diphenylmethylene(tert-butylcyclopentadienyl)(3-phenyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(tert-butylcyclopentadienyl)(3-tert-butyl-5-dimethylsilyl-5-methyl-2-phenoxy)titanium  
25 dichloride, diphenylmethylene(tert-butylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium dichloride, diphenylmethylene(tert-

butylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, diphenylmethylenetert-butylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,

5 diphenylmethylenetetramethylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride, diphenylmethylenetetramethylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride, diphenylmethylenetetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,

10 diphenylmethylenetetramethylcyclopentadienyl)(3-phenyl-2-phenoxy)titanium dichloride, diphenylmethylenetetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,

15 diphenylmethylenetetramethylcyclopentadienyl)(3-trimethylsilyl-5-methyl-2-phenoxy)titanium dichloride, diphenylmethylenetetramethylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, diphenylmethylenetetramethylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride, diphenylmethylenetrimethylsilylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride,

20 diphenylmethylenetrimethylsilylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride, diphenylmethylenetrimethylsilylcyclopentadienyl)(3-

25

tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(trimethylsilylcyclopentadienyl)(3-  
phenyl-2-phenoxy)titanium dichloride,  
diphenylmethylene(trimethylsilylcyclopentadienyl)(3-  
5 tert-butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
diphenylmethylene(trimethylsilylcyclopentadienyl)(3-  
trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride,  
10 diphenylmethylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
diphenylmethylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
diphenylmethylene(fluorenyl)(3,5-dimethyl-2-  
15 phenoxy)titanium dichloride,  
diphenylmethylene(fluorenyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
diphenylmethylene(fluorenyl)(3-tert-butyl-5-methyl-  
2-phenoxy)titanium dichloride,  
20 diphenylmethylene(fluorenyl)(3-phenyl-2-  
phenoxy)titanium dichloride,  
diphenylmethylene(fluorenyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, diphenylmethylene(fluorenyl)(3-  
25 trimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, diphenylmethylene(fluorenyl)(3-tert-  
butyl-5-methoxy-2-phenoxy)titanium dichloride,

diphenylmethylene(fluorenyl)(3-tert-butyl-5-chloro-  
2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(2-  
phenoxy)titanium dichloride, dimethylsilylene-  
5 (cyclopentadienyl)(3-methyl-2-phenoxy)titanium  
dichloride, dimethylsilylene(cyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
10 dimethylsilylene(cyclopentadienyl)(3-tert-butyl-5-  
methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(3,5-di-tert-  
butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(5-methyl-3-  
15 phenyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
dichloride, dimethylsilylene(cyclopentadienyl)(5-  
methyl-3-trimethylsilyl-2-phenoxy)titanium  
20 dichloride, dimethylsilylene(cyclopentadienyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(3-tert-butyl-5-  
chloro-2-phenoxy)titanium dichloride,  
dimethylsilylene(cyclopentadienyl)(3,5-diamyl-2-  
25 phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(2-  
phenoxy)titanium dichloride,

dimethylsilylene(methylcyclopentadienyl)(3-methyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
5 dimethylsilylene(methylcyclopentadienyl)(3-tert-  
butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3-tert-  
butyl-5-methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3,5-di-  
10 tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(5-methyl-3-  
phenyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3-tert-  
butyldimethylsilyl-5-methyl-2-phenoxy)titanium  
15 dichloride,  
dimethylsilylene(methylcyclopentadienyl)(5-methyl-3-  
trimethylsilyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3-tert-  
butyl-5-methoxy-2-phenoxy)titanium dichloride,  
20 dimethylsilylene(methylcyclopentadienyl)(3-tert-  
butyl-5-chloro-2-phenoxy)titanium dichloride,  
dimethylsilylene(methylcyclopentadienyl)(3,5-diamyl-  
2-phenoxy)titanium dichloride, dimethylsilylene(n-  
butylcyclopentadienyl)(2-phenoxy)titanium dichloride,  
25 dimethylsilylene(n-butylcyclopentadienyl)(3-methyl-  
2-phenoxy)titanium dichloride, dimethylsilylene(n-  
butylcyclopentadienyl)(3,5-dimethyl-2-

phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3,5-di-tert-butyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(5-methyl-3-phenyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(5-methyl-3-trimethylsilyl-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride, dimethylsilylene(n-butylcyclopentadienyl)(3,5-diamyl-2-phenoxy)titanium dichloride, dimethylsilylene(tert-butylcyclopentadienyl)(2-phenoxy)titanium dichloride, dimethylsilylene(tert-butylcyclopentadienyl)(3-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(tert-butylcyclopentadienyl)(3,5-dimethyl-2-phenoxy)titanium dichloride, dimethylsilylene(tert-butylcyclopentadienyl)(3-tert-butyl-2-phenoxy)titanium dichloride, dimethylsilylene(tert-

butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride, dimethylsilylene(tert-  
butylcyclopentadienyl)(3,5-di-tert-butyl-2-  
phenoxy)titanium dichloride, dimethylsilylene(tert-  
5 butylcyclopentadienyl)(5-methyl-3-phenyl-2-  
phenoxy)titanium dichloride, dimethylsilylene(tert-  
butylcyclopentadienyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(tert-butylcyclopentadienyl)(5-  
10 methyl-3-trimethylsilyl-2-phenoxy)titanium  
dichloride, dimethylsilylene(tert-  
butylcyclopentadienyl)(3-tert-butyl-5-methoxy-2-  
phenoxy)titanium dichloride, dimethylsilylene(tert-  
butylcyclopentadienyl)(3-tert-butyl-5-chloro-2-  
15 phenoxy)titanium dichloride, dimethylsilylene(tert-  
butylcyclopentadienyl)(3,5-diamyl-2-phenoxy)titanium  
dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(2-  
phenoxy)titanium dichloride,  
20 dimethylsilylene(tetramethylcyclopentadienyl)(3-  
methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(3,5-  
dimethyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(3-  
25 tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium dichloride,

dimethylsilylene(tetramethylcyclopentadienyl)(3,5-  
di-tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(5-  
methyl-3-phenyl-2-phenoxy)titanium dichloride,  
5 dimethylsilylene(tetramethylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium  
dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(5-  
methyl-3-trimethylsilyl-2-phenoxy)titanium  
10 dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(3-  
tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
15 dimethylsilylene(tetramethylcyclopentadienyl)(3,5-  
diamyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(2-  
phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
20 methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3,5-  
-dimethyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-2-phenoxy)titanium dichloride,  
25 dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3,5

-di-tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(5-  
methyl-3-phenyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
5 tert-butyl-5-methyl-2-phenoxy)titanium  
dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(5-  
methyl-3-trimethylsilyl-2-phenoxy)titanium  
dichloride,  
10 dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3-  
tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
dimethylsilylene(trimethylsilylcyclopentadienyl)(3,5  
15 -diamyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(2-phenoxy)titanium  
dichloride, dimethylsilylene(indenyl)(3-methyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3,5-dimethyl-2-  
20 phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3-tert-butyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3-tert-butyl-5-methyl-2-  
phenoxy)titanium dichloride,  
25 dimethylsilylene(indenyl)(3,5-di-tert-butyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(5-methyl-3-phenyl-2-

phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(5-methyl-3-trimethylsilyl-  
5 2-phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3-tert-butyl-5-methoxy-2-phenoxy)titanium dichloride,  
dimethylsilylene(indenyl)(3-tert-butyl-5-chloro-2-phenoxy)titanium dichloride,  
10 dimethylsilylene(indenyl)(3,5-diamyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(2-phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)(3-methyl-2-phenoxy)titanium dichloride,  
15 dimethylsilylene(fluorenyl)(3,5-dimethyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(3-tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride,  
20 dimethylsilylene(fluorenyl)(3,5-di-tert-butyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(5-methyl-3-phenyl-2-phenoxy)titanium dichloride,  
25 dimethylsilylene(fluorenyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium dichloride, dimethylsilylene(fluorenyl)(5-methyl-3-

trimethylsilyl-2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(3-tert-butyl-5-methoxy-  
2-phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(3-tert-butyl-5-chloro-2-  
5 phenoxy)titanium dichloride,  
dimethylsilylene(fluorenyl)(3,5-diamyl-2-  
phenoxy)titanium dichloride,  
dimethylsilylene(tetramethylcyclopentadienyl)(1-  
naphthox-2-yl)titanium dichloride and the like, and  
10 compounds wherein (2-phenoxy) of these compounds is  
replaces with (3-phenyl-2-phenoxy), (3-  
trimethylsilyl-2-phenoxy) or (3-tert-  
butyldimethylsilyl-2-phenoxy), compounds wherein  
dimethylsilylene of these compounds is replaced with  
15 diethylsilylene, diphenylsilylene or dimethoxysilylene,  
compounds wherein dichloride of these compounds is  
replaced with difluoride, dibromide, diiodide, dimethyl,  
diethyl, diisopropyl, bis(dimethylamido),  
bis(diethylamido), dimethoxide, diethoxide, di-n-  
20 butoxide or diisopropoxide.

(tert-butylamido)tetramethylcyclopentadienyl-  
1,2-ethanediyltitanium dichloride, (tert-  
butylamido)tetramethylcyclopentadienyl-1,2-  
ethanediyltitanium dimethyl, (tert-  
25 butylamido)tetramethylcyclopentadienyl-1,2-  
ethanediyltitanium dibenzyl,  
(methylamido)tetramethylcyclopentadienyl-1,2-

ethanediyltitanium dichloride,  
(ethylamido)tetramethylcyclopentadienyl-1,2-  
ethanediyltitanium dichloride, (tert-  
butylamido)tetramethylcyclopentadienyldimethylsilane  
5 titanium dichloride, (tert-  
butylamido)tetramethylcyclopentadienyldimethylsilane  
titanium dimethyl, (tert-  
butylamido)tetramethylcyclopentadienyldimethylsilane  
-titanium dibenzyl,  
10 (benzylamido)tetramethylcyclopentadienyl-  
dimethylsilanetitanium dichloride,  
(phenylphosphido)tetramethylcyclopentadienyldimethyl-  
-silanetitanium dibenzyl, (tert-butylamido)indenyl-  
1,2-ethanediyltitanium dichloride, (tert-  
15 butylamido)indenyl-1,2-ethanediyltitanium dimethyl,  
(tert-butylamido)tetrahydroindenyl-1,2-  
ethanediyltitanium dichloride, (tert-  
butylamido)tetrahydroindenyl-1,2-ethanediyltitanium  
dimethyl, (tert-butylamido)fluorenyl-1,2-  
20 ethanediyltitanium dichloride, (tert-  
butylamido)fluorenyl-1,2-ethanediyltitanium dimethyl,  
(tert-butylamido)indenyldimethylsilanetitanium  
dichloride, (tert-  
butylamido)indenyldimethylsilanetitanium  
25 dimethyl, (tert-  
butylamido)tetrahydroindenyldimethylsilanetitanium  
dichloride, (tert-

- butylamido)tetrahydroindenyl dimethylsilanetitanium  
dimethyl, (tert-  
butylamido)fluorenyl dimethylsilanetitanium  
dichloride, (tert-  
5 butylamido)fluorenyl dimethylsilanetitanium dimethyl,  
(dimethylaminomethyl)tetramethylcyclopentadienyl-  
titanium(III) dichloride,  
(dimethylaminoethyl)tetramethylcyclopentadienyl-  
titanium(III) dichloride,  
10 (dimethylaminopropyl)tetramethylcyclopentadienyl-  
titanium(III) dichloride, (N-  
pyrrolidinyethyl)tetramethylcyclopentadienyl-  
titanium dichloride, (B-  
dimethylaminoborabenzene)cyclopentadienylzirconium  
15 dichloride, cyclopentadienyl(9-  
mesitylboraanthracenyl)zirconium dichloride, 2,2'-  
thiobis[4-methyl-6-(1-methylethyl)phenoxy]titanium  
dichloride, 2,2'-thiobis[4,6-  
dimethylphenoxy]titanium dichloride, 2,2'-thiobis(4-  
20 methyl-6-tert-butylphenoxy)titanium dichloride,  
2,2'-methylenebis(4-methyl-6-tert-  
butylphenoxy)titanium dichloride, 2,2'-  
ethylenebis(4-methyl-6-tert-butylphenoxy)titanium  
dichloride, 2,2'-sulfinylbis(4-methyl-6-tert-  
25 butylphenoxy)titanium dichloride, 2,2'-(4,4',6,6'-  
tetra-tert-butyl-1,1'-biphenoxy)titanium dichloride,  
2,2'-thiobis[4-methyl-6-tert-butylphenoxy]titanium

diisopropoxide, 2,2'-methylenebis(4-methyl-6-tert-butylphenoxy)titanium diisopropoxide, 2,2'-ethylenebis(4-methyl-6-tert-butylphenoxy)titanium diisopropoxide, 2,2'-sulfinylbis(4-methyl-6-tert-butylphenoxy)titanium diisopropoxide, (di-tert-butyl-1,3-propanediamido)titanium dichloride, (dicyclohexyl-1,3-propanediamido)titanium dichloride, [bis(trimethylsilyl)-1,3-propanediamido]titanium dichloride, [bis(tert-butyldimethylsilyl)-1,3-propanediamido]titanium dichloride, [bis(2,6-dimethylphenyl)-1,3-propanediamido]titanium dichloride, [bis(2,6-diisopropylphenyl)-1,3-propanediamido]titanium dichloride, [bis(2,6-di-tert-butylphenyl)-1,3-propanediamido]titanium dichloride, [bis(triisopropylsilyl)naphthalenediamido]titanium dichloride, [bis(trimethylsilyl)naphthalenediamido]titanium dichloride, [bis(tert-butyldimethylsilyl)naphthalenediamido]titanium dichloride, [bis(tert-butyldimethylsilyl)naphthalenediamido]titanium dibromide, [hydrotris(3,5-dimethylpyrazolyl)borate]titanium trichloride, [hydrotris(3,5-dimethylpyrazolyl)borate]titanium tribromide, [hydrotris(3,5-dimethylpyrazolyl)borate]titanium triiodide,

[hydrotris(3,5-diethylpyrazolyl)borate]titanium  
trichloride, [hydrotris(3,5-  
diethylpyrazolyl)borate]titanium tribromide,  
[hydrotris(3,5-diethylpyrazolyl)borate]titanium  
5 triiodide, [hydrotris(3,5-di-tert-  
butylpyrazolyl)borate]titanium trichloride,  
[hydrotris(3,5-di-tert-  
butylpyrazolyl)borate]titanium tribromide,  
[hydrotris(3,5-di-tert-  
10 butylpyrazolyl)borate]titanium triiodide, [tris(3,5-  
dimethylpyrazolyl)methyl]titanium trichloride,  
[tris(3,5-dimethylpyrazolyl)methyl]titanium  
tribromide, [tris(3,5-  
dimethylpyrazolyl)methyl]titanium triiodide,  
15 [tris(3,5-diethylpyrazolyl)methyl]titanium  
trichloride, [tris(3,5-  
diethylpyrazolyl)methyl]titanium tribromide,  
[tris(3,5-diethylpyrazolyl)methyl]titanium triiodide,  
[tris(3,5-di-tert-butylpyrazolyl)methyl]titanium  
20 trichloride, [tris(3,5-di-tert-  
butylpyrazolyl)methyl]titanium tribromide,  
[tris(3,5-di-tert-butylpyrazolyl)methyl]titanium  
triiodide and the like, compounds in which titanium of  
these compounds is replaced with zirconium or hafnium,  
25 compounds in which (2-phenoxy) of these compounds is  
replaced with (3-phenyl-2-phenoxy), (3-  
trimethylsilyl-2-phenoxy) or (3-tert-

butyldimethylsilyl-2-phenoxy), compounds in which  
dimethylsilylene of these compounds is replaced with  
diethylsilylene, diphenylsilylene, or  
dimethoxysilylene, compounds in which dichloride of  
5 these compounds is replaced with difluoride, dibromide,  
diiodide, dimethyl, diethyl, diisopropyl,  
bis(dimethylamide), bis(diethylamide), dimethoxide,  
diethoxide, di-n-butoxide, diisopropoxide or  
bis(diacetoxy) and the like.

10           Among the metal compounds(II) represented by the  
general formula [10], specific examples of a compound  
in which a metal atom is a nickel atom include 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
dimethyloxazoline]nickel dichloride, 2,2'-  
15 methylenebis[(4R)-4-phenyl-5,5'-  
dimethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
diethyloxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
20 diethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-di-n-  
propyloxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-di-n-  
propyloxazoline]nickel dibromide, 2,2'-  
25 methylenebis[(4R)-4-phenyl-5,5'-  
diisopropyloxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-

- diisopropyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
dicyclohexyloxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
5 dicyclohexyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
dimethoxyoxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
dimethoxyoxazoline]nickel dibromide, 2,2'-  
10 methylenebis[(4R)-4-phenyl-5,5'-  
diethoxyoxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
diethoxyoxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
15 diphenyloxazoline]nickel dichloride, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5'-  
diphenyloxazoline]nickel dibromide,  
methylenebis[(4R)-4-methyl-5,5'-di-(2-  
methylphenyl)oxazoline]nickel dibromide,  
20 methylenebis[(4R)-4-methyl-5,5'-di-(3-  
methylphenyl)oxazoline]nickel dibromide,  
methylenebis[(4R)-4-methyl-5,5'-di-(4-  
methylphenyl)oxazoline]nickel dibromide,  
methylenebis[(4R)-4-methyl-5,5'-di-(2-  
25 methoxyphenyl)oxazoline]nickel dibromide,  
methylenebis[(4R)-4-methyl-5,5'-di-(3-  
methoxyphenyl)oxazoline]nickel dibromide,

- methylenebis[(4R)-4-methyl-5,5'-di-(4-methoxyphenyl)oxazoline]nickel dibromide,  
methylenebis[spiro{(4R)-4-methyloxazoline-5,1'-cyclobutane}]nickel dibromide,  
5 methylenebis[spiro{(4R)-4-methyloxazoline-5,1'-cyclopentane}]nickel dibromide,  
methylenebis[spiro{(4R)-4-methyloxazoline-5,1'-cyclohexane}]nickel dibromide,  
methylenebis[spiro{(4R)-4-methyloxazoline-5,1'-cycloheptane}]nickel dibromide, 2,2'-  
10 methylenebis[(4R)-4-isopropyl-5,5-dimethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isopropyl-5,5-diethyloxazoline]nickel dibromide, 2,2'-  
15 methylenebis[(4R)-4-isopropyl-5,5-di-n-propyloxazoline]nickel dibromide, methylenebis[(4R)-4-isopropyl-5,5-diisopropyloxazoline]nickel  
dibromide, 2,2'-methylenebis[(4R)-4-isopropyl-5,5-dicyclohexyloxazoline]nickel dibromide, 2,2'-  
20 methylenebis[(4R)-4-isopropyl-5,5-diphenyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isopropyl-5,5-di-(2-methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isopropyl-5,5-di-(3-methylphenyl)oxazoline]nickel dibromide, 2,2'-  
25 methylenebis[(4R)-4-isopropyl-5,5-di-(4-methylphenyl)oxazoline]nickel dibromide, 2,2'-

- methylenebis[(4R)-4-isopropyl-5,5-di-(2-methoxyphenyl)oxazoline]nickel dibromide, 2,2'-
- methylenebis[(4R)-4-isopropyl-5,5-di-(3-methoxyphenyl)oxazoline]nickel dibromide, 2,2'-
- 5 methylenebis[(4R)-4-isopropyl-5,5-di-(4-methoxyphenyl)oxazoline]nickel dibromide, 2,2'-
- methylenebis[spiro{(4R)-4-isopropylloxazoline-5,1'-cyclobutane}]nickel dibromide, 2,2'-
- methylenebis[spiro{(4R)-4-isopropylloxazoline-5,1'-cyclopentane}]nickel dibromide, 2,2'-
- 10 methylenebis[spiro{(4R)-4-isopropylloxazoline-5,1'-cyclohexane}]nickel dibromide, 2,2'-
- methylenebis[spiro{(4R)-4-isopropylloxazoline-5,1'-cycloheptane}]nickel dibromide, 2,2'-
- 15 methylenebis[(4R)-4-isobutyl-5,5-dimethyloxazoline]nickel dibromide, 2,2'-
- methylenebis[(4R)-4-isobutyl-5,5-diethyloxazoline]nickel dibromide, 2,2'-
- methylenebis[(4R)-4-isobutyl-5,5-di-n-propylloxazoline]nickel dibromide, 2,2'-
- 20 methylenebis[(4R)-4-isobutyl-5,5-diisopropylloxazoline]nickel dibromide, 2,2'-
- methylenebis[(4R)-4-isobutyl-5,5-dicyclohexylloxazoline]nickel dibromide, 2,2'-
- 25 methylenebis[(4R)-4-isobutyl-5,5-diphenylloxazoline]nickel dibromide, 2,2'-
- methylenebis[(4R)-4-isobutyl-5,5-di-(2-

- methyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isobutyl-5,5-di-(3-  
methyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isobutyl-5,5-di-(4-  
5 methyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isobutyl-5,5-di-(2-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-isobutyl-5,5-di-(3-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
10 methylenebis[(4R)-4-isobutyl-5,5-di-(4-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-isobutyloxazoline-5,1'-  
cyclobutane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-isobutyloxazoline-5,1'-  
15 cyclopentane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-isobutyloxazoline-5,1'-  
cyclohexane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-isobutyloxazoline-5,1'-  
cycloheptane}]nickel dibromide, 2,2'-  
20 methylenebis[(4R)-4-tert-butyl-5,5-  
dimethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-  
diethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-di-n-  
25 propyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-  
diisopropyloxazoline]nickel dibromide, 2,2'-

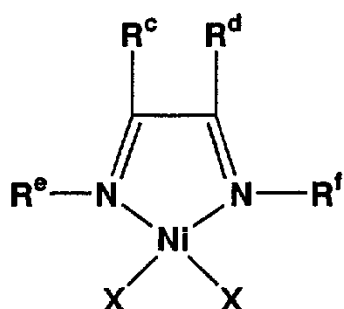
- methylenebis[(4R)-4-tert-butyl-5,5-  
diphenyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-  
dicyclohexyloxazoline]nickel dibromide, 2,2'-  
5 methylenebis[(4R)-4-tert-butyl-5,5-di-(2-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-di-(3-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-di-(4-  
10 methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-di-(2-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-tert-butyl-5,5-di-(3-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
15 methylenebis[(4R)-4-tert-butyl-5,5-di-(4-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-tert-butyloxazoline-5,1'-  
cyclobutane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-tert-butyloxazoline-5,1'-  
20 cyclopentane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-tert-butyloxazoline-5,1'-  
cyclohexane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-tert-butyloxazoline-5,1'-  
cycloheptane}]nickel dibromide, 2,2'-  
25 methylenebis[(4R)-4-phenyl-5,5-  
dimethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-

- diethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-di-n-  
propyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-  
5 diisopropyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-  
dicyclohexyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-  
diphenyl)oxazoline]nickel dibromide, 2,2'-  
10 methylenebis[(4R)-4-phenyl-5,5-di-(2-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-di-(3-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-di-(4-  
15 methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-di-(2-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-phenyl-5,5-di-(3-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
20 methylenebis[(4R)-4-phenyl-5,5-di-(4-  
methoxyphenyl)oxazoline]nickel dibromide,  
methylenebis[spiro{(4R)-4-phenyloxazoline-5,1'-  
cyclobutane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-phenyloxazoline-5,1'-  
25 cyclopentane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-phenyloxazoline-5,1'-  
cyclohexane}]nickel dibromide, 2,2'-

- methylenebis[spiro{(4R)-4-phenyloxazoline-5,1'-  
cycloheptane}]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-  
dimethyloxazoline]nickel dibromide, 2,2'-  
5 methylenebis[(4R)-4-benzyl-5,5-  
diethyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-di-n-  
propyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-  
10 diisopropyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-  
dicyclohexyloxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-  
diphenyl)oxazoline]nickel dibromide, 2,2'-  
15 methylenebis[(4R)-4-benzyl-5,5-di-(2-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-di-(3-  
methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-di-(4-  
20 methylphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-di-(2-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[(4R)-4-benzyl-5,5-di-(3-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
25 methylenebis[(4R)-4-benzyl-5,5-di-(4-  
methoxyphenyl)oxazoline]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-benzyloxazoline-5,1'-

cyclobutane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-benzyloxazoline-5,1'-  
cyclopentane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-benzyloxazoline-5,1'-  
5 cyclohexane}]nickel dibromide, 2,2'-  
methylenebis[spiro{(4R)-4-benzyloxazoline-5,1'-  
cycloheptane}]nickel dibromide, and compounds in which  
(4R) in each of the above-mentioned compounds  
corresponds to (4S), etc. Further, examples of the meso  
10 type isomer include compounds in which (4R) of two  
skeletons in each of the compounds which are mentioned  
above as the optically active substances of  
bisoxazolines were changed to (4R) of one oxazoline  
skeleton and (4S) of another oxazoline skeleton, and  
15 [hydrotris(3,5-dimethylpyrazolyl)borate]nickel  
chloride, [hydrotris(3,5-  
dimethylpyrazolyl)borate]nickel bromide,  
[hydrotris(3,5-dimethylpyrazolyl)borate]nickel  
iodide, [hydrotris(3,5-  
20 dimethylpyrazolyl)borate]nickel methyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]nickel ethyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]nickel allyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]nickel  
methallyl, [hydrotris(3,5-  
25 diethylpyrazolyl)borate]nickel chloride,  
[hydrotris(3,5-diethylpyrazolyl)borate]nickel  
bromide, [hydrotris(3,5-

diethylpyrazolyl)borate]nickel iodide,  
 [hydrotris(3,5-diethylpyrazolyl)borate]nickel methyl,  
 [hydrotris(3,5-diethylpyrazolyl)borate]nickel ethyl,  
 [hydrotris(3,5-diethylpyrazolyl)borate]nickel allyl,  
 5 [hydrotris(3,5-diethylpyrazolyl)borate]nickel  
 methallyl, [hydrotris(3,5-di-tert-  
 butylpyrazolyl)borate]nickel chloride,  
 [hydrotris(3,5-di-tert-butylpyrazolyl)borate]nickel  
 bromide, [hydrotris(3,5-di-tert-  
 10 butylpyrazolyl)borate]nickel iodide, [hydrotris(3,5-  
 di-tert-butylpyrazolyl)borate]nickel methyl,  
 [hydrotris(3,5-di-tert-butylpyrazolyl)borate]nickel  
 ethyl, [hydrotris(3,5-di-tert-  
 butylpyrazolyl)borate]nickel allyl, [hydrotris(3,5-  
 15 di-tert-butylpyrazolyl)borate]nickel methallyl,  
 compounds indicated by the structural formula described  
 below:



(wherein each of  $\text{R}^{\text{c}}$  and  $\text{R}^{\text{d}}$  is a 2,6-diisopropylphenyl  
 20 group, and  $\text{X}$ ,  $\text{R}^{\text{e}}$  and  $\text{R}^{\text{f}}$  are any one of the combination  
 of the substituents represented in Table 1 described  
 below.)  $\text{R}^{\text{g}}$  and  $\text{R}^{\text{h}}$  may be one bi-valent group (e.g. a

acenaphthyl group) in one united body.

Table 1

|                                |                                      |                                                   |
|--------------------------------|--------------------------------------|---------------------------------------------------|
| $R^e=R^f=H$<br>$X^a=F$         | $R^e=R^f=methyl$<br>$X^a= F$         | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = F$         |
| $R^e=R^f=H$<br>$X^a= Cl$       | $R^e=R^f=methyl$<br>$X^a= Cl$        | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = Cl$        |
| $R^e=R^f=H$<br>$X^a= I$        | $R^e=R^f=methyl$<br>$X^a= I$         | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = I$         |
| $R^e=R^f=H$<br>$X^a=Methyl$    | $R^e=R^f=methyl$<br>$X^a= methyl$    | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = methyl$    |
| $R^e=R^f=H$<br>$X^a= Ethyl$    | $R^e=R^f=methyl$<br>$X^a=ethyl$      | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = ethyl$     |
| $R^e=R^f=H$<br>$X^a=n-propyl$  | $R^e=R^f=methyl$<br>$X^a= n-propyl$  | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = n-propyl$  |
| $R^e=R^f=H$<br>$X^a=isopropyl$ | $R^e=R^f=methyl$<br>$X^a= isopropyl$ | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = isopropyl$ |
| $R^e=R^f=H$<br>$X^a= n-butyl$  | $R^e=R^f=methyl$<br>$X^a= n-butyl$   | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = n-butyl$   |
| $R^e=R^f=H$<br>$X^a= phenyl$   | $R^e=R^f=methyl$<br>$X^a= phenyl$    | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = phenyl$    |
| $R^e=R^f=H$<br>$X^a= benzyl$   | $R^e=R^f=methyl$<br>$X^a= benzyl$    | Acenaphthyl by $R^e$ & $R^f$<br>$X^a = benzyl$    |

Further, compounds wherein a nickel atom is replaced with a palladium atom, a cobalt atom, a rhodium atom or a ruthenium atom can be similarly exemplified in the 5 above-mentioned nickel compounds.

Among the metal compounds(II) represented by the general formula[11], specific examples of a compound in

which a transition metal atom is an iron atom include  
2,6-bis-[1-(2,6-  
dimethylphenylimino)ethyl]pyridineiron dichloride,  
2,6-bis-[1-(2,6-diisopropylphenylimino)ethyl]  
5 pyridineiron dichloride, 2,6-bis-[1-(2-tert-  
butylphenylimino)ethyl]pyridineiron dichloride,  
[hydrotris(3,5-dimethylpyrazolyl)borate]iron  
chloride, [hydrotris(3,5-dimethylpyrazolyl)  
borate]iron bromide, [hydrotris(3,5-  
10 dimethylpyrazolyl)borate]iron iodide,  
[hydrotris(3,5-dimethylpyrazolyl)borate]iron methyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]iron ethyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]iron allyl,  
[hydrotris(3,5-dimethylpyrazolyl)borate]iron  
15 methallyl, [hydrotris(3,5-diethylpyrazolyl)  
borate]iron chloride, [hydrotris(3,5-  
diethylpyrazolyl)borate]iron bromide,  
[hydrotris(3,5-diethylpyrazolyl)borate]iron iodide,  
[hydrotris(3,5-diethylpyrazolyl)borate]iron methyl,  
20 [hydrotris(3,5-diethylpyrazolyl)borate]iron ethyl,  
[hydrotris(3,5-diethylpyrazolyl)borate]iron allyl,  
[hydrotris(3,5-diethylpyrazolyl)borate]iron  
methallyl, [hydrotris(3,5-di-tert-  
butylpyrazolyl)borate]iron chloride, [hydrotris(3,5-  
25 di-tert-butylpyrazolyl)borate]iron bromide,  
[hydrotris(3,5-di-tert-butylpyrazolyl)borate]iron  
iodide, [hydrotris(3,5-di-tert-

butylpyrazolyl)borate]iron methyl, [hydrotris(3,5-di-tert-butylpyrazolyl)borate]iron ethyl, [hydrotris(3,5-di-tert-butylpyrazolyl)borate]iron allyl, [hydrotris(3,5-di-tert-butylpyrazolyl)borate]iron methallyl, and the like.

Further, compounds wherein an iron atom is replaced with a cobalt atom or a nickel atom can be similarly exemplified in the above-mentioned iron compounds.

Moreover, among the metal compounds(II) represented by the general formula[11], specific examples of  $\mu$ -oxo type compounds include  $\mu$ -oxobis{isopropylidene(cyclopentadienyl)(2-phenoxy)titanium chloride},  $\mu$ -oxobis{isopropylidene(cyclopentadienyl)(2-phenoxy)titanium methoxide},  $\mu$ -oxobis{isopropylidene(cyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium chloride},  $\mu$ -oxobis{isopropylidene(cyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium methoxide},  $\mu$ -oxobis{isopropylidene(methylcyclopentadienyl)(2-phenoxy)titanium chloride},  $\mu$ -oxobis{isopropylidene(methylcyclopentadienyl)(2-phenoxy)titanium methoxide},  $\mu$ -oxobis{isopropylidene(methylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium chloride},  $\mu$ -oxobis{isopropylidene(methylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium methoxide},  $\mu$ -

-oxobis{isopropylidene  
(tetramethylcyclopentadienyl)(2-phenoxy)titanium  
chloride},  $\mu$ -  
oxobis{isopropylidene(tetramethylcyclopentadienyl)(2  
5 -phenoxy)titanium methoxide},  $\mu$ -  
oxobis{isopropylidene(tetramethylcyclopentadienyl)(3  
-tert-butyl-5-methyl-2-phenoxy)titanium chloride},  $\mu$ -  
oxobis{isopropylidene  
(tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-  
10 2-phenoxy)titanium methoxide},  $\mu$ -  
oxobis(dimethylsilylene(cyclopentadienyl)(2-  
phenoxy)titanium chloride},  $\mu$ -  
oxobis(dimethylsilylene(cyclopentadienyl)(2-  
phenoxy)titanium methoxide},  $\mu$ -  
15 oxobis(dimethylsilylene(cyclopentadienyl)(3-tert-  
butyl-5-methyl-2-phenoxy)titanium chloride},  
 $\mu$ -oxobis(dimethylsilylene(cyclopentadienyl)(3-tert-  
butyl-5-methyl-2-phenoxy)titanium methoxide},  
 $\mu$ -oxobis(dimethylsilylene(methylcyclopentadienyl)  
20 (2-phenoxy)titanium chloride},  $\mu$ -  
oxobis(dimethylsilylene(methylcyclopentadienyl)(2-  
phenoxy)titanium methoxide},  $\mu$ -  
oxobis(dimethylsilylene(methylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium chloride},  $\mu$ -  
25 -oxobis(dimethylsilylene(methylcyclopentadienyl)(3-  
tert-butyl-5-methyl-2-phenoxy)titanium methoxide},  $\mu$ -  
oxobis(dimethylsilylene

(tetramethylcyclopentadienyl)(2-phenoxy)titanium  
 chloride},  $\mu$ -oxobis(dimethylsilylene  
 (tetramethylcyclopentadienyl)(2-phenoxy)titanium  
 methoxide},  $\mu$ -

5 oxobis(dimethylsilylene(tetramethylcyclopentadienyl)  
 (3-tert-butyl-5-methyl-2-phenoxy)titanium chloride),  
 $\mu$ -oxobis(dimethylsilylene  
 (tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-  
 2-phenoxy)titanium methoxide) di- $\mu$ -

10 oxobis[isopropylidene(cyclopentadienyl)(2-  
 phenoxy)titanium], di- $\mu$ -  
 oxobis[isopropylidene(cyclopentadienyl)(3-tert-  
 butyl-5-methyl-2-phenoxy)titanium],  
 di- $\mu$ -

15 oxobis[isopropylidene(methylcyclopentadienyl)(2-  
 phenoxy)titanium], di- $\mu$ -  
 oxobis[isopropylidene(methylcyclopentadienyl)(3-  
 tert-butyl-5-methyl-2-phenoxy)titanium],  
 di- $\mu$ -oxobis[isopropylidene

20 (tetramethylcyclopentadienyl)(2-phenoxy)titanium],  
 di- $\mu$ -oxobis[isopropylidene  
 (tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-  
 2-phenoxy)titanium], di- $\mu$ -oxobis  
 [dimethylsilylene(cyclopentadienyl)(2-

25 phenoxy)titanium], di- $\mu$ -  
 oxobis[dimethylsilylene(cyclopentadienyl)(3-tert-  
 butyl-5-methyl-2-phenoxy)titanium], di- $\mu$ -

oxobis[dimethylsilylene(methylcyclopentadienyl)(2-phenoxy)titanium], di- $\mu$ -

oxobis[dimethylsilylene(methylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium], di- $\mu$ -

5 oxobis[dimethylsilylene(tetramethylcyclopentadienyl)(2-phenoxy)titanium], di- $\mu$ -

oxobis[dimethylsilylene(tetramethylcyclopentadienyl)(3-tert-butyl-5-methyl-2-phenoxy)titanium] and the like.

10 Furthermore, compounds in which a titanium atom is replaced with a zirconium atom or a hafnium atom can be similarly exemplified in the above-mentioned titanium compounds.

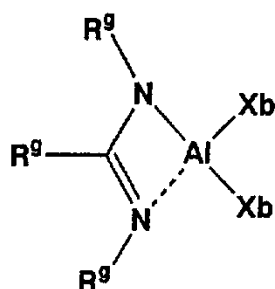
Specific Examples of the metal compounds(II) other  
 15 than the metal compounds represented by the general formula [11] and  $\mu$ -oxo type metal compounds include nickel chloride, nickel bromide, nickel iodide, nickel sulfate as a compound in which metal atom is nickel atom, nickel nitrate, nickel perchlorate, nickel acetate,  
 20 nickel trifluoroacetate, nickel cyanide, nickel oxalate, nickel acetylacetonate, bis(allyl) nickel, bis(1,5-cyclooctadiene)nickel, dichloro(1,5-cyclooctadiene)nickel, dichlorobis(acetonitrile)nickel, dichlorobis(benzonitrile)nickel, carbonyl  
 25 tris(triphenylphosphine)nickel, dichlorobis(triethylphosphine)nickel, di-acetobis

(triphenylphosphine)nickel,  
tetrakis(triphenylphosphine)nickel, dichloro[1,2- bis  
(diphenylphosphino)ethane]nickel, bis[1,2-  
bis(diphenylphosphino)ethane]nickel, dichloro[1,3-  
5 bis(diphenylphosphino)propane]nickel, bis[1,3-  
bis(diphenylphosphino)propane]nickel, tetraamine  
nickel nitrate, tetrakis(acetonitrile)nickel  
tetrafluoroborate, nickel phthalocyanine, etc.

Among the metal compounds(II), specific examples of a  
10 compound in which a transition metal atom is a vanadium  
atom include vanadium acetylacetonate, vanadium  
tetrachloride, vanadium oxy trichloride and the like.

Among the metal compounds(II), specific examples of a  
compound in which a transition metal atom is a samarium  
15 atom include bis(pentamethylcyclopentadienyl)samarium  
methylnetetrahydrofuran and the like.

Among the metal compounds(II), specific examples of  
a compound in which a transition metal atom is an  
ytterbium atom include  
20 bis(pentamethylcyclopentadienyl)ytterbium  
methylnetetrahydrofuran and the like.



(wherein respective  $R^g$  groups independently represent a hydrogen atom, halogen atom or hydrocarbon group, they may be the same or different, and two or more of them may be bonded mutually and may form a ring.  $Xb$  groups  
 5 independently represent a hydrogen atom, halogen atom or hydrocarbon group, they may be the same or different, and may be bonded mutually and may form a ring.)

These metal compounds(II) may be used alone, or in combination of 2 or more kinds of the compounds.

10 In the metal compounds described above, as a metal compound(II) used in the present invention, compounds represented by the general formula [11] are preferable.

Among these, metal compounds in which M in the general formula [10] is a transition metal are preferable,  
 15 and further, particularly metal compounds in which L in the general formula [10] is a group having at least one cyclopentadiene type anion skeleton, are preferable.

#### (III) Organoaluminum compound

As the organoaluminum compound (III) which is a  
 20 component used for the catalyst for addition polymerization of the present invention, known organoaluminum compounds can be used. The

organoaluminum compound indicated by the general formula [13] described below is preferable.



(wherein  $R^h$  represents a hydrocarbon group, all of  $R^h$ 's  
5 may be the same or different. Z represents a hydrogen atom, a halogen atom, an alkoxy group, an aralkyloxy group or an aryloxy group, and "b" represents a numeral satisfying  $0 < b \leq 3$ .)

$R^h$  in the general formula [13] representing the  
10 organoaluminum compound is preferably a hydrocarbon group having 1 to 24 carbon atoms, and more preferably an alkyl group having 1 to 24 carbon atoms. Specific examples include a methyl group, an ethyl group, a  
n-propyl group, a n-butyl group, an isobutyl group, a  
15 n-hexyl group, a 2-methylhexyl group, a n-octyl group and the like, and an ethyl group, a n-butyl group, an isobutyl group or a n-hexyl group is preferable.

Further, specific example of a case in which Z is a halogen atom includes a fluorine atom, a chlorine atom,  
20 a bromine atom, an iodine atom, and a chlorine atom is preferable.

The alkoxy group in Z is preferably an alkoxy group having 1 to 24 carbon atoms, and specific examples include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group, a sec-  
25 butoxy group, a tert-butoxy group, a n-pentoxy group, a neopentoxy group, a n-hexoxy group, a n-octoxy group,

a n-dodecoxy group, a n-pentadecoxy group, a n-icosoxy group and the like, and a methoxy group, an ethoxy group or a tert-butoxy group is preferable.

Any one of these alkoxy groups may be substituted  
5 with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom or an iodine atom, an alkoxy group such as a methoxy group, an ethoxy group or the like, or an aryloxy group such as a phenoxy group or the like.

The aryloxy group in Y is preferably an aryloxy  
10 group having 6 to 24 carbon atoms, and specific examples include a phenoxy group, a 2-methylphenoxy group, a 3-methylphenoxy group, a 4-methylphenoxy group, a 2,3-dimethylphenoxy group, a 2,4-dimethylphenoxy group, a 2,5-dimethylphenoxy group, a 2,6-dimethylphenoxy  
15 group, a 3,4-dimethylphenoxy group, a 3,5-dimethylphenoxy group, a 2,3,4-trimethylphenoxy group, a 2,3,5-trimethylphenoxy group, a 2,3,6-trimethylphenoxy group, a 2,4,5-trimethylphenoxy group, a 2,4,6-trimethylphenoxy group, a 3,4,5-trimethylphenoxy group, a 2,3,4,5-tetramethylphenoxy  
20 group, a 2,3,4,6-tetramethylphenoxy group, 2,3,5,6-tetramethylphenoxy group, a pentamethylphenoxy group, an ethylphenoxy group, a n-propylphenoxy group, an isopropylphenoxy group, a n-butylphenoxy group, a  
25 sec-butylphenoxy group, a tert-butylphenoxy group, a n-hexylphenoxy group, a n-octylphenoxy group, a n-decylphenoxy group, a n-tetradecylphenoxy group, a

naphthoxy group, an anthrathenoxy group and the like.

Any one of these aryloxy groups may be substituted with a halogen atom such as a fluorine atom, a chlorine atom, a bromine atom, an iodine atom or the like, an alkoxy group such as a methoxy group, an ethoxy group or the like, or an aryloxy group such as a phenoxy group or the like.

The aralkyloxy group in Y is preferably an aralkyloxy group having 7 to 24 carbon atoms, and specific examples include a benzyloxy group, a (2-methylphenyl)methoxy group, a (3-methylphenyl)methoxy group, a (4-methylphenyl)methoxy group, a (2,3-dimethylphenyl)methoxy group, a (2,4-dimethylphenyl)methoxy group, a (2,5-dimethylphenyl)methoxy group, a (2,6-dimethylphenyl)methoxy group, a (3,4-dimethylphenyl)methoxy group, a (3,5-dimethylphenyl)methoxy group, a (2,3,4-trimethylphenyl)methoxy group, a (2,3,5-trimethylphenyl)methoxy group, a (2,3,6-trimethylphenyl)methoxy group, a (2,4,5-trimethylphenyl)methoxy group, a (2,4,6-trimethylphenyl)methoxy group, a (3,4,5-trimethylphenyl)methoxy group, a (2,3,4,5-tetramethylphenyl)methoxy group, a (2,3,4,6-tetramethylphenyl)methoxy group, a (2,3,5,6-

tetramethylphenyl)methoxy group, a  
(pentamethylphenyl)methoxy group, an  
(ethylphenyl)methoxy group, a (n-  
propylphenyl)methoxy group, an  
5 (isopropylphenyl)methoxy group, a (n-  
butylphenyl)methoxy group, a (sec-  
butylphenyl)methoxy group, a (tert-  
butylphenyl)methoxy group, a (n-hexylphenyl)methoxy  
group, a (n-octylphenyl)methoxy group, a (n-  
10 decylphenyl)methoxy group, a (n-  
tetradecylphenyl)methoxy group, a naphthylmethoxy  
group, an anthrathenylmethoxy group and the like, and  
a benzyloxy group is preferable.

Any one of these aralkyloxy groups may be  
15 substituted with a halogen atom such as a fluorine atom,  
a chlorine atom, a bromine atom, an iodine atom or the  
like, an alkoxy group such as a methoxy group, an ethoxy  
group or the like, or an aryloxy group such as a phenoxy  
group or the like.

20 Specific examples of the organoaluminum compound  
represented by the general formula (13) include  
trialkylaluminums such as trimethylaluminum,  
triethylaluminum, tri-n-propylaluminum, tri-n-  
butylaluminum, triisobutylaluminum, tri-n-  
25 hexylaluminum, tri-n-octylaluminum and the like;  
dialkylaluminum chlorides such as dimethylaluminum  
chloride, diethylaluminum chloride, di-n-

propylaluminum chloride, di-n-butylaluminum chloride,  
diisobutylaluminum chloride, di-n-hexylaluminum  
chloride and the like; alkylaluminum dichlorides such  
as methylaluminum dichloride, ethylaluminum  
5 dichloride, n-propylaluminum dichloride, n-  
butylaluminum dichloride, isobutylaluminum  
dichloride, n-hexylaluminum dichloride and the like;  
dialkylaluminum hydrides such as dimethylaluminum  
hydride, diethylaluminum hydride, di-n-  
10 propylaluminum hydride, di-n-butylaluminum hydride,  
diisobutylaluminum hydride, di-n-hexylaluminum  
hydride and the like, alkyl(dialkoxy)aluminums such  
as methyl(dimethoxy)aluminum,  
methyl(diethoxy)aluminum, methyl(di-tert-  
15 butoxy)aluminum and the like;  
dialkyl(alkoxy)aluminums such as  
dimethyl(methoxy)aluminum, dimethyl(ethoxy)aluminum,  
dimethyl(tert-butoxy)aluminum and the like;  
alkyl(diaryloxy)aluminums such as  
20 methyl(diphenoxy)aluminum, methylbis(2,6-  
diisopropylphenoxy)aluminum, methylbis(2,6-  
diphenylphenoxy)aluminum and the like;  
dialkyl(aryloxy)aluminums such as  
dimethyl(phenoxy)aluminum, dimethyl(2,6-  
25 diisopropylphenoxy)aluminum, dimethyl(2,6-  
diphenylphenoxy)aluminum and the like, etc.

Among these, a trialkylaluminum is preferable, and

trimethylaluminum, triethylaluminum, tri-n-butylaluminum, triisobutylaluminum or tri-n-hexylaluminum, is more preferable, and in particular, triisobutylaluminum or tri-n-hexylaluminum is  
5 preferable.

These organoaluminum compounds may be used alone, or in combination of two or more.

The ratio (molar ratio) of the amount used of the respective catalyst components in the present invention  
10 is not particularly limited, and the molar ratio of the component (I) to the component (II) is usually a molar ratio of a range of (I) : (II) = from 1 : 1 to 10000 : 1, preferably from 1 : 1 to 5000 : 1, and more preferably a molar ratio of a range of from 1 : 1 to 1000 : 1. The  
15 amount used in case of using the component(III) is usually a molar ratio of a range of (II) : (III) = from 0.1 : 1 to 1 : 10000, and preferably a molar ratio of a range of from 1 : 1 to 1 : 1000.

As the catalyst for addition polymerization of the  
20 present invention, a reaction product obtained by preliminarily contacting the component (I) and the component (II), optionally, further the component (III) may be also used, and they may be also used by being separately charged in a polymerization vessel. The  
25 arbitrary two components among them may be also previously contacted, and further, another component may be also contacted.

When the respective components are used as a solution, the concentration of the component (I) and the component (III) are usually 0.0001 to 100 mmol/L converted to metal atom, and preferably 0.01 to 10mmol/L, respectively. The concentration of the component (II) is usually 0.0001 to 100 mmol/L converted to metal atom, and preferably 0.01 to 10mmol/L.

The method of feeding the respective components in a reactor is not particularly limited. A method of feeding the respective components in a solid condition, a method of feeding them in a condition of a solution in which they are dissolved in a hydrocarbon solvent from which components such as moisture, oxygen and the like deactivating catalyst components are removed, or a suspension or a slurry, and the like are mentioned.

Concerning the polymerization method, it should not be specifically limited. For example, there are mentioned a solvent polymerization or a slurry polymerization in which an aliphatic hydrocarbon such as butane, pentane, hexane, heptane, octane or the like; an aromatic hydrocarbon such as benzene, toluene or the like; or a halogenated hydrocarbon such as methylene dichloride or the like is used as a solvent, a bulk polymerization in which polymerization is carried out in a liquid monomer, a gas phase polymerization in which polymerization is carried out in a gaseous monomer, a high-pressure polymerization method in which

polymerization is carried out in a supercritical liquid condition at a high temperature under a high pressure, etc. As polymerization form, either of a batch-wise type and a continuous type are possible.

5           The polymerization temperature is usually from -100°C to 350°C, preferably from -20°C to 300°C, and more preferably from 20°C to 300°C. The polymerization pressure is usually from 1 to 3500kg/cm<sup>2</sup>G, preferably from 1 to 3000kg/cm<sup>2</sup>G, and more preferably from 1 to 10   2000kg/cm<sup>2</sup>G. In general, the polymerization time is appropriately determined according to the kind of a desired polymer and a reaction apparatus, and a range of from 1 minute to 20 hours can be adopted.

          As monomers which can be used, any one of olefins 15   having 2 to 100 carbon atoms, diolefins, cyclic olefins, alkenyl aromatic hydrocarbons and polar monomers can be used, and two or more monomers thereof can also be used, simultaneously. Specific examples thereof include olefins such as ethylene, propylene, 1-butene, 1- 20   pentene, 4-methyl-1-pentene-1, 5-methyl-1-hexene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, vinylcyclohexene and the like; diolefins such as 1,5-hexadiene, 1,4-hexadiene, 1,4-pentadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 4-methyl- 25   1,4-hexadiene, 5-methyl-1,4-hexadiene, 7-methyl-1,6-octadiene, 5-ethylidene-2-norbornene, dicyclopentadiene, 5-vinyl-2-norbornene, 5-methyl-2-

norbornene, norbornadiene, 5-methylene-2-norbornene,  
1,5-cyclooctadiene, 5,8-  
endomethylenehexahydronaphthalene, 1,3-butadiene,  
isoprene, 1,3-hexadiene, 1,3-octadiene, 1,3-  
5 cyclooctadiene, 1,3-cyclohexadiene and the like; cyclic  
olefins such as norbornene, 5-methylnorbornene, 5-  
ethylnorbornene, 5-butylnorbornene, 5-  
phenylnorbornene, 5-benzylnorbornene,  
tetracyclododecene, tricyclodecene, tricycloundecene,  
10 pentacyclopentadecene, pentacyclohexadecene, 8-  
methyltetracyclododecene, 8-ethyltetracyclododecene,  
5-acetylnorbornene, 5-acetyloxynorbornene, 5-  
methoxycarbonylnorbornene, 5-  
ethoxycarbonylnorbornene, 5-methyl-5-  
15 methoxycarbonylnorbornene, 5-cyanonorbornene, 8-  
methoxycarbonyltetracyclododecene, 8-methyl-8-  
tetracyclododecene, 8-cyanotetracyclododecene and the  
like; alkenylbenzenes such as styrene, 2-  
phenylpropylene, 2-phenylbutene, 3-phenylpropylene  
20 and the like; alkylstyrenes such as p-methylstyrene,  
m-methylstyrene, o-methylstyrene, p-ethylstyrene, m-  
ethylstyrene, o-ethylstyrene, 2,4-dimethylstyrene,  
2,5-dimethylstyrene, 3,4-dimethylstyrene, 3,5-  
dimethylstyrene, 3-methyl-5-ethylstyrene, p-tert-  
25 butylstyrene, p-sec-butylstyrene and the like;  
bis(alkenyl)benzenes such as divinylbenzene and the  
like; alkenyl aromatic hydrocarbons such as

alkenylnaphthalenes and the like such as 1-  
vinylnaphthalene and the like; polar monomers such as  
 $\alpha, \beta$ -unsaturated carboxylic acids such as acrylic acid,  
methacrylic acid, fumaric acid, maleic anhydride,  
5 itaconic acid, itaconic anhydride, bicyclo(2,2,1)-5-  
heptene-2,3-dicarboxylic acid and the like, and metal  
salts thereof such as sodium, potassium, lithium, zinc,  
magnesium, calcium and the like;  $\alpha, \beta$ -unsaturated  
carboxylic acid esters such as methyl acrylate, ethyl  
10 acrylate, n-propyl acrylate, isopropyl acrylate,  
tert-butyl acrylate, 2-ethylhexyl acrylate, methyl  
methacrylate, ethyl methacrylate, n-propyl  
methacrylate, isopropyl methacrylate, n-butyl  
methacrylate, isobutyl methacrylate and the like;  
15 unsaturated dicarboxylic acids such as maleic acid,  
itaconic acid and the like; vinyl esters such as vinyl  
acetate, vinyl propionate, vinyl capronate, vinyl  
caprate, vinyl laurate, vinyl stearate, vinyl  
trifluoroacetate and the like; unsaturated carboxylic  
20 acid glycidylate such as acrylic acid glycidylate,  
methacrylic acid glycidylate, itaconic acid  
monoglycidylate and the like; etc.

The present invention can be applied to  
homopolymerization or copolymerization of these monomers.  
25 Specific examples of the monomer constituting the  
copolymer include ethylene and propylene, ethylene and  
1-butene, ethylene and 1-hexene, propylene and 1-butene,

and the like, but the present invention should not be limited thereto.

In order to control the molecular weight of a polymer, a chain transfer agent such as hydrogen or the like can be added.

The catalyst for addition polymerization of the present invention is particularly suitable as a catalyst for olefin polymerization, and suitably used for a production process of an olefin polymer. The olefin polymer is preferably a copolymer of ethylene with an  $\alpha$ -olefin in particular, and specifically, a linear low density polyethylene (LLDPE) is preferable. Further, a propylene polymer is preferably as the olefin polymer in particular

15

#### EXAMPLE

The present invention is further illustrated in detail according to Examples and Comparative Examples below, but the present invention is not limited thereto.

The measurement values of respective items in Examples were measured according to methods described below.

(1) The content of  $\alpha$ -olefin unit in a copolymer was determined by using a calibration curve from the characteristic absorption of ethylene and  $\alpha$ -olefin using an infrared spectrometer (FT-IR7300, manufactured by NIPPON BUNKO Inc.) and was represented as a short-chain branch (SCB) number per 1000 carbon atoms.

(2) Intrinsic viscosity ( $[\eta]$ ):

It was measured at 135°C in a tetralin solution using an Ubbelohde viscometer.

(3) Measurement of  $^{13}\text{C}$ -NMR

5 JNM-EX270 (67.5MHz,  $^{13}\text{C}$ ) of Nihon Denshi Company was used for measuring  $^{13}\text{C}$ -NMR. A deuterated solvent described in Example was used and measurement was carried out at room temperature.

(4) Molecular weight and molecular weight  
10 distribution:

They were determined under the under-mentioned conditions according to a gel permeation chromatography (GPC). Calibration curve was prepared using a standard polystyrene. Molecular weight distribution was  
15 evaluated by a ratio ( $M_w/M_n$ ) of weight average molecular weight ( $M_w$ ) to number average molecular weight ( $M_n$ ).

Equipment: 150C type, manufactured by Millipore Waters Co., Ltd.

Column: TSK-GEL GMH-HT;  $7.5 \times 600 \times 2$  columns  
20 Measurement temperature: 140°C

Solvent: O-dichlorobenzene

Measurement concentration: 5 mg/5 ml

(5) Melting point of a copolymer was determined using SSC-5200 of Seiko Co., Ltd. according to the condition  
25 below.

Raise of temperature: 40°C to 150°C (10°C/min.),  
retaining for 5 minutes.

Cooling: 150°C to 40°C (5°C/min.),  
retaining for 10 minutes.  
Measurement: 40°C to 160°C (5°C/min.)

5           Example 1

(1) Synthesis of compound (I-1)

Into a 200ml four-necked flask in which the  
atmosphere was replaced with argon, 10ml (10mmol) of  
ZnEt<sub>2</sub>(diethylzinc) (1.02M, hexane solution) and 50ml of  
10   toluene were charged and the mixture was cooled to -  
78°C. Thereto, 5.7ml (10mmol) of pentafluorophenol  
(1.78M, hexane solution) was added dropwise. After  
completion of dropwise addition, temperature was  
gradually raised to room temperature, and stirring was  
15   further carried out for 2 hours. Then, 89.0mg (4.94mmol)  
of H<sub>2</sub>O was gradually added dropwise by a micro syringe  
at room temperature. The content became muddy in white.  
After completion of dropwise addition, stirring was  
further carried out for 11 hours. The white gel solid  
20   prepared was dried at room temperature under reduced  
pressure to obtain 2.56g of a white powder. As a result  
of measurements of <sup>1</sup>H-NMR and <sup>13</sup>C-NMR, a spectrum  
according to an unreacted Zn-Et structure was confirmed.

<sup>1</sup>H-NMR (THF-d<sub>8</sub>): δ 1.18 (t, 3H, J=7.9Hz, ZnCH<sub>2</sub>CH<sub>3</sub>),  
25   0.28 (q, 2H, J=7.9Hz, ZnCH<sub>2</sub>CH<sub>3</sub>)

<sup>13</sup>C-NMR (THF-d<sub>8</sub>): δ 141.9 (m), 141.4 (m, JC-F=233Hz),  
139.0 (m, JC-F=245Hz), 131.7 (m, JC-F=236Hz), 12.5 (s,

$\text{ZnCH}_2\text{CH}_3$ ), -3.0 (s,  $\text{ZnCH}_2\text{CH}_3$ )

## (2) Polymerization

After drying under vacuum an autoclave reactor having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0μmol of ethylenebis(indenyl)zirconium dichloride was charged, 22.1mg (86.2μmol-Zn) of the component (I-1) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 7.88g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $1.6 \times 10^7$ g/mol/h. SCB = 13.73,  $[\eta] = 1.24$ dl/g,  $M_w = 79000$ ,  $M_w/M_n = 1.7$ .

## Example 2

### (1) Synthesis of compound (I-2)

Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 10ml (10mmol) of  $\text{ZnEt}_2$  (1.02M, hexane solution) and 50ml of toluene were charged and the mixture was cooled to -78°C. Thereto, 6.9ml (10mmol) of pentafluorophenol (1.48M, hexane

solution) was added dropwise. After completion of dropwise addition, temperature was gradually raised to room temperature, and stirring was further carried out over night. Then, stirring was carried out for one hour under reflux condition, and the mixture was cooled to room temperature. Then, 93.8mg (5.21mmol) of H<sub>2</sub>O was gradually added dropwise by a micro syringe. The content became white slurry-like. After completion of dropwise addition, stirring was carried out for 6 hours under reflux condition. Volatile materials were removed by distillation under reduced pressure from the white slurry product prepared, and the solid prepared was dried at room temperature under reduced pressure to obtain 2.21g of a white powder.

## (2) Polymerization

After drying under vacuum an autoclave reactor having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the system was stabilized, 0.25mmol of triisobutylaluminum was charged, and successively, 1.0 μmol of ethylenebis(indenyl)zirconium dichloride was charged, 23.4mg (91.2 μmol-Zn) of the compound (I-2) obtained in the above-mentioned (1) was further charged, and

polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 8.69g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $1.7 \times 10^7$  g/mol/h. SCB = 16.46,  $[\eta] = 1.33$  dl/g,  $M_w = 77000$ ,  $M_w/M_n = 2.0$ .

### Example 3

#### (1) Synthesis of compound (I-3)

Into a 200ml four-necked flask in which the atmosphere was replaced with argon after reduced pressure drying under vacuum, 10ml (10mmol) of a hexane solution of diethylzinc [1.02 mol/L (M)] and 50ml of tetrahydrofuran were charged, and the mixture was cooled to  $-78^\circ\text{C}$  and stirred. Thereto, 6.9ml (10mmol) of pentafluorophenol (1.48M, hexane solution) was added dropwise. After completion of dropwise addition, the temperature was gradually raised to room temperature, and stirring was carried out for 2 hours. Then, 93.7mg (5.20mmol) of  $\text{H}_2\text{O}$  was gradually added dropwise by a micro syringe. The content became a yellow transparent solution. After completion of dropwise addition, stirring was carried out for 20 hours. Volatile materials were removed by distillation under reduced pressure, and the solid prepared was dried at  $120^\circ\text{C}$  for 8 hours under reduced pressure to obtain 2.34g of an ivory powder. As a result of measurements of  $^1\text{H}$ -NMR and  $^{13}\text{C}$ -NMR, a spectrum derived from a Zn-Et structure could not be

confirmed.

$^{13}\text{C}$ -NMR (THF- $d_8$ ):  $\delta$  141.9 (m), 141.4 (m, JC-F=234Hz),  
139.0 (m, JC-F=249Hz), 131.6 (m, JC-F=236Hz)

## (2) Polymerization

5        After drying under vacuum an autoclave reactor  
having an inner volume of 400ml equipped with a stirrer  
and replacing the atmosphere thereof with argon, 190ml  
of hexane as a solvent and 10ml of 1-hexene as a comonomer  
were charged and the reactor was heated to 70°C. After  
10    the raise of temperature, ethylene was fed while  
adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the  
system was stabilized, 0.25mmol of triisobutylaluminum  
was charged, successively, 1.0  $\mu$ mol of  
ethylenebis(indenyl)zirconium dichloride was charged,  
15    31.4mg (122  $\mu$ mol-Zn) of the compound (I-3) obtained in  
the above-mentioned (1) was further charged, and  
polymerization was started. The polymerization was  
carried out for 30 minutes. As a result of the  
polymerization, 15.75g of an ethylene-1-hexene  
20    copolymer was obtained. Polymerization activity was 3.2  
 $\times 10^7$ g/mol/h. SCB = 15.23,  $[\eta]$  = 1.24dl/g, Mw = 72000,  
Mw/Mn = 2.0.

## Example 4

### (1) Synthesis of compound (I-4)

25        Into a 200ml four-necked flask in which the  
atmosphere was replaced with argon after reduced  
pressure drying under vacuum, 20ml (20mmol) of a hexane

solution of diethylzinc (1.02M) and 100ml of tetrahydrofuran were charged, and the mixture was cooled to  $-78^{\circ}\text{C}$  and stirred. Thereto, 4.4ml (5.1mmol) of pentafluorophenol (1.17M, hexane solution) was added dropwise. After completion of dropwise addition, the temperature was gradually raised to room temperature, and stirring was carried out for 2 hours. Then, 321  $\mu\text{l}$  (17.8mmol) of  $\text{H}_2\text{O}$  was gradually added dropwise by a micro syringe. After completion of dropwise addition, stirring was carried out for 14 hours. Volatile materials were removed by distillation under reduced pressure, and the solid prepared was dried at  $120^{\circ}\text{C}$  for 8 hours under reduced pressure to obtain an ivory powder.

## (2) Polymerization

After drying under vacuum an autoclave reactor having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to  $70^{\circ}\text{C}$ . After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of  $6\text{kg}/\text{cm}^2$ . After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively,  $0.3\mu\text{mol}$  of ethylenebis(indenyl)zirconium dichloride was charged, 9.0mg ( $72\mu\text{mol}$ -Zn) of the compound (I-4) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was

carried out for 30 minutes. As a result of the polymerization, 2.4g of an ethylene-hexene-1 copolymer was obtained. Polymerization activity was  $1.6 \times 10^7 \text{g/mol/h}$ . SCB = 15.54.

5      Example 5

        (1) Synthesis of compound (I-5)

        Into a 200ml four-necked flask in which the atmosphere was replaced with argon after reduced pressure drying under vacuum, 20ml (20mmol) of a hexane  
10      solution of diethylzinc (1.02 M) and 100ml of tetrahydrofuran were charged, and the mixture was cooled to  $-78^\circ\text{C}$  and stirred. Thereto, 8.7ml (10mmol) of pentafluorophenol (1.17M, hexane solution) was added dropwise. After completion of dropwise addition, the  
15      temperature was gradually raised to room temperature, and stirring was carried out for 2 hours. Then, 275  $\mu\text{l}$  (15.3mmol) of  $\text{H}_2\text{O}$  was gradually added dropwise by a micro syringe. After completion of dropwise addition, stirring was carried out at room temperature over night.  
20      Volatile materials were removed by distillation under reduced pressure, and the solid prepared was dried at  $120^\circ\text{C}$  for 8 hours under reduced pressure to obtain an ivory powder.

        (2) Polymerization

25      After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of

hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the  
5 inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 0.3 μmol of ethylenebis(indenyl)zirconium dichloride was charged, 9.3mg (55 μmol-Zn) of the compound (I-5) obtained in the above-mentioned (1) was further charged,  
10 and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 11.06g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was 7.4 × 10<sup>7</sup>g/mol/h. SCB = 12.79.

15 Example 6

(1) Polymerization

After drying under vacuum an autoclave reactor having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml  
20 of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the system was stabilized, 0.25mmol of triisobutylaluminum  
25 was charged, successively, 0.3 μmol of ethylenebis(indenyl)zirconium dichloride was charged, 23.2mg (90.5 μmol-Zn) of the compound (I-3) obtained in

Example 3(1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 6.9g of an ethylene-1-hexene copolymer was obtained.

5 Polymerization activity was  $4.6 \times 10^7$  g/mol/h. SCB = 15.39.

#### Example 7

##### (1) Synthesis of compound (I-6)

Into a 200ml four-necked flask in which the  
10 atmosphere was replaced with argon after reduced pressure drying under vacuum, 20ml (20mmol) of a hexane solution of diethylzinc (1.02M) and 100ml of tetrahydrofuran were charged, and the mixture was cooled to -78°C and stirred. Thereto, 26.2ml (30.7mmol) of  
15 pentafluorophenol (1.17M, hexane solution) was added dropwise. After completion of dropwise addition, the temperature was gradually raised to room temperature, and stirring was carried out for 2 hours. Then, 92  $\mu$ l (5.1mmol) of H<sub>2</sub>O was gradually added dropwise by a micro  
20 syringe. After completion of dropwise addition, stirring was carried out at room temperature over night. Volatile materials were removed by distillation under reduced pressure, and the solid prepared was dried at 120°C for 8 hours under reduced pressure to obtain an  
25 ivory powder.

##### (2) Polymerization

After drying under vacuum an autoclave having an

inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After  
5 the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 0.3  $\mu$ mol of ethylenebis(indenyl)zirconium dichloride was  
10 charged, 27.0mg (78.5  $\mu$ mol-Zn) of the compound (I-6) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 1.3g of an ethylene-hexene-1 copolymer  
15 was obtained. Polymerization activity was  $8.7 \times 10^6$ g/mol/h. SCB = 17.04.

#### Example 8

##### (1) Polymerization of propylene

A magnetic stirrer was placed in an autoclave  
20 having an inner volume of 100ml, it was dried under vacuum, and the atmosphere was replaced with argon. Thereto, 70.6mg (275  $\mu$ mol-Zn) of the compound (I-2) obtained in Example 2(1), 0.5mmol of triisobutylaluminum and 2  $\mu$ mol of ethylenebis(indenyl)zirconium dichloride were  
25 charged. In the autoclave, 40g of propylene was charged, temperature was raised to 40°C, and polymerization was started. The polymerization was carried out for 60

minutes. As a result of the polymerization, 2.23g of a propylene polymer was obtained. Polymerization activity was  $2.2 \times 10^6$  g/mol/h.  $M_w = 21000$ ,  $M_w/M_n = 1.9$ .

#### Example 9

##### 5 (1) Synthesis of compound (I-7)

Into a 300ml four-necked flask in which the atmosphere was replaced with argon after reduced pressure drying under vacuum, 16.49g (90.07mmol) of pentafluoroaniline and 70ml of toluene were charged, and  
10 the mixture was cooled to 0°C and stirred. Thereto, 176.6ml of diethylzinc (1.02M, hexane solution) was added, then the temperature was gradually raised to room temperature, and stirring was carried out over night. The content article became a white slurry. After  
15 stirring was carried out for 8 hours under reflux condition, volatile materials were removed by distillation under reduced pressure to obtain 18.32g of a solid product.

After drying the solid product under reduced  
20 pressure in vacuum, 3.68g of the solid product and 100ml of toluene were charged in the 300ml four-necked flask in which the atmosphere was replaced with argon, and the mixture was stirred at room temperature. Thereto, 17.0ml (19.9mmol) of pentafluorophenol (1.17M, hexane  
25 solution) was added, and stirring was carried out for 68 hours. Volatile materials were removed by distillation under reduced pressure to obtain a white

solid.

## (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1μmol of ethylenebis(indenyl)zirconium dichloride was charged, 40.8mg (120μmol-Zn) of the compound (I-7) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 1.02g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $2.0 \times 10^6$ g/mol/h.

## Example 10

Into a 300ml four-necked flask in which the atmosphere was replaced with argon, 106ml of tetrahydrofuran and 40ml (80mmol) of ZnEt<sub>2</sub> (2M, hexane solution) were charged, and the mixture was cooled to 4°C. Thereto, 14.5ml (32mmol) of pentafluorophenol (2.21M, tetrahydrofuran solution) was added dropwise for 50 minutes. After completion of dropwise addition,

stirring was further carried out at 5°C for 1 hour. The temperature was lowered to 20°C by ice bath, and 7.3ml (72.3mmol) of H<sub>2</sub>O (9.9M, tetrahydrofuran solution) was added dropwise for 1 hour. After completion of dropwise addition, stirring was further carried out for 2 hours, then the mixture was stood alone at room temperature overnight. Then, stirring was carried out for 8 hours under reflux condition (63°C). As a result, the component (A) was obtained as an yellow transparent solution.

Example 11

Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 40ml of tetrahydrofuran and 40ml (80mmol) of ZnEt<sub>2</sub> (2M, hexane solution) were charged, and the mixture was cooled to 5°C. Thereto, 34.3ml (80mmol) of 3,4,5-trifluorophenol (2.33M, tetrahydrofuran solution) was added dropwise for 120 minutes. After completion of dropwise addition, stirring was carried out at 5°C for 90 minutes and then, further at 40°C for 70 minutes. Then, the temperature was lowered to 20°C by ice bath, and 0.72ml (40mmol) of H<sub>2</sub>O was added dropwise for 80 minutes. After completion of dropwise addition, stirring was carried out at 20°C for 60 minutes and then, further, at 40°C for 120 minutes. As a result, the mixture was separated into a transparent liquid article and an yellow gel article. After standing them alone at room temperature over night, the volatile components were removed by distillation, and drying was

carried out at 120°C for 8 hours under reduced pressure. As a result, 17.05g of an yellow solid product was obtained.

#### Example 12

5           Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 40ml of tetrahydrofuran and 40ml (80mmol) of ZnEt<sub>2</sub> (2M, hexane solution) were charged, and the mixture was cooled to 5°C. Thereto, 13.7ml (32mmol) of 3,4,5-trifluorophenol  
10           (2.33M, tetrahydrofuran solution) was added dropwise for 45minutes. After completion of dropwise addition, stirring was carried out at 5°C for 90 minutes and then, further at 40°C for 70 minutes. Then, the temperature was lowered to 20°C by ice bath, and 1.30ml (72mmol) of  
15           H<sub>2</sub>O was added dropwise for 145 minutes. After completion of dropwise addition, stirring was carried out at 20°C for 60 minutes and then, further, at 40°C for 120 minutes. As a result, the mixture was separated into a transparent liquid article and an yellow gel article. After standing  
20           them alone at room temperature over night, the volatile components were removed by distillation, and drying was carried out at 120°C for 8 hours under reduced pressure. As a result, 10.39g of an yellow solid product was obtained.

#### 25           Example 13

          Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 40ml of

tetrahydrofuran and 40ml (80mmol) of  $\text{ZnEt}_2$  (2M, hexane solution) were charged, and the mixture was cooled to  $5^\circ\text{C}$ . Thereto, 34.3ml (80mmol) of 3,5-difluorophenol (2.33M, tetrahydrofuran solution) was added dropwise for 120minutes. After completion of dropwise addition, stirring was carried out at  $5^\circ\text{C}$  for 90 minutes and then, further at  $40^\circ\text{C}$  for 70 minutes. Then, the temperature was lowered to  $20^\circ\text{C}$  by ice bath, and 0.72ml (40mmol) of  $\text{H}_2\text{O}$  was added dropwise for 80 minutes. After completion of dropwise addition, stirring was carried out at  $20^\circ\text{C}$  for 60 minutes and then, further, at  $40^\circ\text{C}$  for 120 minutes. As a result, a white yellow slurry article was obtained. After standing it alone at room temperature over night, the volatile components were removed by distillation, and drying was carried out at  $120^\circ\text{C}$  for 8 hours under reduced pressure. As a result, 14.66g of an yellow solid product was obtained.

#### Example 14

Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 40ml of tetrahydrofuran and 40ml (80mmol) of  $\text{ZnEt}_2$  (2M, hexane solution) were charged, and the mixture was cooled to  $5^\circ\text{C}$ . Thereto, 34.3ml (80mmol) of perfluoro-tert-butanol (2.33M, tetrahydrofuran solution) was added dropwise for 120 minutes. After completion of dropwise addition, stirring was carried out at  $5^\circ\text{C}$  for 90 minutes and then, further at  $40^\circ\text{C}$  for 70 minutes. Then, the temperature

was lowered to 20°C by ice bath, and 0.72ml (40mmol) of H<sub>2</sub>O was added dropwise for 80 minutes. After completion of dropwise addition, stirring was carried out at 20°C for 60 minutes and then, further, at 40°C for 120 minutes. As a result, a white yellow solution was obtained. After standing it alone at room temperature over night, the volatile components were removed by distillation, and drying was carried out at 120°C for 8 hours under reduced pressure. As a result, 26.35g of an yellow solid product was obtained.

#### Example 15

Into a 200ml four-necked flask in which the atmosphere was replaced with argon, 40ml of tetrahydrofuran and 40ml (80mmol) of ZnEt<sub>2</sub> (2M, hexane solution) were charged, and the mixture was cooled to 5°C. Thereto, 34.3ml (80mmol) of 1,1,1,3,3,3-hexafluoro-2-propanol (2.33M, tetrahydrofuran solution) was added dropwise for 120 minutes. After completion of dropwise addition, stirring was carried out at 5°C for 90 minutes and then, further at 40°C for 70 minutes. Then, the temperature was lowered to 20°C by ice bath, and 0.72ml (40mmol) of H<sub>2</sub>O was added dropwise for 80 minutes. After completion of dropwise addition, stirring was carried out at 20°C for 60 minutes and then, further, at 40°C for 120 minutes. As a result, a white yellow solution was obtained. After standing it alone at room temperature over night, the volatile components

were removed by distillation, and drying was carried out at 120°C for 8 hours under reduced pressure. As a result, 15.47g of an yellow solid product was obtained.

#### Comparative Example 1

##### 5 (1) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer  
10 were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0μ  
15 mol of ethylenebis(indenyl)zirconium dichloride was charged, 0.1ml (100μmol) of ZnEt<sub>2</sub> (1.02M, hexane solution) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, only a trace  
20 of a polymer was obtained.

#### Example 16

##### (1) Synthesis of μ-oxo-bis(diethylzinc)

Into a 200ml four-necked flask in which the atmosphere was replaced with argon after reduced  
25 pressure drying under vacuum, 10ml (10mmol) of a hexane solution of diethylzinc (1.02mol/L) and 50ml of toluene were charged and the mixture was stirred. Thereto,

89.2mg (4.95mmol) of H<sub>2</sub>O was gradually added dropwise at room temperature.

The content article became opaque in yellow in accordance with proceeding of the reaction. After completion of dropwise addition, stirring was further carried out for 11 hours. The solvent was removed by distillation under reduced pressure, and drying was carried out to obtain 0.245g of an yellow solid.

## (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0μmol of ethylenebis(indenyl)zirconium dichloride was charged, 29.9mg (146μmol) of μ-oxo-bis(diethylzinc) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 0.663g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $1.3 \times 10^6$ g/mol/h. SCB = 13.96,  $[\eta] = 1.30$ dl/g, Mw = 88000, Mw/Mn = 1.9.

## Example 17

## (1) Synthesis of bis(pentafluorophenoxy)zinc

Into a 200ml four-necked flask in which the atmosphere was replaced with argon after reduced pressure drying under vacuum, 50ml of hexane and 10ml (10mmol) of a hexane solution of diethylzinc (1.00mol/L) were charged and the mixture was cooled to  $-78^{\circ}\text{C}$ . Thereto, 20ml (20mmol) of a hexane solution (1.0mol/L) of pentafluorophenol was gradually added dropwise at room temperature. The content article became white slurry in accordance with proceeding of the reaction. After completion of dropwise addition, the temperature was gradually raised to room temperature, and stirring was further carried out for 4 hours. The white solid prepared was separated by filtration with a glass filter, and drying was carried out under reduced pressure to obtain 3.41g (7.90mmol, 79%) of bis(pentafluorophenoxy)zinc as a white solid.

$^{13}\text{C}$ -NMR (THF- $d_8$ ):  $\delta$  141.4 (m, JC-F=233Hz), 141.8 (m), 139.0 (m, JC-F=249Hz), 131.7 (m, JC-F=236Hz)

## (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to  $70^{\circ}\text{C}$ . After the raise of temperature, ethylene was fed while

adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the  
inside of system was stabilized, 0.25mmol of  
triisobutylaluminum was charged, successively, 1.0μ  
mol of ethylenebis(indenyl)zirconium dichloride was  
5 charged, 40mg (92μmol) of the zinc compound obtained  
in the above-mentioned (1) was further charged, and  
polymerization was started. The polymerization was  
carried out for 30 minutes. As a result of the  
polymerization, 1.35g of an ethylene-1-hexene copolymer  
10 was obtained. Polymerization activity was  $2.7 \times 10^6$ g/mol/h. SCB = 16.8,  $[\eta] = 1.41$ dl/g,  $M_w = 97000$ ,  $M_w/M_n = 2.2$ . Melting point was 111.5°C.

#### Example 18

(1) Synthesis of bis(pentafluorophenoxyzincoxy)  
15 methylborane compound

Into a 200ml four-necked flask in which the  
atmosphere was replaced with argon, 655.4mg (10.6mmol)  
of methylboric acid (97%) and 50ml of toluene were  
charged and the mixture was cooled to -78°C. While  
20 vigorously stirring the slurry article, 20.8ml  
(21.2mmol) of ZnEt<sub>2</sub> (1.02M, hexane solution) was added  
dropwise. A white gel precipitate was prepared in  
accordance with increase of the amount of dropwise  
addition. After completion of dropwise addition, the  
25 temperature was gradually raised to room temperature,  
and stirring was further carried out for 2 hours. Thereto,  
11.9ml (21.2mmol) of pentafluorophenol (1.78M, hexane

solution) was gradually added dropwise, and stirring was further carried out for 11 hours. The solvent was removed by distillation under reduced pressure, and drying was carried out to obtain 6.06g of a white powder.

5       (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer  
10       were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0μ  
15       mol of ethylenebis(indenyl)zirconium dichloride was charged, 34.2mg (61.7μmol) of the zinc compound obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the  
20       polymerization, 3.42g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $6.8 \times 10^6$ g/mol/h.

Example 19

(1) Synthesis of compound (I-8)

25       Into a 100ml flask in which the atmosphere was replaced with argon, 18.3ml (18.7mmol) of diethylzinc (1.02M, hexane solution) and 10ml of toluene were

charged and the mixture was cooled to  $-78^{\circ}\text{C}$ . Thereto,  
10.5ml (18.7mmol) of pentafluorophenol (1.78M, hexane  
solution) was gradually added dropwise. After  
completion of dropwise addition, temperature was  
5 gradually raised to room temperature, and stirring was  
further carried out for 1 hour. Then, 10ml of a toluene  
solution of 1.01g (9.36mmol) of 1,3-cyclopentanediol (a  
mixture of cis-isomer and trans-isomer; manufactured by  
Aldrich Co., Ltd.; purity = 95%) was gradually added  
10 dropwise at room temperature, and stirring was carried  
out over night. Then, the solvent was removed by  
distillation under reduced pressure, and the solid  
prepared was dried at room temperature under reduced  
pressure to obtain 5.44g of the compound (I-8).

15 (2) Polymerization

After drying under vacuum an autoclave having an  
inner volume of 400ml equipped with a stirrer and  
replacing the atmosphere thereof with argon, 190ml of  
hexane as a solvent and 10ml of 1-hexene as a comonomer  
20 were charged and the reactor was heated to  $70^{\circ}\text{C}$ . After  
the raise of temperature, ethylene was fed while  
adjusting at an ethylene pressure of  $6\text{kg}/\text{cm}^2$ . After the  
inside of system was stabilized, 0.25mmol of  
triisobutylaluminum was charged, successively,  $1.0\mu$   
25 mol of ethylenebis(indenyl)zirconium dichloride was  
charged, 36.3mg ( $122\mu\text{mol-Zn}$ ) of the compound (I-8)  
obtained in the above-mentioned (1) was further charged,

and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 0.53g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $1.1 \times 10^6$  g/mol/h.

#### Example 20

##### (1) Synthesis of compound (I-9)

Into a 100ml flask in which the atmosphere was replaced with argon, 1.01g (8.04mmol) of 1,2,3-trihydroxybenzene and 30ml of toluene were charged, and the mixture was stirred and cooled to 0°C. Thereto, 15.8ml (16.1mmol) of diethylzinc (1.02M, hexane solution) was added dropwise. After completion of dropwise addition, temperature was gradually raised to room temperature, and stirring was further carried out for 24 hours. Thereto, 4.0ml (8.0mmol) of pentafluorophenol (2M, toluene solution) was added dropwise at room temperature. After completion of dropwise addition, and stirring was further carried out over night. Then, volatile materials were removed by distillation, and the solid prepared was dried at room temperature under reduced pressure to obtain the compound (I-9).

##### (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of

hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the  
5 inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0 μmol of ethylenebis(indenyl)zirconium dichloride was charged, 26.0mg (119 μmol-Zn) of the compound (I-9) obtained in the above-mentioned (1) was further charged,  
10 and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 0.24g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $4.8 \times 10^5$ g/mol/h.

15 Example 21

(1) Synthesis of compound (I-10)

Into a 100ml flask in which the atmosphere was replaced with argon, 1.02g (8.07mmol) of 1,2,3-trihydroxybenzene and 30ml of toluene were charged, and  
20 the mixture was stirred and cooled to 0°C. Thereto, 23.7ml (24.2mmol) of diethylzinc (1.02M, hexane solution) was added dropwise. After completion of dropwise addition, temperature was gradually raised to room temperature, and stirring was further carried out  
25 for 24 hours. Thereto, 12.1ml (24.2mmol) of pentafluorophenol (2M, toluene solution) was added dropwise at room temperature. After completion of

dropwise addition, and stirring was further carried out over night. Then, volatile materials were removed by distillation, and the solid prepared was dried at room temperature under reduced pressure to obtain 7.89g of the compound (I-10).

## (2) Polymerization

After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0μmol of ethylenebis(indenyl)zirconium dichloride was charged, 38.6mg (133μmol-Zn) of the compound (I-10) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was carried out for 30 minutes. As a result of the polymerization, 0.13g of an ethylene-1-hexene copolymer was obtained. Polymerization activity was  $2.6 \times 10^5$ g/mol/h.

## Example 22

### (1) Synthesis of compound (I-11)

Into a 100ml flask in which the atmosphere was replaced with argon, 8.0ml (8.2mmol) of diethylzinc

(1.02M, hexane solution) and 10ml of toluene were charged, and the mixture was stirred and cooled to -78°C. Thereto, 4.6ml (8.2mmol) of pentafluorophenol (1.78M, toluene solution) was gradually added dropwise.

5 After completion of dropwise addition, temperature was gradually raised to room temperature, and stirring was further carried out for 1 hour. Then, 0.97g (2.0mmol) of calix[4]arene (89%) (manufactured by aldrich Co,) (2M, toluene solution) was added, and stirring was carried

10 out over night. Then, volatile materials were removed by distillation, and the solid prepared was dried at room temperature under reduced pressure to obtain 2.52g of the compound (I-11).

## (2) Polymerization

15 After drying under vacuum an autoclave having an inner volume of 400ml equipped with a stirrer and replacing the atmosphere thereof with argon, 190ml of hexane as a solvent and 10ml of 1-hexene as a comonomer were charged and the reactor was heated to 70°C. After

20 the raise of temperature, ethylene was fed while adjusting at an ethylene pressure of 6kg/cm<sup>2</sup>. After the inside of system was stabilized, 0.25mmol of triisobutylaluminum was charged, successively, 1.0 μmol of ethylenebis(indenyl)zirconium dichloride was

25 charged, 41.2mg (117 μmol-Zn) of the compound (I-11) obtained in the above-mentioned (1) was further charged, and polymerization was started. The polymerization was

carried out for 30 minutes. As a result of the polymerization, 0.084g of an ethylene-hexene-1 copolymer was obtained. Polymerization activity was  $1.7 \times 10^5 \text{g/mol/h}$ .

5           As described above in detail, according to the present invention, a compound other than a compound of Group XIII as a compound capable of forming a catalyst for addition polymerization which reveals a high polymerization activity by using as a catalyst aid  
10           component for activation, is provided, and a production method of the compound, a catalyst component for addition polymerization comprising the compound, a catalyst for addition polymerization which is made by using the compound and reveals a high polymerization  
15           activity, and an efficient process for producing an olefin polymer using the catalyst for addition polymerization, are provided.

## CLAIMS:

1. An electron withdrawing group-containing metal compound  
(I) obtained by a process comprising contacting (a),  
5 (b) and (c) described below in the presence of an ether  
compound as a solvent:

(a) a compound represented by the general formula [1],

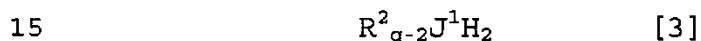


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(b) a compound represented by the general formula [2],



(c) a compound represented by the general formula [3],



wherein in each of the general formulae [1] to [3],  $M^1$   
represents an atom of Group III to XII or the  
lanthanide series of the Periodic Table; c represents a  
20 valence of  $M^1$ ;  $L^1$  represents a hydrogen atom, a halogen  
atom or a hydrocarbon group; when a plural number of  
 $L^1$ 's exist, they may be mutually the same or different;  
 $R^1$  represents a halogen atom-containing group;  $R^2$   
represents a halogenated hydrocarbon group; when a  
25 plural number of  $R^2$ 's exist, they may be mutually the  
same or different; each of  $T^1$  and  $J^1$  independently  
represents a nitrogen atom or an oxygen atom; and each  
of p and q represents a valence of  $T^1$  and  $J^1$ ,  
respectively.

30

2. The compound according to claim 1 wherein  $M^1$  is an atom  
of Group XII.

3. The compound according to claim 2 wherein the atom is zinc.
4. A catalyst compound for addition polymerisation  
5 composed of the electron withdrawing group-containing metal compound (I) of any one of claims 1 to 3.