

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 March 2001 (22.03.2001)

PCT

(10) International Publication Number
WO 01/19786 A1

(51) International Patent Classification⁷: C07C 251/24,
211/55, 223/06, C07D 317/28

(74) Agent: BELL, Catherine, L.; Frohwitter, Three River-
way, Suite 500, Houston, TX 77056 (US).

(21) International Application Number: PCT/US99/21156

(22) International Filing Date:
10 September 1999 (10.09.1999)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): SYMYX
TECHNOLOGIES [US/US]; 3100 Central Expressway,
Santa Clara, CA 95051 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): GURAM, Anil, S.
[IN/US]; 19930-D Olivewood Street, Cupertino, CA 95014
(US). LUND, Cheryl [US/US]; 1410 Cuciz Lane, Milpitas,
CA 95035 (US). TURNER, Howard, W. [US/US]; 2948
Massih Court, Campbell, CA 95008 (US). UNO, Tetsuo
[JP/US]; 480 Warren Drive #530, San Francisco, CA 94131
(US).

(81) Designated States (national): AE, AL, AM, AT, AU, AZ,
BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK,
DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL,
IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU,
LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO,
RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG,
US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,
KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM,
AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT,
BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,
GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: CATALYST LIGANDS, CATALYTIC METAL COMPLEXES AND PROCESSES USING AND METHODS OF MAK-
ING SAME

(57) Abstract: New ligands that include a benzene ring in the backbone can be combined with a metal or metal precursor compound or formed into a metal-ligand complex catalyze a number of different chemical transformations, including olefin polymerization reactions. The ligands, complexes formed with the ligands and compositions including the ligands are useful catalysts, depending on the reaction.

WO 01/19786 A1

5 **CATALYST LIGANDS, CATALYTIC METAL COMPLEXES AND
 PROCESSES USING AND METHODS OF MAKING SAME**

 FIELD OF THE INVENTION

10 The present invention relates to new organic compounds (e.g., ligands),
their metal complexes and compositions using those compounds; the invention
also relates to the field of catalysis. In particular, this invention relates to new
compounds which when combined with suitable metals or metal precursor
compounds provide useful catalysts for various bond-forming reactions,
15 including polymerizations and small molecule transformations. The invention
also relates to combinatorial chemistry in that combinatorial techniques were
used in connection with creating the ligands and testing compositions containing
the ligands.

20 BACKGROUND OF THE INVENTION

 Ancillary (or spectator) ligand-metal coordination complexes (e.g.,
organometallic complexes) and compositions are useful as catalysts, additives,
stoichiometric reagents, monomers, solid state precursors, therapeutic reagents
25 and drugs. Ancillary ligand-metal coordination complexes of this type can be
prepared by combining an ancillary ligand with a suitable metal compound or
metal precursor in a suitable solvent at a suitable temperature. The ancillary
ligand contains functional groups that bind to the metal center(s), remain
associated with the metal center(s), and therefore provide an opportunity to
30 modify the steric, electronic and chemical properties of the active metal center(s)
of the complex.

 Certain known ancillary ligand-metal complexes and compositions are
catalysts for reactions such as oxidation, reduction, hydrogenation,
hydrosilylation, hydrocyanation, hydroformylation, polymerization,
35 carbonylation, isomerization, metathesis, carbon-hydrogen activation, carbon-
halogen activation, cross-coupling, Friedel-Crafts acylation and alkylation,

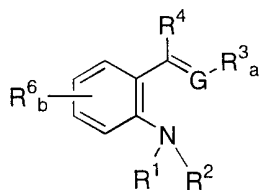
hydration, dimerization, trimerization, oligomerization, Diels-Alder reactions and other transformations. See, e.g., U.S. patents nos. 5,576,460 and 5,550,236, both of which are incorporated herein by reference.

One example of the use of these types of ancillary ligand-metal
5 complexes and compositions is in the field of polymerization catalysis. In connection with single site catalysis, the ancillary ligand offers opportunities to modify the electronic and/or steric environment surrounding an active metal center. This allows the ancillary ligand to create possibly different polymers. Ancillary ligands and ancillary metal complexes that are similar to those
10 disclosed herein have been discussed in WO 98/30609, incorporated herein by reference for all purposes. However, that application does not specifically disclose any of the ligands, complexes or compositions disclosed herein and does not disclose any method of making the ligands (i.e., the ancillary ligands) of this invention.

15 It is always a desire to discover new ancillary ligands, which upon coordination to a metal center or addition of a metal compound or precursor will catalyze or assist in catalysis of reactions differently from known ligand systems. This invention provides new ancillary ligands that may be used for coordination to a metal center or included in a composition with a metal or metal precursor
20 compound. Upon coordination to the metal center or inclusion in the composition, such ligands influence the electronic and steric environment of the resulting coordination complex and may catalyze reactions differently, including more efficiently and selectively than known systems.

SUMMARY OF THE INVENTION

In a first aspect, the invention disclosed herein is a new ligand (i.e., an ancillary ligand), which can be characterized by the general formula:

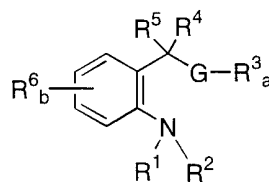


5

wherein each R^1 , R^2 , R^3 , R^4 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure and/or R^1 and R^6 are joined together in a ring structure; and b is 0, 1, 2, 3 or 4. Where b is at least 2, two R^6 groups may be joined in a fused ring structure with the benzene ring in the backbone of the ligand. G is either oxygen or nitrogen. When G is oxygen, a is 0. When G is nitrogen, a is 1.

15

In a second aspect, this invention is a compound characterized by the general formula:



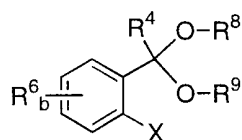
20

wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure and/or R^1

25

and R⁶ are joined together in a ring structure; G is either oxygen or nitrogen and a is either 1 or 2 depending on G; and b is 0, 1, 2, 3 or 4. When G is nitrogen and a is 2, the two R³ groups may also join to form a ring structure.

This invention also relates to a novel method of making these new
 5 ligands. The general method of making these ligands is to start with a compound characterized by the general formula:



wherein R⁴ and R⁶ are as defined above and X is selected from the group consisting of chloro, bromo, iodo, triflate, tosylate and nonaflate; and R⁸ and R⁹
 10 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof. This compound is reacted with an amine
 15 characterized by the general formula HNR¹R², where R¹ and R² are as defined above. This provides ligands within the second aspect. Optionally, an acetyl or ketal functionality of the product is then hydrolyzed, providing ligands within the first aspect. Thereafter, the product can be reacted with a primary or secondary amine to transform the ligand. Hydrogenation is thereafter an
 20 optional step. All steps may or may not be performed using parallel or high throughput or combinatorial methods.

In yet another aspect, this invention provides new metal-ligand complexes or compositions comprising the new ligands and a metal precursor. For catalysis, the ligands can be included in a composition including a suitable
 25 metal or metal precursor compound that can be of the form ML_n, where the composition has catalytic properties. Also, the ligands can be coordinated with a metal precursor to form metal-ligand complexes, which may be catalysts. Depending on the groups chosen for R¹, R² and R³ in the ligand (i.e., prior to reaction with the metal precursor), the metal-ligand complexes can be

characterized by one of many different general formulas depending on how the ligand attaches to or associates with the metal.

A further aspect of this invention provides for the novel ligands, compositions or complexes to be created and tested in a combinatorial manner.

5 Thus, the ligands, compositions or complexes may be in an array with each ligand, composition or complex in a different region of a substrate. The number of ligands, compositions or complexes on a single substrate will vary according to the desired density, but will typically have at least 10 ligands, compositions or complexes on a single substrate.

10 These metal-ligand complexes or compositions catalyze polymerization and copolymerization reactions, particularly with monomers that are olefins, diolefins or otherwise acetylenically unsaturated. Other reactions that can be catalyzed include activation of and/or formation of H-Si, H-H, H-N, H-O, H-P, H-S, C-H, C-C, C=C, C• C, C-halogen, C-N, C-O, C-S, C-P, and C-Si bonds.
15 Specifically, such reactions include carbonylation, hydroformylation, hydroxycarbonylation, hydrocarbonylation, hydroesterification, hydrogenation, transfer hydrogenation, hydrosilylation, hydroboration, hydroamination, epoxidation, aziridation, reductive amination, C-H activation, insertion, C-H activation-insertion, C-H activation-substitution, C-halogen activation, C-
20 halogen activation-substitution, C-halogen activation-insertion, cyclopropanation, alkene metathesis, alkene oligomerization, alkene polymerization, alkyne oligomerization, alkyne polymerization, CO-alkene co-oligomerization, CO-alkene co-polymerization, CO-alkyne co-oligomerization and CO-alkyne co-polymerization.

25 Thus, in another aspect of the invention, a polymerization process is disclosed for olefins, diolefins and other acetylenically unsaturated compounds. The polymerization process involves contacting monomers to the catalyst compositions or to the coordination complexes of this invention under polymerization conditions. The catalyst compositions or the coordination
30 complexes may be active catalysts themselves or make be activated with a known activating technique or compound. The polymerization process can be continuous, batch or semi-batch and can be homogeneous or heterogeneous, as discussed further below.

Further aspects of this invention will be evident to those of skill in the art upon review of this specification.

DETAILED DESCRIPTION OF THE INVENTION

5

The inventions disclosed herein are new ligands that may be combined with metals or metal precursor compounds to form coordination complexes or compositions of matter, which are useful as catalysts for chemical reactions. The invention also is for processes for making the ligand, processes for making
10 the metal complexes and processes for using the resultant composition or coordination complex as a catalyst. Finally, the invention provides these new compounds and compositions and complexes in an array format.

As used herein, the phrase "characterized by the formula" is not intended to be limiting and is used in the same way that "comprising" is commonly used.
15 The term "independently selected" is used herein to indicate that the R groups, e.g., R¹, R², R³, R⁴, and R⁵ can be identical or different (e.g. R¹, R², R³, R⁴, and R⁵ may all be substituted alkyls or R¹ and R² may be a substituted alkyl and R³ may be an aryl, etc.). A named R group will generally have the structure that is recognized in the art as corresponding to R groups having that name. For the
20 purposes of illustration, representative R groups as enumerated above are defined herein. These definitions are intended to supplement and illustrate, not preclude, the definitions known to those of skill in the art.

The term "alkyl" is used herein to refer to a branched or unbranched, saturated or unsaturated acyclic hydrocarbon radical. Suitable alkyl radicals
25 include, for example, methyl, ethyl, n-propyl, i-propyl, 2-propenyl (or allyl), vinyl, n-butyl, t-butyl, i-butyl (or 2-methylpropyl), etc. In particular embodiments, alkyls have between 1 and 200 carbon atoms, between 1 and 50 carbon atoms or between 1 and 20 carbon atoms.

"Substituted alkyl" refers to an alkyl as just described in which one or
30 more hydrogen atom to any carbon of the alkyl is replaced by another group such as a halogen, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, and combinations thereof. Suitable substituted alkyls include, for example, benzyl, trifluoromethyl and the like.

The term "heteroalkyl" refers to an alkyl as described above in which one

or more hydrogen atoms to any carbon of the alkyl is replaced by a heteroatom selected from the group consisting of N, O, P, B, S, Si, Se and Ge. The bond between the carbon atom and the heteroatom may be saturated or unsaturated. Thus, an alkyl substituted with a heterocycloalkyl, substituted heterocycloalkyl, 5 heteroaryl, substituted heteroaryl, alkoxy, aryloxy, boryl, phosphino, amino, silyl, thio, or seleno is within the scope of the term heteroalkyl. Suitable heteroalkyls include cyano, benzoyl, 2-pyridyl, 2-furyl and the like.

The term "cycloalkyl" is used herein to refer to a saturated or unsaturated cyclic non-aromatic hydrocarbon radical having a single ring or multiple 10 condensed rings. Suitable cycloalkyl radicals include, for example, cyclopentyl, cyclohexyl, cyclooctenyl, bicyclooctyl, etc. In particular embodiments, cycloalkyls have between 3 and 200 carbon atoms, between 3 and 50 carbon atoms or between 3 and 20 carbon atoms.

"Substituted cycloalkyl" refers to cycloalkyl as just described including 15 in which one or more hydrogen atom to any carbon of the cycloalkyl is replaced by another group such as a halogen, alkyl, substituted alkyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, boryl, phosphino, amino, silyl, thio, seleno and combinations thereof. Suitable 20 substituted cycloalkyl radicals include, for example, 4-dimethylaminocyclohexyl, 4,5-dibromocyclohept-4-enyl, and the like.

The term "heterocycloalkyl" is used herein to refer to a cycloalkyl radical as described, but in which one or more or all carbon atoms of the saturated or 25 unsaturated cyclic radical are replaced by a heteroatom such as nitrogen, phosphorous, oxygen, sulfur, silicon, germanium, selenium, or boron. Suitable heterocycloalkyls include, for example, piperazinyl, morpholinyl, tetrahydropyranyl, tetrahydrofuranyl, piperidinyl, pyrrolidinyl, oxazolinyl and the like.

"Substituted heterocycloalkyl" refers to heterocycloalkyl as just 30 described including in which one or more hydrogen atom to any atom of the heterocycloalkyl is replaced by another group such as a halogen, alkyl, substituted alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, boryl, phosphino, amino, silyl, thio, seleno and combinations thereof. Suitable substituted heterocycloalkyl radicals include, for example, N-

methylpiperazinyl, 3-dimethylaminomorpholinyl and the like.

The term "aryl" is used herein to refer to an aromatic substituent which may be a single aromatic ring or multiple aromatic rings which are fused together, linked covalently, or linked to a common group such as a methylene or ethylene moiety. The common linking group may also be a carbonyl as in benzophenone or oxygen as in diphenylether or nitrogen in diphenylamine. The aromatic ring(s) may include phenyl, naphthyl, biphenyl, diphenylether, diphenylamine and benzophenone among others. In particular embodiments, aryls have between 1 and 200 carbon atoms, between 1 and 50 carbon atoms or between 1 and 20 carbon atoms.

"Substituted aryl" refers to aryl as just described in which one or more hydrogen atom to any carbon is replaced by one or more functional groups such as alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, halogen, alkylhalos (e.g., CF₃), hydroxy, amino, phosphido, alkoxy, amino, thio and both saturated and unsaturated cyclic hydrocarbons which are fused to the aromatic ring(s), linked covalently or linked to a common group such as a methylene or ethylene moiety. The linking group may also be a carbonyl such as in cyclohexyl phenyl ketone.

The term "heteroaryl" as used herein refers to aromatic rings in which one or more carbon atoms of the aromatic ring(s) are replaced by a heteroatom(s) such as nitrogen, oxygen, boron, selenium, phosphorus, silicon or sulfur. Heteroaryl refers to structures that may be a single aromatic ring, multiple aromatic ring(s), or one or more aromatic rings coupled to one or more non-aromatic ring(s). In structures having multiple rings, the rings can be fused together, linked covalently, or linked to a common group such as a methylene or ethylene moiety. The common linking group may also be a carbonyl as in phenyl pyridyl ketone. As used herein, rings such as thiophene, pyridine, isoxazole, phthalimide, pyrazole, indole, furan, etc. or benzo-fused analogues of these rings are defined by the term "heteroaryl."

"Substituted heteroaryl" refers to heteroaryl as just described including in which one or more hydrogen atoms to any atom of the heteroaryl moiety is replaced by another group such as a halogen, alkyl, substituted alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, boryl, phosphino, amino, silyl, thio, seleno and combinations thereof. Suitable

substituted heteroaryl radicals include, for example, 4-N,N-dimethylaminopyridine.

The term "alkoxy" is used herein to refer to the $-OZ^1$ radical, where Z^1 is selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, silyl groups and combinations thereof as described herein. Suitable alkoxy radicals include, for example, methoxy, ethoxy, benzyloxy, t-butoxy, etc. A related term is "aryloxy" where Z^1 is selected from the group consisting of aryl, substituted aryl, heteroaryl, substituted heteroaryl, and combinations thereof. Examples of suitable aryloxy radicals include phenoxy, substituted phenoxy, 2-pyridinoxy, 8-quinolinoxy and the like.

As used herein the term "silyl" refers to the $-SiZ^1Z^2Z^3$ radical, where each of Z^1 , Z^2 , and Z^3 is independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, heterocycloalkyl, heterocyclic, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino, silyl and combinations thereof.

As used herein the term "boryl" refers to the $-BZ^1Z^2$ group, where each of Z^1 and Z^2 is independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, heterocycloalkyl, heterocyclic, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino, silyl and combinations thereof.

As used herein, the term "phosphino" refers to the group $-PZ^1Z^2$, where each of Z^1 and Z^2 is independently selected from the group consisting of hydrogen, substituted or unsubstituted alkyl, cycloalkyl, heterocycloalkyl, heterocyclic, aryl, heteroaryl, silyl, alkoxy, aryloxy, amino and combinations thereof.

The term "amino" is used herein to refer to the group $-NZ^1Z^2$, where each of Z^1 and Z^2 is independently selected from the group consisting of hydrogen; alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl and combinations thereof.

The term "thio" is used herein to refer to the group $-SZ^1$, where Z^1 is selected from the group consisting of hydrogen; alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted

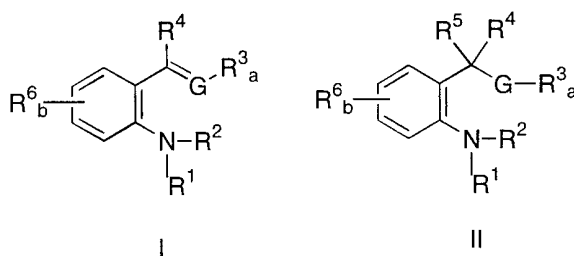
heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl and combinations thereof.

The term "seleno" is used herein to refer to the group $-\text{SeZ}^1$, where Z^1 is selected from the group consisting of hydrogen; alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl and combinations thereof.

The term "saturated" refers to lack of double and triple bonds between atoms of a radical group such as ethyl, cyclohexyl, pyrrolidinyl, and the like.

The term "unsaturated" refers to the presence one or more double and triple bonds between atoms of a radical group such as vinyl, acetylenyl, oxazolinyl, cyclohexenyl, acetyl and the like.

The new ligands of this invention can be characterized by either of the general formulas:



15

wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure; and b is 0, 1, 2, 3 or 4. G is an element selected from the group consisting of oxygen and nitrogen. In connection with structure I, a is 0 when G is oxygen and a is 1 when G is nitrogen. In connection with structure II, a is 1 when G is oxygen and a is 2 when G is nitrogen. Also in connection with structure II, when a is 2, the two R^3 groups may be the same or different and optionally may be joined together in a ring structure.

In more specific embodiments, R^1 and R^2 are independently selected from a group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl and silyl. Specific examples of R^1 and R^2 are hydrogen, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl, and the like. In those embodiments where R^1 and R^2 are joined together in a ring structure, the ring (including R^1 , R^2 and N) has from 3 to 15 non-hydrogen atoms as part of the backbone of the ring. Specific examples of R^1 and R^2 together are ethylene (giving a 3-member ring), propylene (giving a 4-membered ring), butylene (giving a 5-membered ring), 3-oxopentylene (giving a 6-membered ring) and the like.

In a preferred embodiment, R^1 is a substituted or unsubstituted phenyl and R^2 is hydrogen. If R^1 is a substituted phenyl, there may be 1, 2, 3, 4 or 5 substituents attached to carbon atoms in the phenyl ring. Each of these substituents may be independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof. More preferably, there are 1, 2 or 3 substituents on the substituted phenyl and the substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

More specifically, R^3 is selected from a group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkyloxy, aryloxy, amino, silyl, boryl and phosphino. Specific examples of R^3 are methyl, ethyl, propyl, butyl, cyclohexyl, cyclopropyl, cycloheptyl, t-butyl, phenyl, biphenyl, naphthyl, benzyl, pyridyl, furyl, quinolyl, morpholinyl, cyano, methoxy, ethoxy, t-butoxy, phenoxy, benzyloxy, dimethylamino, diethylamino, diphenylamino, phenylmethylamino, benzylmethylamino, trimethylsilyl, dimethyl-t-butylsilyl, triphenylsilyl, triethoxysilyl, dimethylboryl, diphenylboryl, diphenoxyboryl, 1,2-

dioxyphenylboryl, 2,2'-biphenoxyboryl, 2,2'-dinaphthoxyboryl, diphenylphosphino, dibutylphosphino, dimethylphosphino, dicyclohexylphosphino, dicyclopentylphosphino, nitro, and methylphenylphosphino.

- 5 Most preferably, R^3 is benzyl or a substituted or unsubstituted phenyl. Where R^3 is a substituted phenyl and there are 1, 2, 3, 4 or 5 substituents on the phenyl ring, with each of said substituents independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, hydroxy, halogens, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof. Preferably in those embodiments there are 1, 2 or 3 substituents on the substituted phenyl and the substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.
- 10
- 15

- Also in more specific embodiments, R^4 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkyloxy, aryloxy, boryl, amino and silyl. In yet other embodiments, R^4 may be selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl. Specific examples of R^4 are hydrogen, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, pyridyl, furyl, morpholino, methoxy, ethoxy, butoxy, phenoxy, benzyloxy, dimethylboryl, diphenylboryl, methylphenylboryl, dimethylamino, diethylamino, diphenylamino, dibenzylamino, trimethylsilyl, triethoxysilyl, triphenylsilyl, triphenoxysilyl, dimethyl-t-butylsilyl, and the like.
- 20
- 25

- In some embodiments where R^3 and R^4 are joined together in a ring structure, the ring (including R^3 , R^4 , G and C) has from 4 to 15 non-hydrogen atoms as part of the backbone of the ring. In connection with structure I, G is nitrogen and a is 1 and R^3 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino and combinations thereof. Specific examples of R^3 and R^4 together are ethylene
- 30

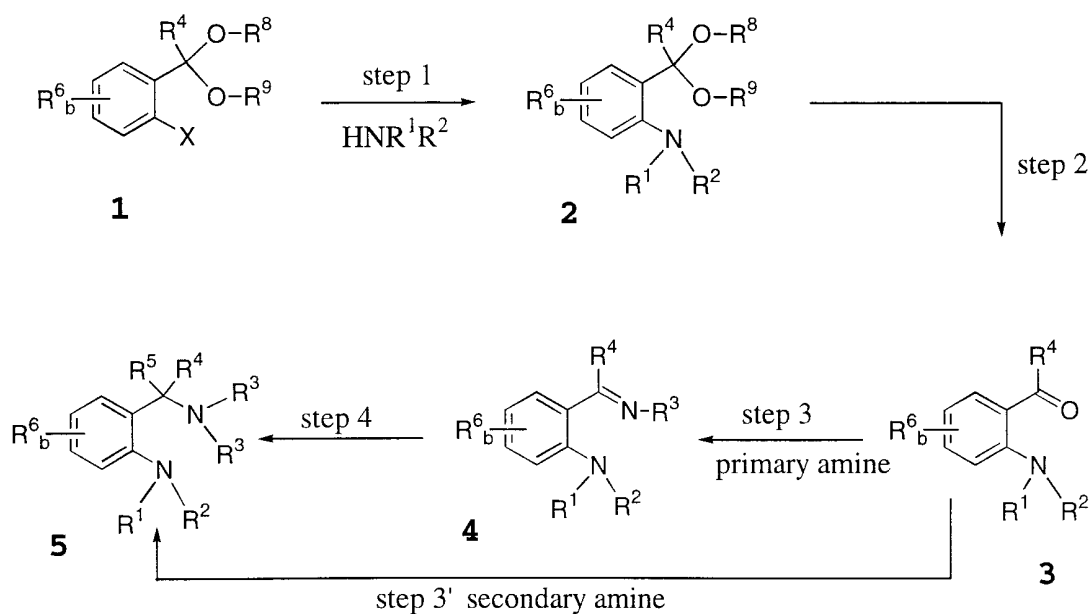
(giving a 4-membered ring), butylene (giving a 6-membered ring), bicyclooctyl, bicyclohexyl, 2,2'-biphenyl (giving a dibenzo fused 6-membered ring), 2,2'-binaphthyl (giving a dinaphtho fused 6-membered ring), 2,2'-biphenoxy (giving a 8-membered ring), 2,2'-dinaphthoxy (giving a 8-membered ring) and diethoxy
5 (giving a 6-membered ring).

Also in more specific embodiments, R^6 is selected from the group consisting of electron withdrawing and electron donating groups and b is 0, 1, 2, 3 or 4. R^6 can take any open position on the benzene ring that helps form the backbone of the ligand. More specifically, R^6 may be chosen from the group
10 consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, silyl, amino, alkoxy, aryloxy, phosphino, boryl, transition metals, halogens and combinations thereof. Specific examples of R^6 include methyl, ethyl, propyl, t-butyl, phenyl, cyano, acetyl, benzyl, nitro,
15 dimethylamino, diethylamino, methylphenylamino, benzylmethylamino, trimethylsilyl, dimethylboryl, diphenylboryl, methylphenylboryl, dimethoxyboryl, chromium tricarbonyl, ruthenium tricarbonyl, and cyclopentadienyl iron. Optionally, two or more R^5 groups combine to form a fused ring structure with the aromatic group that forms a part of the ligand
20 backbone. The additional fused ring may or may not contain a heteroatom. Examples of the aromatic group that is part of the backbone as combined with two or more R^6 groups that have formed a fused ring are naphthalene, quinoline, indole and the like.

In connection with structure II, R^5 is present. R^5 may be selected from
25 the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl. In more specific embodiments, R^5 is selected from the group consisting of hydrogen, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, pyridyl, furyl, morpholino,
30 methoxy, ethoxy, butoxy, phenoxy, benzyloxy, dimethylboryl, diphenylboryl, methylphenylboryl, dimethylamino, diethylamino, diphenylamino, dibenzylamino, trimethylsilyl, triethoxysilyl, triphenylsilyl, triphenoxysilyl, dimethyl-t-butylsilyl, and the like. Also in connection with structure II, R^5 may be joined in a ring structure with G and R^3 in the backbone of the ring. Such a

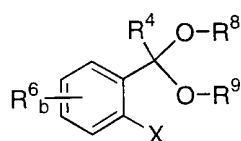
ring will have at least four atoms in the backbone of the ring. In the case of a ring, G can be oxygen or nitrogen and R^3 forms a methylene bridge to R^5 . In this case, R^5 is alkoxy, so that the ring has at least five atoms in the backbone of the ring, as follows: $C-O-(CH_2)_x-CH_2-O$, with the last O being bonded to the first C and x denoting the length of the alkyl portion of R^5 . In yet other embodiments, R^4 and R^5 are joined in a ring structure, having at least three atoms in the backbone. Where R^4 and R^5 are joined together in a ring structure, the ring (including R^4 , R^5 and C) has from 3 to 15 non-hydrogen atoms as part of the backbone of the ring. Specific examples of R^4 and R^5 together are ethylene (giving a 3-member ring), propylene (giving a 4-membered ring), butylene (giving a 5-membered ring), 3-oxopentylene (giving a 6-membered ring) and the like.

The ligands of this invention may be synthesized using an aryl amination reaction. The synthesis can be carried out in solution phase or solid phase (using organic or inorganic supports). For solid-phase synthesis, the ligands may be left on the support and used with metal added metal complexes as heterogeneous catalysts. Alternatively, the ligands can be cleaved either before or after reaction with a metal precursor and then used as a homogeneous catalyst. One the general route for synthesis of the ligands of this invention is shown below in scheme 1:

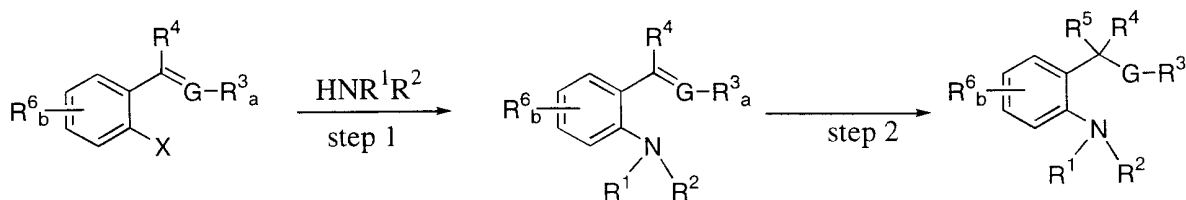


Scheme 1

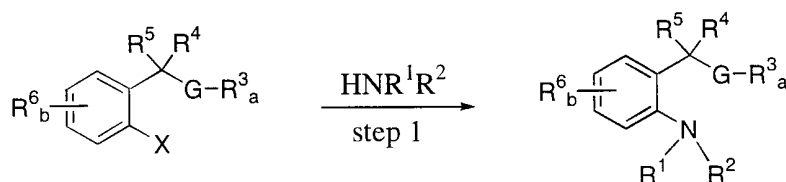
As shown in scheme 1, compounds 3 and 4 are within general structure I above, and compounds 2 and 5 are within general structure II above. Generally, the synthesis employs an aryl amination reaction to attach the nitrogen group to the benzene ring at the appropriate location. Following scheme 1, above, step 1 is an aryl amination reaction starting with a compound characterized by the general formula:



- wherein R^4 and R^6 are as defined above and X is selected from the group consisting of chloro, bromo, iodo, triflate, nonaflate, alkyl sulfonates, aryl sulfonates and tosylate; and R^8 and R^9 are independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof. Compounds of this type can be purchased from Aldrich Chemical or prepared using known techniques. See, e.g., Greene, Theodora W. and Wuts, Peter G.M., *Protecting Groups in Organic Synthesis*, 2nd Edition (John Wiley & Sons, New York, New York 1991).
- The aryl amination reaction could also start with other compounds, such as those characterized by the following general formulas in the following Schemes 2 and 3:



Scheme 2



Scheme 3

In these schemes, the variable groups have the previously indicated meanings.

Step 1 in any scheme is the aryl amination reaction. This reaction uses an amine that can be characterized by the general formula HNR^1R^2 , where R^1 and R^2 are as defined above. This aryl amination reaction is typically performed using a catalyst that comprises known or possibly new metal and ligand catalyst compositions. For example, the catalyst may be characterized by the general formula M'/L' , where M' is a complex that contains a metal selected from the group consisting of late transition metals, preferably a Group 10 metal such as Pd, Ni or Pt. M' is any homogeneous or heterogeneous metal precursor catalyst or catalyst, L' is a ligand that may be selected from the group consisting of phosphine or nitrogen ligands. L' may be monodentate, bidentate, tridentate, hemi-labile, unsubstituted or substituted, supported or unsupported, water-soluble or insoluble, soluble or insoluble in organic solvents including fluorinated solvents. The reaction can take place at known conditions, such as a temperature of from room temperature to about 150°C . Aryl amination reactions are described in U.S. Patent No. 5,576,460 herein incorporated by reference.

Referring now to scheme 1, the second step of the reaction converts compound 2 to compound 3 by hydrolysis of an acetal or ketal functionality. This reaction can be performed by one of skill in the art. See, e.g., Greene, Theodora W. and Wuts, Peter G.M., *Protecting Groups in Organic Synthesis*, 2nd

Edition (John Wiley & Sons, New York, New York 1991), herein incorporated by reference.

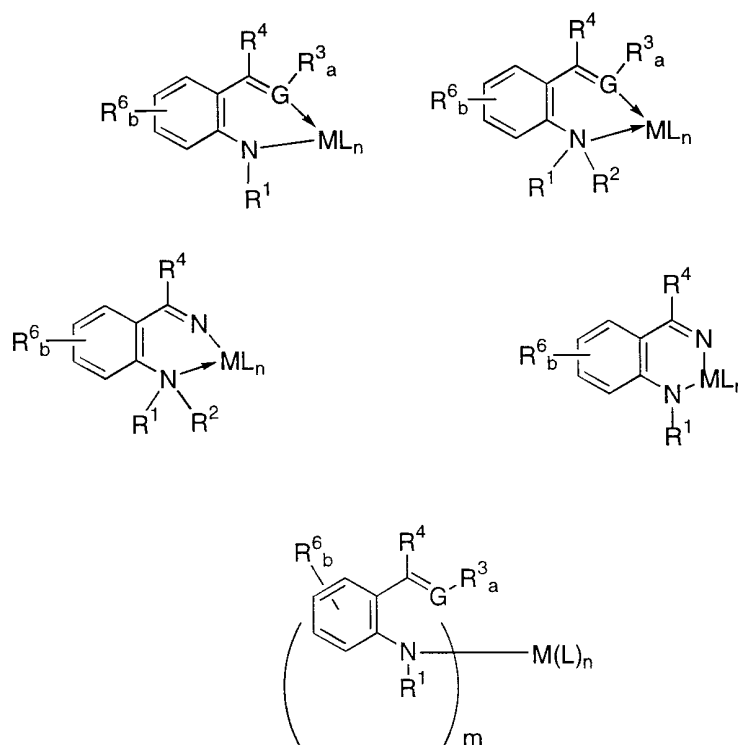
Thereafter in scheme 1, compound 3 can be reacted with a primary or secondary amine for transform the ligand. The primary or secondary amine in
5 step 3 or 3' can be characterized by the general formula $H_{3-a}NR^3_a$, where R^3 is as defined above and a is 1 for a primary amine and a is 2 for a secondary amine. A primary amine provides compound 4 in above scheme 1 following step 3. A secondary amine in the presence of a hydride source provides a compound within above general ligand structure II in above scheme 1 following step 3'. If
10 a primary amine is employed, hydrogenation is thereafter an optional fourth step in scheme 1.

Once the desired ligand is formed, it may be combined with a metal atom, ion, compound or other metal precursor compound. In many applications, the ligands of this invention will be combined with such a metal compound or
15 precursor and the product of such combination is not determined, if a product forms. For example, the ligand may be added to a reaction vessel at the same time as the metal or metal precursor compound along with the reactants. The metal precursor compounds may be characterized by the general formula $M(L)_n$ where M is a metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8,
20 9 and 10 of the Periodic Table of Elements. In more specific embodiments, M is selected from the group consisting of Ti, Zr, Hf, V, Ta, Cr, W, Mo, Ru, Co, Ni, Pd, Fe, Mn, and Pt. L is a ligand chosen from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted
25 heteroaryl, alkoxy, aryloxy, hydroxy, boryl, silyl, hydrido, thio, seleno, phosphino, amino, and combinations thereof. When L is a charged ligand, L is selected from the group consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted
30 heteroaryl, alkoxy, aryloxy, acetoxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof. When L is a neutral ligand, L is selected from the group consisting of carbon monoxide, isocyanide, dibenzylideneacetone, nitrous oxide, PA_3 , NA_3 , OA_2 , SA_2 , SeA_2 , and combinations thereof, wherein each A is independently selected from a group consisting of alkyl, substituted alkyl,

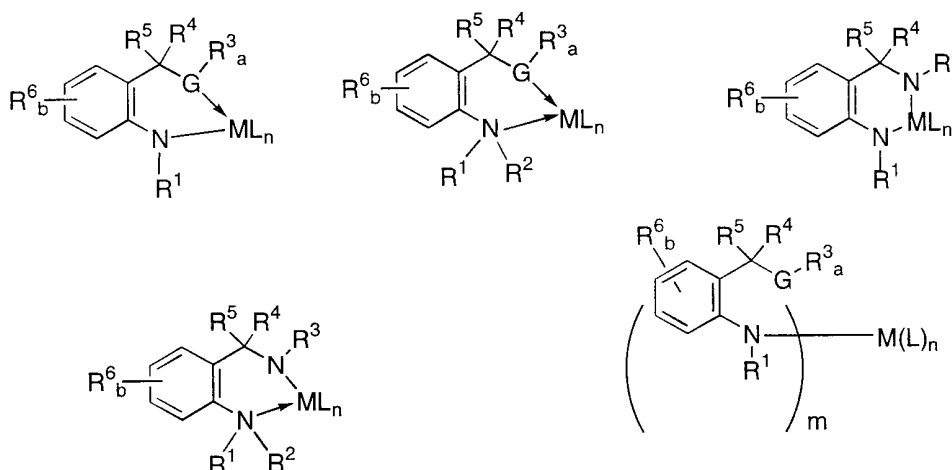
heteroalkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, and amino. Specific examples of suitable metal precursor compounds include $\text{Pd}(\text{dba})_2$ (dba = dibenzylideneacetone), $\text{Pd}(\text{OAc})_2$ (Ac = acetate) and the like. In this context, the ligand to metal precursor compound ratio is in the range of about 0.01:1 to about 100:1, more preferably in the range of about 0.5:1 to about 20:1.

In other applications, the ligand will be mixed with a suitable metal precursor compound prior to or simultaneous with allowing the mixture to be contacted to the reactants. When the ligand is mixed with the metal precursor compound, a metal-ligand complex may be formed, which may be a catalyst.

Depending on the substituents chosen for the ligand prior to reaction with the metal precursor compound, the metal complexes may be characterized by any of the following general formulas. For general ligand structure I, the possible metal complexes formed include:



For general ligand structure II, the possible metal complexes formed include:



In each of these formulas, each R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , G , a and b are as defined
 5 above; and

M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements. Selection of the metal is most preferably dependent on whether the ligand is monoanionic or dianionic. In more specific embodiments, M is selected from the group consisting of V, Ta,
 10 Cr, W, Mo, Ru, Co, Ni, Pd, Fe, Mn and Pt.

L is independently each occurrence, a neutral and/or charged ligand. Generally, L is a ligand chosen from the group consisting of halide, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy,
 15 aryloxy, hydroxy, boryl, silyl, hydrido, thio, seleno, phosphino, amino, and combinations thereof. When L is a charged ligand, L is selected from the group consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl,
 20 phosphino, amino, thio, seleno, and combinations thereof. When L is a neutral ligand, L is selected from the group consisting of carbon monoxide, isocyanide, nitrous oxide, PA_3 , NA_3 , OA_2 , SA_2 , SeA_2 , and combinations thereof, wherein each A is independently selected from a group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl,

substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, and amino.

n is the number 0, 1, 2, 3, 4, and 5. Additionally, m is 1, 2, 3, or 4. M can be neutral, cationic or anionic. In this form, the ligands of this invention that
5 bind to a metal via the N atoms with dative bonds are shown with arrows and covalent binding is shown with a line. Coordination modes described above may or may not depend on the nature of ligands L on the metal M, and for a given ligand L, the coordination modes may switch from one to another at different stages of a catalytic cycle.

10 These transition metal-ligand complexes or metal/ligand compositions of matter catalyze reactions involving activation of and formation of bonds between H-Si, H-H, H-N, H-O, H-P, H-S, C-H, C-C, C=C, C• C, C-halogen, C-N, C-O, C-S, C-P, and C-Si. Specifically, such reactions include carbonylation, hydroformylation, hydroxycarbonylation, hydrocarbonylation,
15 hydroesterification, hydrogenation, hydrosilylation, hydroboration, hydroamination, epoxidation, aziridation, reductive amination, C-H activation, insertion, C-H activation-insertion, C-H activation-substitution, C-halogen activation, C-halogen activation-substitution, C-halogen activation-insertion, alkene metathesis, polymerization, alkene oligomerization, alkene
20 polymerization, alkyne oligomerization, alkyne polymerization, co-polymerization, CO-alkene co-oligomerization, CO-alkene co-polymerization, CO-alkyne co-oligomerization and CO-alkyne co-polymerization. These reactions may occur at previously known conditions (or possibly novel conditions). Moreover, these reactions may be homogeneous or heterogeneous.
25 In the case of heterogeneous reactions, the ligands may be supported, with or without the metal coordinated, on an organic or inorganic support. Suitable supports include silicas, aluminas, zeolites, polyethyleneglycols, polystyrenes, polyesters, polyamides, peptides and the like.

Polymerization catalysis with the compositions and metal complexes of
30 this invention is a particularly effective process. In particular, the complexes and compositions of this invention are active catalysts also for the polymerization of olefins, possibly in combination with an activator or activating technique. When an activator or activating technique is used, those of skill in the art may use alumoxanes, strong Lewis acids, compatible noninterfering

activators and combinations of the foregoing. The foregoing activators have been taught for use with different metal complexes in the following references, which are hereby incorporated by reference in their entirety: U.S. Patents 5,599,761, 5,616,664, 5,453,410, 5,153,157, 5,064,802, and EP-A-277,004.

- 5 Preferred activators include methylalumoxane, trimethylaluminum, AgBF_4 , AgBPh_4 , NaBAR'_4 , $\text{H}(\text{OEt}_2)_2\text{BAR}'_4$ and the like (where Ar' is a substituted aromatic, like perfluorophenyl or 3,5- $(\text{CF}_3)_2(\text{C}_6\text{H}_3)$).

Ratios of neutral complex to activator are on the order of 1 to 1000 to 1000 to 1. A scavenger can also be used with this invention. Scavengers useful
10 herein include metal complexes, alumoxanes, aluminum alkyls and the like. Other additives that are standard for polymerization reactions can be used.

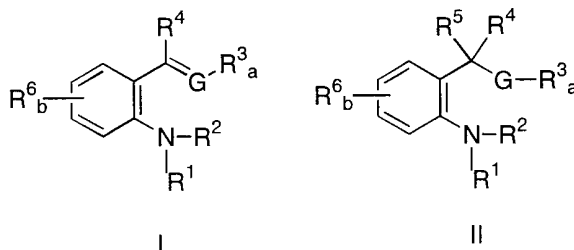
The catalysts herein may be used to polymerize ethylenically or acetylenically unsaturated monomers having from 2 to 20 carbon atoms either alone or in combination. Monomers include C_2 to C_{20} • -olefins such as
15 ethylene, propylene, 1-butene, 1-hexene, 1-octene, 4-methyl-1-pentene, styrene and mixtures thereof.

The compounds and catalysts of this invention usefully polymerize functionalized monomers, such as acetates and acrylates. Novel polymers, copolymers or interpolymers may be formed having unique physical and/or melt
20 flow properties. Such novel polymers can be employed alone or with other polymers in a blend to form products that may be molded, cast, extruded or spun. End uses for the polymers made with the catalysts of this invention include films for packaging, trash bags, foams, coatings, insulating devices and household items. Also, such functionalized polymers are useful as solid supports for
25 organometallic or chemical synthesis processes.

Polymerization can be carried out in the Ziegler-Natta or Kaminsky-Sinn methodology, including temperatures of from 0°C to 400°C and pressures from atmospheric to 3000 atmospheres. Suspension, solution, slurry, gas phase or high-pressure polymerization processes may be employed with the catalysts and
30 compounds of this invention. Such processes can be run in a batch or continuous mode. Examples of such processes are well known in the art. A support for the catalyst may be employed, which may be alumina, silica or a polymers support. Methods for the preparation of supported catalysts are known in the art. Slurry, suspension, solution and high-pressure processes use a

suitable solvent as known to those skilled in the art.

The ligands, metal complexes and compositions of this invention can be prepared and tested for catalytic activity in one or more of the above reactions in a combinatorial fashion. Combinatorial chemistry generally involves the parallel or rapid serial synthesis and/or screening or characterization of compounds and compositions of matter. U.S. Patent No. 5,776,359 and WO 98/03521, both of which are incorporated herein by reference generally disclose combinatorial methods. In this regard, the ligands, complexes or compositions may be prepared and/or tested in rapid serial and/or parallel fashion, e.g., in an array format. When prepared in an array format, for example, the ligands may be take the form of an array comprising a plurality of compounds wherein each compound can be characterized by either of the general formulas:



wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure; G is either oxygen or nitrogen. In connection with structure I, a is 0 or 1 depending on G. In connection with structure II, a is 1 or 2 depending on G. Also, b is 0, 1, 2, 3 or 4.

In such a combinatorial array, typically each of the plurality of compounds has a different composition and each compound is at a selected region on a substrate such that each compound is isolated from the other compounds. This isolation can take many forms, typically depending on the substrate used. If a flat substrate is used, there may simply be sufficient space

between regions so that there cannot be interdiffusion between compounds. As another example, the substrate can be a microtiter or similar plate having wells so that each compound is in a region separated from other compounds in other regions by a physical barrier.

5 The array typically comprises at least 10 compounds, complexes or compositions each having a different chemical formula, meaning that there must be at least one different atom or bond differentiating the plurality in the array. In other embodiments, there are at least 25 compounds, complexes or compositions on or in the substrate each having a different chemical formula. In still other
10 embodiments, there are at least 50 or 96 or 124 compounds, complexes or compositions on or in the substrate each having a different chemical formula. Because of the manner of forming combinatorial arrays, it may be that each compound, complex or composition is not pure. Typically, plurality of compounds are at least 50% pure within said regions.

15 The catalytic performance (activity and selectivity) of the ligands of this invention in combination with a suitable metal precursor or metal-ligand coordination complexes of this invention can be tested in a combinatorial or high throughput fashion. For any of the listed transformation, thin layer chromatography (TLC) in combination with imaging technology may be
20 employed. TLC is well known in the art, see for example Vol. 1, *Thin-Layer Chromatography, Reagents & Detection Methods*, Jork et al. (VCH Publishers, New York, New York 1990). Polymerizations can also be performed in a combinatorial fashion, see, e.g., commonly owned provisional U.S. Patent Application No. 60/096,603, filed August 13, 1998 (having attorney docket no.
25 65304-010), herein incorporated by reference. High throughput screening can also be performed optically and in parallel, for example, as disclosed in commonly owned U.S. Patent Applications 09/067,448, filed April 2, 1998, 08/947,085, filed October 8, 1997, and 08/946,135, filed October 7, 1997, each of which is incorporated by reference.

30

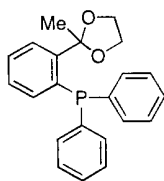
EXAMPLES

General: All reactions were performed under argon atmosphere in oven-dried glass Schlenk tubes using standard Schlenk techniques. All aryl halides, all

1-3

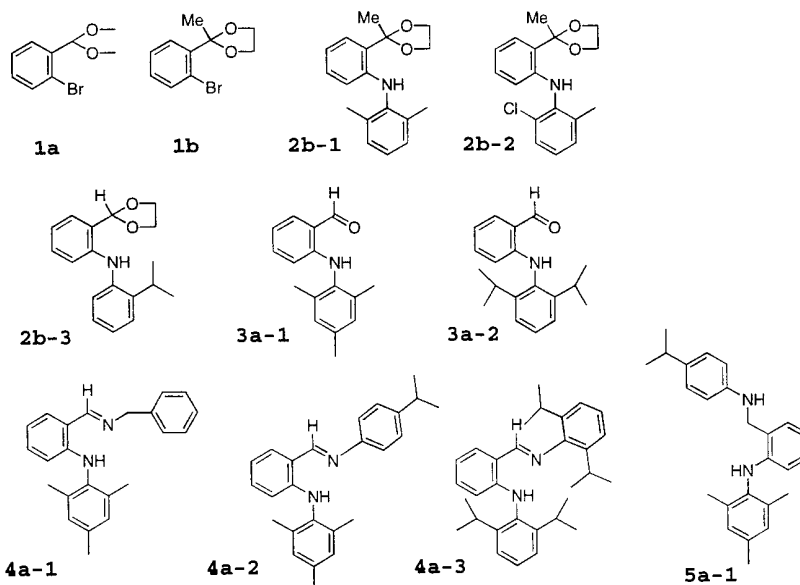
amines, sodium *t*-butoxide, bis(dibenzylideneacetone)palladium, and all solvents used were purchased from commercial sources and used as such. All solvents used were of the anhydrous, Sure-Seal® grade. Column chromatography was performed using commercially available Silica Gel 60 (particle size: 0.063 –
5 0.100 mm), hexanes and ethyl acetate. GCMS analyses were conducted on a Hewlett-Packard 5890 instrument. ¹H, and ¹³C spectra were obtained using a Bruker 300 MHz FT-NMR spectrometer. Chemical shifts in ¹H and ¹³C NMR spectra were calibrated with reference to the chemical shift of residual protiated solvent. Elemental analyses were performed by E & R Microanalytical
10 Laboratory Inc., NJ. Ligand A was used for the aryl amination reaction and is

2-(2'-dicyclohexylphosphinophenyl)-2-methyl-1,3-dioxolane having the



following structure: **Ligand A** Synthesis and use of ligand A is disclosed in detail in commonly owned and copending U.S. patent application no. 09/062,128 filed April 17, 1998 and incorporated herein by reference. Also U.S. provisional
 5 patent application no. _____, filed August 6, 1998 (Attorney Docket No. 98-22) and herein incorporated by reference discloses other ligands that can be used in the aryl amination reaction.

The following ligands shown in structural form below are referred to using the code given below each structure:



10

Example 1: 2-Bromo-1-(dimethoxymethyl)benzene (1a). To a 500 mL round bottom flask equipped with a reflux condenser were added 2-bromobenzaldehyde (102.5 g, 0.554 mol, Aldrich), trimethyl orthoformate (64.9 mL, 0.594 mol, Aldrich), 10-camphor sulfonic acid (1.25 g, 5.40 mmol, Aldrich), and methanol (100 mL). The reaction was heated at reflux for 14 hrs and concentrated in vacuo. The residue was taken up in 500 mL of ether, washed with 200 mL each of sat. aqueous sodium bicarbonate, water, and sat. aqueous NaCl, dried over anhydrous sodium sulfate, filtered and concentrated in

25

vacuo. The crude product was distilled through a 27 cm Vigreux column (b.p. 78-82 °C/1.2 mmHg), affording a clear colorless oil (120.8 g, 94%). ¹H-NMR (300 MHz, CDCl₃) • 3.37 (s, 6H), 5.54 (s, 1H), 7.18 (dt, 1H, J=1.7, 8.1 Hz), 7.31 (dt, 1H, J=1.2, 7.5 Hz), 7.54 (dd, 1H, J=1.2, 8.1 Hz), 7.59 (dd, 1H, J=1.7, 7.5 Hz). Mass spectrum (EI+) m/e 230, 232 (M⁺), 199, 201 (bp).

Example 2: 2-[2'-(2,6-Dimethylanilino)phenyl]-2-methyl-1,3-dioxolane (2b-1): A mixture of 2-(2'-bromophenyl)-2-methyl-1,3-dioxolane (362 mg, 1.49 mmol), 2,6-dimethylaniline (189 mg, 1.56 mmol), NaO^tBu (172 mg, 1.79 mmol), Pd(dba)₂ (17 mg, 0.03 mmol), ligand A (21 mg, 0.06 mmol) in toluene (4 mL) was heated to 105 °C for 4.5 hours. The reaction was cooled to room temperature, taken up in diethyl ether (125 mL), washed with water (2 X 30 mL) and brine (30 mL), dried over MgSO₄, filtered and concentrated under vacuum. The crude product was purified by column chromatography on silica gel using hexane (or hexanes: ethyl acetate) as the eluent to afford compound 2b-1, after drying under vacuum, as an off-white solid (yield: 391 mg, 93 %). ¹H NMR (CDCl₃): δ 7.41 (dd, 1H, J = 7.8, 1.8 Hz, ArH), 7.13 – 6.99 (m, 4H, ArH), 6.70 (dt, 1H, J = 7.5, 1.2 Hz, ArH), 6.15 (dd, 1H, J = 7.8, 0.9, ArH), 4.12 (m, 2H, O-CH-CH-O), 3.93 (m, 2H, O-CH-CH-O), 2.18 (s, 6H, Ar-CH₃), 1.84 (s, 3H, CH₃). ¹³C NMR (CDCl₃): δ 143.5, 138.6, 135.2, 129.1, 128.5, 126.3, 125.6, 125.2, 117.3, 112.6, 109.8, 64.1, 24.1, 18.3. Anal. for C₁₈H₂₁NO₂; Calcd: C, 76.29; H, 7.47; N, 4.94; Found: C, 75.86; H, 7.46; N, 4.89.

Example 3: 2-[2'-(2-Chloro-6-methylanilinophenyl)]-2-methyl-1,3-dioxolane (2b-2): Compound 2b-2 (381 mg, 96 % yield) was obtained as a colorless solid from the reaction of 2-(2'-bromophenyl)-2-methyl-1,3-dioxolane (318 mg, 1.31 mmol), 2-chloro-6-methylaniline (195 mg, 1.38 mmol), NaO^tBu (152 mg, 1.58 mmol), Pd(dba)₂ (15 mg, 0.03 mmol), ligand A (18 mg, 0.05 mmol) in toluene (4 mL) at 105 °C for 2 hours. The experimental procedure described for the synthesis of compound 2a-1 was generally followed. ¹H NMR (CDCl₃): δ 7.51 (m, 2H, ArH), 7.36 (d, 1H, J = 7.9 Hz, ArH), 7.19 (d, 1H, J = 7.3 Hz, ArH), 7.13 – 7.06 (m, 2H, ArH), 6.83 (t, 1H, J = 7.3 Hz, ArH), 6.27 (d, 1H, J = 7.9 Hz, ArH), 4.17 (m, 2H, O-CH-CH-O), 3.97 (m, 2H, O-CH-CH-O), 2.23 (s, 3H, Me),

1.89 (s, 3H, Me). ^{13}C NMR (CDCl_3): δ 142.4, 137.4, 136.8, 131.2, 129.3, 128.8, 127.5, 126.8, 126.4, 125.3, 118.5, 113.5, 109.6, 64.1, 24.1, 18.8. Anal. for $\text{C}_{17}\text{H}_{18}\text{ClNO}_2$; Calcd: C, 67.21; H, 5.97; N, 4.61; Found: C, 66.92; H, 5.83; N, 4.53.

5

Example 4: 2-[2'-(2-Isopropylanilinophenyl)]-1,3-dioxolane (2b-3):

Compound 2b-3 (354 mg, 90 % yield) was obtained as a yellow oil from the reaction of 2-(2'-bromophenyl)-1,3-dioxolane (321 mg, 1.40 mmol), 2-isopropylaniline (199 mg, 1.47 mmol), NaO^tBu (141 mg, 1.47 mmol), $\text{Pd}(\text{dba})_2$ (16 mg, 0.03 mmol), ligand A (27 mg, 0.08 mmol) in toluene (4 mL) at 105 °C for 75 minutes. The experimental procedure described for the synthesis of compound 2a-1 was generally followed. ^1H NMR (CDCl_3): δ 7.45 (d, 1H, $J = 7.6$ Hz, ArH), 7.33 – 7.12 (m, 4H, ArH), 7.05 (t, 1H, $J = 7.4$ Hz, ArH), 6.85 (t, 1H, $J = 7.4$ Hz, ArH), 6.68 (br.s, 1H, NH), 5.93 (s, 1H, O-CH-O), 4.10 (m, 4H, O-CH₂-CH₂-O), 3.13 (septet, 1H, $J = 6.8$ Hz, CHMe_2), 1.26 (d, 6H, $J = 6.8$ Hz, 2 Me's). ^{13}C NMR (CDCl_3): δ 143.8, 140.0, 139.5, 129.7, 127.2, 126.3, 126.1, 123.7, 122.9, 121.6, 118.9, 115.5, 103.0, 64.9, 27.8, 22.8. Anal. for $\text{C}_{18}\text{H}_{21}\text{NO}_2$; Calcd: C, 76.29; H, 7.47; N, 4.94; Found: C, 75.75; H, 7.96; N, 4.81.

Example 5: 2-[(2',4',6'-trimethylphenyl)amino]benzaldehyde (3a-1). In an oven-dried 500 mL Schlenk flask were added sodium *t*-butoxide (5.77 g, 60.0 mmol, Aldrich), $\text{Pd}(\text{dba})_2$ (0.144 g, 0.250 mmol, ACROS), ligand A (0.174 g, 0.500 mmol) and **1a** (14.45 g, 62.6 mmol). Toluene (130 mL, anhydrous, Aldrich) and 2,4,6-trimethylaniline (8.71 g, 64.4 mmol, Aldrich) were added and the reaction was heated to 105 °C for 6 hrs. An additional 1.44 g of sodium *t*-butoxide was added to the reaction and the reaction was heated at the same temperature for an additional 1 hr, at which time a GLC analysis revealed the reaction was completed. The reaction was cooled to room temperature. The reaction mixture was diluted with 100 mL of ether and washed with 200 mL each of water and sat. aqueous NaCl, dried over anhydrous sodium sulfate, filtered and concentrated in vacuo, affording 20.1 g of a red oil as crude product. The crude material was chromatographed through a 6x15 cm silica gel column (1-5 % step

gradient of ether in hexanes). During this operation, the acetal was partially hydrolyzed. The fractions containing the acetal and the aldehyde were combined and concentrated in vacuo, affording 16.61 g of a yellow viscous oil. The oil was stirred in a mixture of THF (50 mL), water (25 mL), and acetic acid (25 mL) at 22 °C for 1 hr. THF was removed by evaporation and 200 mL of ether was added. The organic phase was washed with 100 mL each of water and sat. aqueous sodium bicarbonate, dried over anhydrous sodium sulfate, filtered and concentrated in vacuo, affording 14.47 g of a deep yellow viscous oil (97%). A GLC analysis and H-NMR analysis indicated this material was pure. ¹H NMR (CDCl₃, 300 MHz): 9.97 (s, 1H), 9.50 (s, 1H), 7.56 (d, J=7.8 Hz, 1H), 7.3-7.2 (m, 4H), 6.98 (s, 2H), 6.74 (t, J=7.5 Hz, 1H), 6.24 (d, J=8.4 Hz, 1H), 2.34 (s, 3H), 2.16 (s, 6H) ppm. ¹³C NMR (CDCl₃, 75 MHz): 194.3, 149.9, 136.5, 136.4, 136.3, 135.7, 133.6, 129.2, 118.3, 115.7, 112.3, 20.9, 18.1 ppm.

Example 6: 2-[2',6'-(diisopropylphenyl)amino]benzaldehyde (3a-2). In an oven-dried 250 mL Schlenk flask were added sodium *t*-butoxide (2.88 g, 30.0 mmol, Aldrich), Pd(dba)₂ (72 mg, 0.13 mmol, ACROS), ligand **A** (87 mg, 0.25 mmol). Toluene (100 mL, anhydrous, Aldrich), **1** (5.70 g, 24.6 mmol), and 2,6-diisopropylaniline (4.37 g, 24.6 mmol, Aldrich) were added and the reaction was heated to 105 C for 14 hrs, at which time a GLC analysis revealed the reaction was completed. The reaction was cooled to room temperature. The reaction mixture was stirred with 50 mL of water and filtered to remove insoluble materials. The organic layer was separated and washed with 50 mL of sat. aqueous NaCl, dried over anhydrous sodium sulfate, filtered and concentrated in vacuo, affording 8.88 g of a red oil as crude product. The crude material was subjected to hydrolysis in the similar way as **3a-1** (THF (50 mL), water (25 mL), and acetic acid (25 mL) at 22 C for 1 hr). The crude product was purified by flash chromatography on a 7x20 cm silica gel column (2.5% ether in hexanes), affording 6.68 g of a very yellow viscous oil (96 %). IR (liquid film) 3292, 1660 cm⁻¹. ¹H-NMR (300 MHz, CDCl₃) δ 1.08 (d, 3H, J=6.9 Hz), 1.13 (d, 3H, J=6.9 Hz), 3.04 (sept, 2H, J=6.9 Hz), 6.20 (d, 1H, J=8.5), 6.70 (t, 1H, J=7.4 Hz), 7.18-7.23 (m, 3H), 7.32 (t, 1H, J=7.6 Hz), 7.53 (dd, 1H, J=7.8, 1.5 Hz), 9.54 (br.s, 1H), 9.94 (s, 1H). ¹³C-NMR (75 MHz, CDCl₃) δ 23.0, 24.5,

28.4, 112.5, 115.7, 118.0, 123.9, 128.0, 133.4, 135.5, 136.1, 147.3, 151.0, 194.2.

Mass spectrum (EI+) m/e 281 (M+), 266 (bp).

Example 7: This example is a general procedure for the formation of 2-mesitylaminobenzaldehyde imines: To a solution of 2-mesitylaminobenzaldehyde **3a-1** (957 mg, 4 mmol) in dichloroethane (6 mL) was added benzylamine (429 mg, 4 mmol) via syringe, followed by a catalytic amount of *p*-toluenesulfonic acid monohydrate (18 mg, ~ 1%) and 4Å molecular sieves. The reaction was heated to reflux overnight while stirring under argon. The disappearance of the aldehyde and formation of the imine was followed by GC/MS. To the crude product was added amino propyl silica and the mixture was shaken. The mixture was then filtered and the resulting solution was concentrated. The product was then precipitated with hexanes. The precipitate was washed with cold hexanes and dried *in vacuo*. **4a-1:** ¹H NMR (CDCl₃, 300 MHz): 10.49 (s, 1H), 8.57 (s, 1H), 7.4-7.25 (m, 6H), 7.12 (t, J= 8 Hz, 1H) 7.01 (s, 1H), 6.69 (t, J=8 Hz, 1H), 6.26 (d, J= 8 Hz, 1H), 4.69 (s, 2H), 2.32 (s, 3H), 2.13 (s, 6H) ppm. ¹³C NMR (CDCl₃, 75 MHz): 165.3, 148.3, 139.8, 136.3, 135.5, 135.2, 133.8, 131.2, 128.9, 128.4, 127.6, 126.8, 116.9, 115.1, 111.5, 65.12, 20.9, 18.2 ppm. GC-MS: *m/z* 328 (M)⁺. **4a-2:** ¹H NMR (CDCl₃, 300 MHz): 10.7 (s, 1H), 8.74 (s, 1H), 7.48 (d, J= 8 Hz, 1H), 7.33 (d, J= 8 Hz, 1H), 7.2 (m, 4H), 7.05 (s, 2H), 6.79 (t, J= 8 Hz, 1H), 6.35 (d, J=8 Hz, 1H), 3.01 (m, 6.9 Hz, 1H), 2.40 (s, 3H), 2.28 (s, 6H), 1.34 (d, J= 6.9 Hz, 6H) ppm. ¹³C NMR (CDCl₃, 75 MHz): 162.3, 148.5, 146.5, 136.3, 135.7, 135.1, 134.5, 131.9, 129.0, 127.1, 120.9, 117.3, 115.4, 111.8, 33.7, 24.1, 20.9, 18.3 ppm. GC-MS: *m/z* 356 (M)⁺.

Example 8: This example is a general procedure for the formation of 2-(2,6-diisopropylphenyl)aminobenzaldehyde imines. To a solution of 2-[(2,6-diisopropylphenyl) amino]benzaldehyde **3a-2** (126 mg, 0.45 mmol) in dichloroethane (500 µL) was added 2,6-diisopropylaniline (84 µL, 0.45 mmol) via syringe, followed by a catalytic amount of *p*-toluenesulfonic acid monohydrate (10 mg, 10%). The resulting solution was concentrated and the resulting oil was heated overnight (external temperature 120 °C). The

disappearance of the aldehyde and formation of the imine was followed by GC/MS. To the crude product was added dichloroethane (1 mL) followed by amino propyl silica and the mixture was shaken. The mixture was then filtered and the resulting solution was concentrated. The product was then precipitated
5 with methanol. The precipitate was washed with cold methanol and dried *in vacuo*. **4a-3**: ^1H NMR (CDCl_3 , 300 MHz): 10.56 (s, 1H), 8.40 (s, 1H), 7.4-7.1 (m, 8H), 6.74 (t, $J = 7$ Hz, 1H), 6.34 (d, $J = 8$ Hz, 1H), 3.25 (m, 2H), 3.14 (m, 2H), 1.3-1.1 (m, 24H) ppm. ^{13}C NMR (CDCl_3 , 75 MHz): 166.2, 150.4, 147.9, 138.6, 134.9, 134.8, 132.6, 127.9, 124.8, 124.2, 123.5, 116.6, 115.5, 112.4 ppm.
10 GC-MS: m/z 440 (M) $^+$.

Example 9: This example is a general procedure for the formation of 2-mesitylaminobenzaldehyde 2-aminomethylenes. To **4a-2** (0.17 mmol, 60 mg) in dichloroethane (2 mL) was added acetic acid (60 μL) followed by $\text{NaBH}(\text{OAc})_3$
15 (0.34 mmol, 70 mg). The resulting mixture was shaken at room temperature for 2 hours. The crude product was extracted from an aqueous Na_2CO_3 solution with dichloroethane (3 x 2 mL) then passed through a plug of silica gel and concentrated to afford a pale yellow oil. **5a-1**: ^1H NMR (CDCl_3 , 300 MHz): 7.27 (d, $J = 7.4$ Hz, 1H), 7.3-7.1 (m, 3H), 6.97 (s, 2H), 6.9-6.7 (m, 3H), 6.61 (s,
20 2H), 6.29 (d, $J = 8$ Hz, 1H), 4.42 (s, 2H), 2.91 (m, $J = 6.9$ Hz, 1H), 2.36 (s, 3H), 2.19 (s, 6H), 1.30 (d, $J = 6.9$ Hz, 6H) ppm. ^{13}C NMR (CDCl_3 , 75 MHz): 146.0, 145.8, 139.5, 135.8, 134.7, 134.6, 130.0, 129.1, 128.9, 127.2, 122.8, 117.4, 114.2, 112.2, 48.2, 33.2, 24.2, 20.6, 18.2 ppm. GC-MS: m/z 358 (M) $^+$

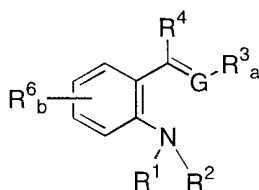
25

It is to be understood that the above description is intended to be illustrative and not restrictive. Many embodiments will be apparent to those of skill in the art upon reading the above description. The scope of the invention should, therefore, be determined not with reference to the above description, but
30 should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. The disclosures

of all articles and references, including patent applications and publications, are incorporated herein by reference for all purposes.

What is claimed is:

1. A compound characterized by the general formula:



- wherein each R^1 , R^2 , R^3 , R^4 and R^6 is independently selected from the group
- 5 consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a
 - 10 ring structure and/or R^1 and R^6 are joined in a ring structure;

G is either oxygen or nitrogen and a is 0 or 1 depending on G ; and b is 0, 1, 2, 3 or 4.

2. The compound of claim 1, wherein each of R^1 and R^2 is
- 15 independently selected from the group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, aryl and substituted aryl.
3. The compound of claim 2, wherein R^1 and R^2 are joined in a ring, wherein the said ring has between 5 and 10 non-hydrogen atoms.
- 20 4. The compound of claim 3, wherein said ring has between 5 and 6 non-hydrogen atoms in the backbone of the ring.
5. The compound of claim 1, wherein R^1 is a substituted or
- 25 unsubstituted phenyl.
6. The compound of claim 5, wherein R^1 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halide, alkyl, substituted

alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

5

7. The compound of claim 6, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and
10 isomers thereof.

8. The compound of claim 1, wherein R^4 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl,
15 alkoxy, aryloxy, amino and silyl.

9. The compound of claim 8, wherein R^4 is selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl.

20 10. The compound of claim 1, wherein R^4 is joined in a ring structure with G and R^3 , wherein said ring has at least four atoms in the backbone of the ring.

11. The compound of claim 10, wherein G is nitrogen and R^3 forms a
25 methylene bridge to R^4 .

12. The compound of claim 1, wherein G is nitrogen and a is 1 and R^3 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted
30 heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno and combinations thereof.

13. The compound of claim 1, wherein R^3 is benzyl or a substituted or unsubstituted phenyl.

14. The compound of claim 13, wherein R^3 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted
5 heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

15. The compound of claim 14, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group
10 consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

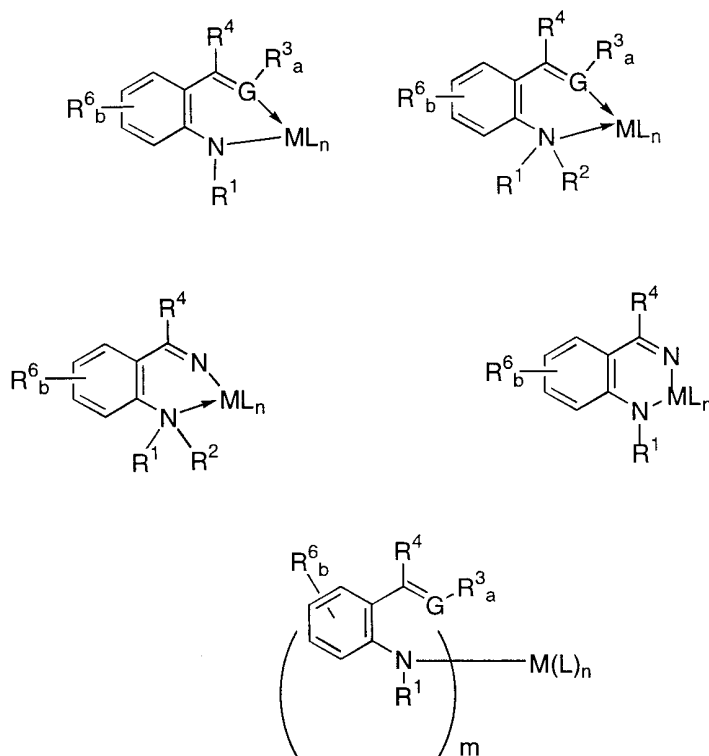
16. The compound of claim 1, wherein R^6 is selected from the group
15 consisting of alkyl, aryl and cycloalkyl and b is 1, 2, 3 or 4.

17. The compound of claim 16, wherein b is 2 and the two R^6 groups are joined into a substituted or unsubstituted fused ring structure with the benzene ring in the backbone of the compound.

20

18. The compound of claim 1, wherein G is oxygen and a is 0.

19. A complex characterized by one of the following general formulas:



5

wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure;

G is either nitrogen or oxygen and a is 0 or 1 depending on G;

b is 0, 1, 2, 3 or 4;

15 M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements;

L is independently each occurrence, a ligand;

n is a number 0, 1, 2, 3, 4, and 5; and

m is 1, 2, 3 or 4.

20

20. The complex of claim 19, wherein M is selected from the group consisting of Sc, Y, Zr, Ti, Hf, V, Nb, Ta, Cr, Mo, Mn, Fe, Ru, Co, Rh, Ni, Pd, Pt.

5 21. The complex of claim 20, wherein M is selected from the group consisting of Pd, Ni, Co, Fe, Ru, Rh, Ir, Pt, Cr, Mo, Mn, and V.

22. The complex of claim 19, wherein L is selected from the group consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted
10 cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

23. The complex of claim 19, wherein L is selected from the group
15 consisting of alkene, diene, carbon monoxide, isocyanide, nitrous oxide, PA_3 , NA_3 , OA_2 , SA_2 , SeA_2 , and combinations thereof, wherein each A is independently selected from a group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy,
20 aryloxy, silyl, and amino.

24. The complex of claim 19, wherein R^1 is a substituted or unsubstituted phenyl.

25 25. The complex of claim 24, wherein R^1 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted
30 heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

26. The complex of claim 25, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group

consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

5 27. The complex of claim 19, wherein R^4 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

10 28. The complex of claim 27, wherein R^4 is selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl.

 29. The complex of claim 19, wherein R^4 is joined in a ring structure with G and R^3 , wherein said ring has at least four atoms in the backbone of the
15 ring.

 30. The complex of claim 29, wherein G is nitrogen and R^3 forms a methylene bridge to R^4 .

20 31. The complex of claim 19, wherein G is nitrogen and a is 1 and R^3 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno and combinations thereof.

25

 32. The complex of claim 19, wherein R^3 is benzyl or a substituted or unsubstituted phenyl.

 33. The complex of claim 32, wherein R^3 is a substituted phenyl and
30 there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted

heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

34. The complex of claim 33, wherein there are 1, 2 or 3 substituents
5 on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

10 35. The complex of claim 19, wherein R^6 is selected from the group consisting of alkyl, aryl and cycloalkyl and b is 1, 2, 3 or 4.

36. The complex of claim 19, wherein b is 2 and the two R^6 groups are joined into a substituted or unsubstituted fused ring structure with the benzene
15 ring in the backbone of the compound.

37. The complex of claim 19, wherein G is oxygen and a is 0.

38. The complex of claim 19, wherein each of R^1 and R^2 is
20 independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, aryl and substituted aryl.

39. The complex of claim 19, wherein R^1 and R^2 are joined in a ring,
wherein the said ring has between 5 and 10 non-hydrogen atoms.
25

40. The complex of claim 39, wherein said ring has between 5 and 6 non-hydrogen atoms in the backbone of the ring.

41. The complex of claim 19, wherein each of R^1 and R^2 is
30 independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

42. The complex of claim 41, wherein each R^1 and R^2 is independently selected from the group consisting of hydrogen alkyl, aryl and cycloalkyl.

43. A composition of matter comprising the compound of claim 1 and a metal precursor characterized by the general formula $M(L)_n$, where M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements; L is independently each occurrence, a ligand; and n is a number 0, 1, 2, 3, 4, and 5.

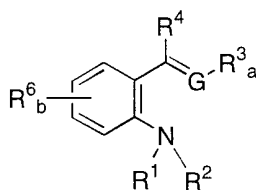
44. The composition of claim 43 wherein the ratio of compound to metal precursor is in the range of about 0.01:1 to about 100:1.

45. The composition of claim 44 wherein the ratio of compound to metal precursor is in the range of about 0.5:1 to about 20:1.

46. The composition of claim 43, wherein the compound is of claim 5.

47. The composition of claim 43, wherein the compound is of claim 12.

48. An array comprising a plurality of compounds wherein each compound can be characterized by the general formula:



wherein each R^1 , R^2 , R^3 , R^4 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2

are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure and/or R^6 and R^1 are joined in a ring structure;

G is either oxygen or nitrogen and a is 0 or 1 depending on G; and

b is 0, 1, 2, 3 or 4.

5

49. The array of claim 48, wherein each of said plurality of compounds has a different composition.

50. The array of claim 49, wherein each of said plurality of compounds is at a selected region on a substrate such that each compound is isolated from the other compounds.

10

51. The array of claim 50, wherein said plurality of compounds comprises at least 10 compounds each having a different composition.

15

52. The array of claim 50, wherein said plurality of compounds comprises at least 25 compounds each having a different composition.

53. The array of claim 50, wherein said plurality of compounds comprises at least 50 compounds each having a different composition.

20

54. The array of claim 48, wherein said substrate is a microtiter plate.

55. The array of claim 50, wherein said plurality of compounds are at least 50% pure within said regions.

25

56. A transition metal-catalyzed reaction employing complex in claim 19.

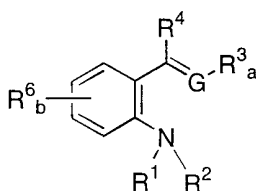
57. The reaction of claim 56, wherein the reaction involves C-H, C-C, C-N, C-O, C-S, C-P, C-B and C-Si bond formation.

30

58. The reaction of claim 57, wherein C-H, C-C, C-N, C-O, C-S, C-P, C-B, and C-Si bond formation involves a sp^2 -hybridized C atom.

59. The reaction of claim 55, wherein the reactions involve carbonylation, hydroformylation, hydroxycarbonylation, hydrocarbonylation, hydroesterification, hydrogenation, hydrosilylation, hydroboration, hydroamination, epoxidation, aziridation, reductive amination, C-H activation, insertion, C-H activation-insertion, C-H activation-substitution, C-halogen activation, C-halogen activation-substitution, C-halogen activation-insertion, alkene metathesis, polymerization, alkene oligomerization, alkene polymerization, alkyne oligomerization, alkyne polymerization, co-polymerization, CO-alkene co-oligomerization, CO-alkene co-polymerization, CO-alkyne co-oligomerization, and CO-alkyne co-polymerization.

60. A polymerization reaction employing a compound characterized by the general formula:



wherein each R^1 , R^2 , R^3 , R^4 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure;

G is either oxygen or nitrogen and a is 0 or 1 depending on G; and b is 0, 1, 2, 3 or 4.

61. The process of claim 60, wherein each of R^1 and R^2 is independently selected from the group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, aryl and substituted aryl.

62. The process of claim 60, wherein R^1 and R^2 are joined in a ring, wherein the said ring has between 5 and 10 non-hydrogen atoms.

63. The process of claim 62, wherein said ring has between 5 and 6
5 non-hydrogen atoms in the backbone of the ring.

64. The process of claim 60, wherein R^1 is a substituted or unsubstituted phenyl.

10 65. The process of claim 64, wherein R^1 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted
15 heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

66. The process of claim 65, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group
20 consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

67. The process of claim 60, wherein R^4 is selected from the group
25 consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

68. The process of claim 67, wherein R^4 is selected from the group
30 consisting of hydrogen, alkyl, aryl and cycloalkyl.

69. The process of claim 60, wherein R^4 is joined in a ring structure with G and R^3 , wherein said ring has at least four atoms in the backbone of the ring.

70. The process of claim 69, wherein G is nitrogen and R³ forms a methylene bridge to R⁴.

5 71. The process of claim 60, wherein G is nitrogen and a is 1 and R³ is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno and combinations thereof.

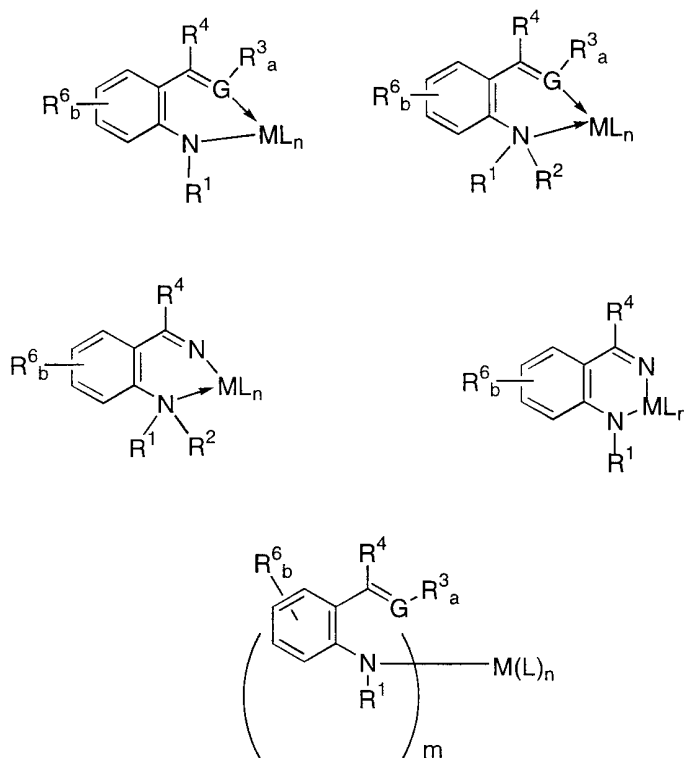
10

72. The process of claim 71, wherein R³ is benzyl or a substituted or unsubstituted phenyl.

73. The process of claim 72, wherein R³ is a substituted phenyl and
15 there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and
20 combinations thereof.

74. The process of claim 73, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl,
25 cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

75. A process for polymerizing an olefin, diolefin or acetylenically unsaturated compound, comprising contacting said olefin, diolefin or acetylenically unsaturated compound to a complex that can be characterized by one of the following general formulas:



- wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure;

G is either nitrogen or oxygen and a is 0 or 1 depending on G;

b is 0, 1, 2, 3 or 4;

M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements;

- L is independently each occurrence, a ligand;

44

n is a number 0, 1, 2, 3, 4, and 5; and

m is 1, 2, 3 or 4.

76. The process of claim 75, wherein M is selected from the group
5 consisting of Sc, Y, Zr, Ti, Hf, V, Nb, Ta, Cr, Mo, Mn, Fe, Ru, Co, Rh, Ni, Pd,
Pt.

77. The process of claim 76, wherein M is selected from the group
consisting of Pd, Ni, Co, Fe, Ru, Rh, Ir, Pt, Cr, Mo, Mn, and V.

10

78. The process of claim 75, wherein L is selected from the group
consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted
cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl,
substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl,
15 phosphino, amino, thio, seleno, and combinations thereof.

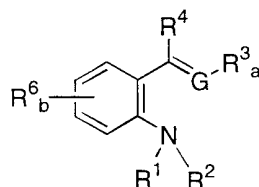
79. The process of claim 75, wherein L is selected from the group
consisting of carbon monoxide, isocyanide, nitrous oxide, PA_3 , NA_3 , OA_2 , SA_2 ,
 SeA_2 , and combinations thereof, wherein each A is independently selected from
20 a group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted
cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl,
heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, and amino.

80. The process of claim 75, wherein R^1 is a substituted or unsubstitued
25 phenyl.

81. The process of claim 80, wherein R^1 is a substituted phenyl and
there are from 1-5 substituents on said phenyl ring, with each of said substituents
independently selected from the group consisting of alkyl, substituted alkyl,
30 cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted
heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy,
aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

82. The process of claim 75, wherein said process is a continuous process at a temperature of between -100°C and 500°C .

83. A process for making a compound characterized by the general
5 formula:

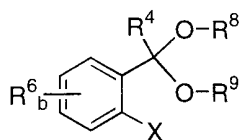


wherein each R^1 , R^2 , R^3 , R^4 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl,
10 substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure;

G is either oxygen or nitrogen and a is 0 or 1 depending on G; and
15 b is 0, 1, 2, 3 or 4;

the steps of the process comprising:

(1) reacting a compound characterized by the general formula:



where X is selected from the group consisting of chloro, bromo, iodo, triflate and
20 tosylate; and R^8 and R^9 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof;

with an amine characterized by the general formula HNR^1R^2 ,
where R^1 and R^2 are as defined above;

(2) hydrolyzing an acetyl or ketal functionality of the product of the
reaction in step (1); and

5 (3) optionally, reacting the product of step (2) with a primary amine.

84. The process of claim 83, wherein step (1) employs a catalyst that is
a composition comprising M' and L' where M' a homogeneous or heterogeneous
metal precursor catalyst or catalyst and L' is a phosphine or nitrogen containing
10 ligand.

85. The process of claim 84, wherein L' is ligand that is either
bidentate, tridentate or hemi-labile and is unsubstituted or substituted, supported
or unsupported, water-soluble or insoluble, soluble or insoluble in organic
15 solvents.

86. The process of claim 84, wherein M' includes a metal selected from
the group consisting of Pd, Ni or Pt.

20 87. The process of claim 83, wherein steps (1) and (2) are performed in
a one-pot reaction, without the isolation of any product from step (1).

88. The process of claim 83 wherein steps (1), (2) and (3) are
performed in a one-pot reaction, without the isolation of any product(s) from
25 steps (1) or (2).

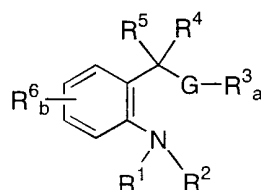
89. The process of claim 83, wherein step (3) is performed and said
primary amine may be characterized by the general formula H_2NR^3 , wherein R^3
is as defined above.

30 90. The process of claim 89, wherein R^3 is benzyl or a substituted or
unsubstituted phenyl.

91. The process of claim 90, wherein R^3 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

92. The process of claim 91, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

93. A compound characterized by the general formula:



wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure and/or R^1 and R^6 are joined together in a ring structure;

G is either oxygen or nitrogen and a is either 1 or 2 depending on G; and b is 0, 1, 2, 3 or 4.

94. The compound of claim 93, wherein each of R^1 and R^2 is independently selected from the group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, aryl and substituted aryl.

5 95. The compound of claim 93, wherein R^1 and R^2 are joined in a ring, wherein the said ring has between 5 and 10 non-hydrogen atoms.

96. The compound of claim 95, wherein said ring has between 5 and 6 non-hydrogen atoms in the backbone of the ring.

10

97. The compound of claim 94, wherein R^1 is a substituted or unsubstituted phenyl.

98. The compound of claim 97, wherein R^1 is a substituted phenyl and
15 there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and
20 combinations thereof.

99. The compound of claim 98, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl,
25 cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

100. The compound of claim 93, wherein R^5 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted
30 cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

101. The compound of claim 100, wherein R^5 is selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl.

102. The compound of claim 93, wherein R^4 is selected from the group consisting hydrogen, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio and seleno.

5

103. The compound of claim 102, wherein R^4 is an alkoxy.

104. The compound of claim 93, wherein R^4 is joined in a ring structure with G and R^3 , wherein said ring has at least five atoms in the backbone of the
10 ring.

105. The compound of claim 104, wherein G is oxygen and R^3 forms a methylene bridge to R^4 and R^4 is methoxy.

15

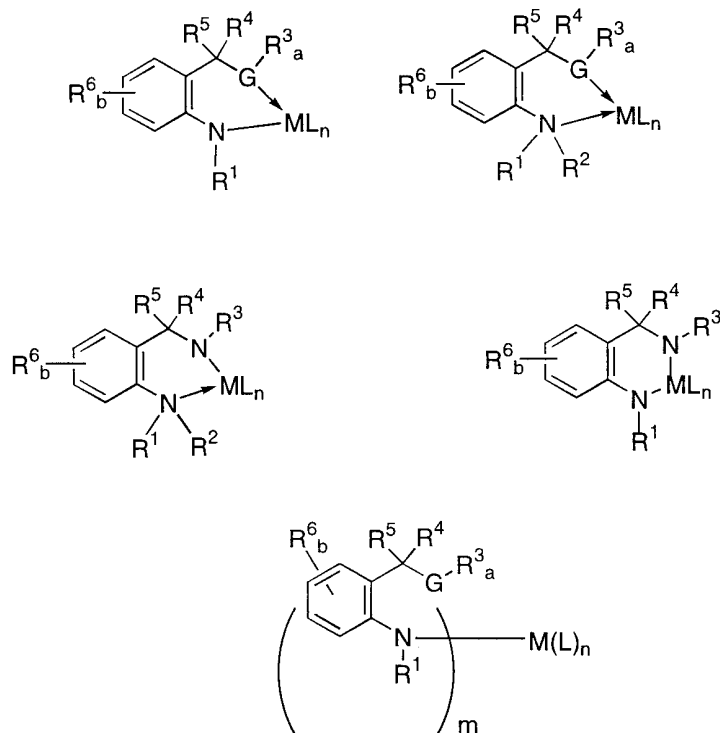
106. The compound of claim 93, wherein G is nitrogen and a is 2 and the two R^3 groups are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio,
20 seleno and combinations thereof.

107. The compound of claim 93, wherein R^6 is selected from the group consisting of alkyl, aryl and cycloalkyl and b is 1, 2, 3 or 4.

25

108. The compound of claim 93, wherein b is 2 and the two R^6 groups are joined into a substituted or unsubstituted fused ring structure with the benzene ring in the backbone of the compound.

109. A complex characterized by one of the following general formulas:



5

wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure;

G is either nitrogen or oxygen and a is 1 or 2 depending on G ;

b is 0, 1, 2, 3 or 4;

15 M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements;

L is independently each occurrence, a ligand;

n is a number 0, 1, 2, 3, 4, and 5; and

m is 1, 2, 3 or 4.

20

110. The complex of claim 109, wherein M is selected from the group consisting of Sc, Y, Zr, Ti, Hf, V, Nb, Ta, Cr, Mo, Mn, Fe, Ru, Co, Rh, Ni, Pd, Pt.

5 111. The complex of claim 110, wherein M is selected from the group consisting of Pd, Ni, Co, Fe, Ru, Rh, Ir, Pt, Cr, Mo, Mn, and V.

112. The complex of claim 109, wherein L is selected from the group consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted
10 cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

113. The complex of claim 109, wherein L is selected from the group
15 consisting of carbon monoxide, isocyanide, nitrous oxide, PA_3 , NA_3 , OA_2 , SA_2 , SeA_2 , and combinations thereof, wherein each A is independently selected from a group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, and amino.

20

114. The complex of claim 109, wherein R^1 is a substituted or unsubstitued phenyl.

115. The complex of claim 114, wherein R^1 is a substituted phenyl and
25 there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and
30 combinations thereof.

116. The complex of claim 115, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl,

cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

117. The complex of claim 109, wherein R^4 is selected from the group
5 consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted
cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl,
alkoxy, aryloxy, amino and silyl.

118. The complex of claim 117, wherein R^4 is selected from the group
10 consisting of hydrogen, alkyl, aryl and cycloalkyl.

119. The complex of claim 109, wherein R^4 is joined in a ring structure
with G and R^3 , wherein said ring has at least four atoms in the backbone of the
ring.
15

120. The complex of claim 119, wherein G is nitrogen and R^3 forms a
methylene bridge to R^4 .

121. The complex of claim 109, wherein G is nitrogen and a is 2 and
20 each R^3 is independently selected from the group consisting of hydrogen, alkyl,
substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl,
heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl,
substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio,
seleno and combinations thereof.
25

122. The complex of claim 109, wherein at least one R^3 is benzyl or a
substituted or unsubstituted phenyl.

123. The complex of claim 122, wherein said R^3 is a substituted phenyl
30 and there are from 1-5 substituents on said phenyl ring, with each of said
substituents independently selected from the group consisting of halogens, alkyl,
substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl,
heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl,

substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

124. The complex of claim 123, wherein there are 1, 2 or 3 substituents
5 on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

10 125. The complex of claim 109, wherein R^6 is selected from the group consisting of alkyl, aryl and cycloalkyl and b is 1, 2, 3 or 4.

126. The complex of claim 109, wherein b is 2 and the two R^6 groups are joined into a substituted or unsubstituted fused ring structure with the
15 benzene ring in the backbone of the compound.

127. The complex of claim 109, wherein G is oxygen and a is 1.

128. The complex of claim 109, wherein R^1 and R^2 are joined in a ring,
20 wherein the said ring has between 5 and 10 non-hydrogen atoms.

129. The complex of claim 129, wherein said ring has between 5 and 6 non-hydrogen atoms in the backbone of the ring.

25 130. The complex of claim 109, wherein each of R^1 and R^2 is independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substitute aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

30 131. The complex of claim 109, wherein R^5 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, aryl, substitute aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

132. The complex of claim 131, wherein R^5 is selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl.

133. A composition of matter comprising the compound of claim 93 and
 5 a metal precursor characterized by the general formula $M(L)_n$, where M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements; L is independently each occurrence, a ligand; and n is a number 0, 1, 2, 3, 4, and 5.

10 134. The composition of claim 133 wherein the ratio of compound to metal precursor is in the range of about 0.01:1 to about 100:1.

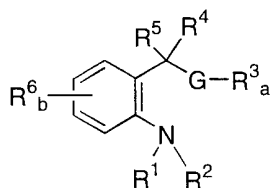
135. The composition of claim 134 wherein the ratio of compound to metal precursor is in the range of about 0.5:1 to about 20:1.

15

136. The composition of claim 133, wherein the compound is of claim 97.

137. The composition of claim 133, wherein the compound is of claim
 20 106.

138. An array comprising a plurality of compounds wherein each compound can be characterized by the general formula:



25

wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl,

phosphino, amino, thio, seleno, and combinations thereof; optionally, R¹ and R² are joined together in a ring structure and/or R³ and R⁴ are joined together in a ring structure;

5 G is either oxygen or nitrogen and a is either 1 or 2 depending on G; and
b is 0, 1, 2, 3 or 4.

139. The array of claim 138, wherein each of said plurality of compounds has a different composition.

10 140. The array of claim 139, wherein each of said plurality of compounds is at a selected region on a substrate such that each compound is isolated from the other compounds.

141. The array of claim 140, wherein said plurality of compounds
15 comprises at least 10 compounds each having a different composition.

142. The array of claim 140, wherein said plurality of compounds comprises at least 25 compounds each having a different composition.

20 143. The array of claim 140, wherein said plurality of compounds comprises at least 50 compounds each having a different composition.

144. The array of claim 140, wherein said substrate is a microtiter plate.

25 145. The array of claim 140, wherein said plurality of compounds are at least 50% pure within said regions.

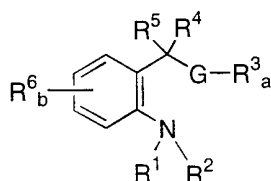
146. A transition metal-catalyzed reaction employing complex in claim
109.
30

147. The reaction of claim 146, wherein the reaction involves C-H, C-C, C-N, C-O, C-S, C-P, C-B and C-Si bond formation.

148. The reaction of claim 146, wherein C-H, C-C, C-N, C-O, C-S, C-P, C-B, and C-Si bond formation involves a sp^2 -hybridized C atom.

149. The reaction of claim 146, wherein the reactions involve
 5 carbonylation, hydroformylation, hydroxycarbonylation, hydrocarbonylation, hydroesterification, hydrogenation, hydrosilylation, hydroboration, hydroamination, epoxidation, aziridation, reductive amination, C-H activation, insertion, C-H activation-insertion, C-H activation-substitution, C-halogen activation, C-halogen activation-substitution, C-halogen activation-insertion,
 10 alkene metathesis, polymerization, alkene oligomerization, alkene polymerization, alkyne oligomerization, alkyne polymerization, co-polymerization, CO-alkene co-oligomerization, CO-alkene co-polymerization, CO-alkyne co-oligomerization, and CO-alkyne co-polymerization.

15 150. A polymerization reaction employing a compound characterized by the general formula:



wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group
 20 consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^3 and R^4 are joined together in a
 25 ring structure and/or R^4 and R^5 are joined together in a ring structure and/or R^1 and R^6 are joined together in a ring structure;

G is either oxygen or nitrogen and a is 1 or 2 depending on G; and
 b is 0, 1, 2, 3 or 4.

151. The process of claim 150, wherein each of R^1 and R^2 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted cycloalkyl, aryl and substituted aryl.

5 152. The process of claim 150, wherein R^1 and R^2 are joined in a ring, wherein the said ring has between 5 and 10 non-hydrogen atoms.

153. The process of claim 152, wherein said ring has between 5 and 6 non-hydrogen atoms in the backbone of the ring.

10

154. The process of claim 150, wherein R^1 is a substituted or unsubstituted phenyl.

155. The process of claim 154, wherein R^1 is a substituted phenyl and
15 there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and
20 combinations thereof.

156. The process of claim 155, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl,
25 cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

157. The process of claim 150, wherein R^4 is selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted
30 cycloalkyl, heteroalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

158. The process of claim 157, wherein R^4 is selected from the group consisting of hydrogen, alkyl, aryl and cycloalkyl.

159. The process of claim 150, wherein R^4 is joined in a ring structure with G and R^3 , wherein said ring has at least four atoms in the backbone of the ring.

5

160. The process of claim 159, wherein G is nitrogen and R^3 forms a methylene bridge to R^4 .

161. The process of claim 150, wherein G is nitrogen and a is 2 and each
10 R^3 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno and combinations thereof.

15

162. The process of claim 161, wherein at least one R^3 is benzyl or a substituted or unsubstituted phenyl.

163. The process of claim 162, wherein said R^3 is a substituted phenyl
20 and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio,
25 seleno, and combinations thereof.

164. The process of claim 163, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl,
30 cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

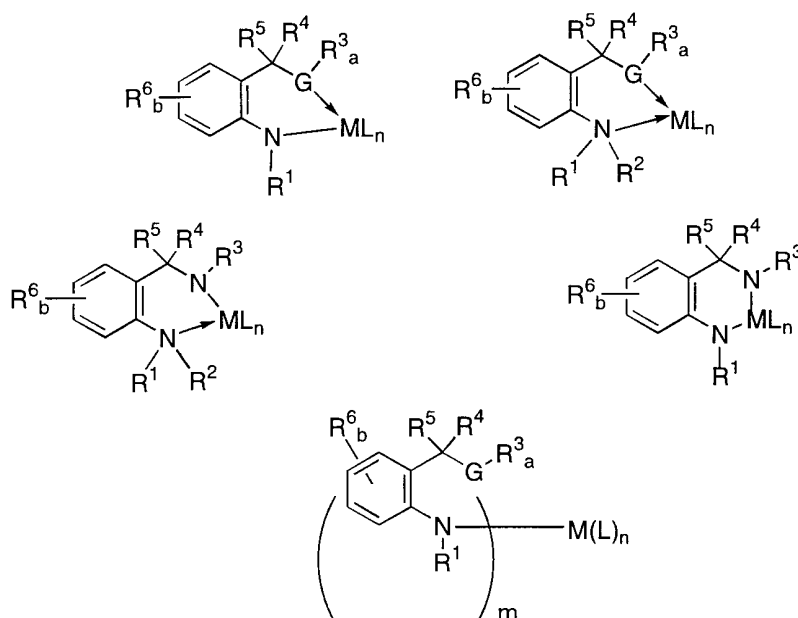
165. The process of claim 150, wherein R^5 is selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl,

59

heteroalkyl, aryl, substitute aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, amino and silyl.

166. The process of claim 165, wherein R^5 is selected from the group consisting of alkyl, aryl and cycloalkyl.

167. A process for polymerizing an olefin, diolefin or acetylenically unsaturated compound, comprising contacting said olefin, diolefin or acetylenically unsaturated compound to a complex that can be characterized by one of the following general formulas:



wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure and/or R^4 and R^5 are joined together in a ring structure and/or R^1 and R^6 are joined together in a ring structure;

G is either nitrogen or oxygen and a is 1 or 2 depending on G;

b is 0, 1, 2, 3 or 4;

M is a transition metal selected from the group consisting of Groups 3, 4, 5, 6, 7, 8, 9 and 10 of the Periodic Table of Elements;

L is independently each occurrence, a ligand;

5 n is a number 0, 1, 2, 3, 4, and 5; and

m is 1, 2, 3 or 4.

168. The process of claim 167, wherein M is selected from the group consisting of Sc, Y, Zr, Ti, Hf, V, Nb, Ta, Cr, Mo, Mn, Fe, Ru, Co, Rh, Ni, Pd,
10 Pt.

169. The process of claim 168, wherein M is selected from the group consisting of Pd, Ni, Co, Fe, Ru, Rh, Ir, Pt, Cr, Mo, Mn, and V.

15 170. The process of claim 167, wherein L is selected from the group consisting of hydrogen, halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

20

171. The process of claim 167, wherein L is selected from the group consisting of carbon monoxide, isocyanide, nitrous oxide, PA₃, NA₃, OA₂, SA₂, SeA₂, and combinations thereof, wherein each A is independently selected from a group consisting of alkyl, substituted alkyl, heteroalkyl, cycloalkyl, substituted
25 cycloalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, and amino.

172. The process of claim 167, wherein R¹ is a substituted or unsubstituted phenyl.

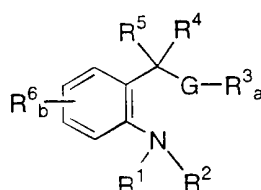
30

173. The process of claim 172, wherein R¹ is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted

heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

174. The process of claim 167, wherein said process is a continuous
5 process run at a temperature of between -100°C and 500°C .

175. A process for making a compound characterized by the general
formula: formula:

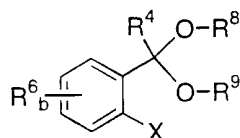


10 wherein each R^1 , R^2 , R^3 , R^4 , R^5 and R^6 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof; optionally, R^1 and R^2
15 are joined together in a ring structure and/or R^3 and R^4 are joined together in a ring structure;

G is either oxygen or nitrogen and a is 1 or 2 depending on G; and
b is 0, 1, 2, 3 or 4;

the step of the process comprising:

20 (1) reacting a compound characterized by the general formula:



where X is selected from the group consisting of chloro, bromo, iodo, triflate and tosylate; and R^8 and R^9 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl,

25 heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl,

heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof;

with an amine characterized by the general formula HNR^1R^2 , where R^1 and R^2 are as defined above.

5

176. The process of claim 175, wherein step (1) employs a catalyst that is a composition comprising M' and L' where M' is a homogeneous or heterogeneous metal precursor catalyst or catalyst and L' is a phosphine or nitrogen containing ligand.

10

177. The process of claim 176, wherein L' is ligand that is either bidentate, tridentate or hemi-labile and is unsubstituted or substituted, supported or unsupported, water-soluble or insoluble, soluble or insoluble in organic solvents.

15

178. The process of claim 176, wherein M' includes a metal selected from the group consisting of Pd, Ni or Pt.

179. The process of claim 175, further comprising the steps of:

20

(2) hydrolyzing an acetyl or ketal functionality of the product of the reaction in step (1); and

(3) reacting the product of step (2) with an amine;

180. The process of claim 179, wherein steps (1) and (2) are performed in a one-pot reaction, without the isolation of any product from step (1).

25

181. The process of claim 179 wherein steps (1), (2) and (3) are performed in a one-pot reaction, without the isolation of any product(s) from steps (1) or (2).

30

182. The process of claim 179, wherein said amine in step (3) is a primary amine which may be characterized by the general formula H_2NR^3 , wherein R^3 is as defined above.

63

183. The process of claim 179, wherein R^3 is benzyl or a substituted or unsubstituted phenyl.

5 184. The process of claim 183, wherein R^3 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted
10 heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

 185. The process of claim 184, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group
15 consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and isomers thereof.

 186. The process of claim 179, wherein said amine in step (3) is a
20 secondary amine which may be characterized by the general formula HNR^3_2 , wherein each R^3 is as defined above.

 187. The process of claim 186, wherein each R^3 is independently
25 selected from the group consisting of benzyl or a substituted or unsubstituted phenyl.

 188. The process of claim 187, wherein R^3 is a substituted phenyl and there are from 1-5 substituents on said phenyl ring, with each of said substituents independently selected from the group consisting of halogens, alkyl, substituted
30 alkyl, cycloalkyl, substituted cycloalkyl, heteroalkyl, heterocycloalkyl, substituted heterocycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, aryloxy, silyl, boryl, phosphino, amino, thio, seleno, and combinations thereof.

189. The process of claim 188, wherein there are 1, 2 or 3 substituents on said substituted phenyl and said substituents are selected from the group consisting of chloro, fluoro, iodo, bromo, methyl, ethyl, propyl, butyl, cyclopentyl, cyclohexyl, cyclooctyl, phenyl, naphthyl, benzyl, trimethylsilyl and
5 isomers thereof.

190. The process of claim 179, further comprising step (4) wherein said step is a hydrogenation reaction of the product of step (3).

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/21156

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C07C251/24 C07C211/55 C07C223/06 C07D317/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 29 00 260 A (NISSAN CHEMICAL INDUSTRIES LTD) 12 July 1979 (1979-07-12) page 8 -page 13; claims; examples	1,2,5-9, 12-16, 18,93, 94, 97-102
X	US 5 143 929 A (BELLIOTTI ET. AL.) 1 September 1992 (1992-09-01) column 12, Scheme 2, Example 12A	1,2,5-9, 18
X	US 4 981 865 A (BELLIOTTI ET. AL.) 1 January 1991 (1991-01-01) page 16, compound VIII", example 33	1,2,5-9, 18
X	WO 98 17650 A (XENOVA LTD.) 30 April 1998 (1998-04-30) page 13, Scheme 2, example 60	1,2,5-9, 18
	-/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

30 May 2000

Date of mailing of the international search report

15/06/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Helps, I

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/21156

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 27179 A (NOVARTIS) 31 July 1997 (1997-07-31) page 73, paragraph 2d ---	1,2,5-9, 18
X	H. OKAWA ET. AL.: "Macro Chelate Rings. III. " BULLETIN OF THE CHEMICAL SOCIETY OF JAPAN, vol. 43, no. 6, June 1970 (1970-06), pages 1729-33, XP000909661 page 1730; figure 2 ---	93, 100-102, 106
X	J. DABROWSKI ET. AL.: "Symmetrically Bifurcate Hydrogen Bonding III. (sym-o,o'-Diacyl)-Diphenylamines." TETRAHEDRON, vol. 29, no. 15, 1973, pages 2257-60, XP000909660 figures 1-3 ---	1,2,5-9, 18
X	W.E. COYNE ET. AL.: "3,4-Dihydro-2(1H)-quinazolines." JOURNAL OF MEDICINAL CHEMISTRY, vol. 11, 1968, pages 1208-1213, XP000909664 table 1 ---	93, 100-102, 106,107
X	J. LEHMANN ET. AL.: "Zur reduzierenden Spaltung von Chinazolin-2,4-dionen." ARCHIV DER PHARMAZIE, vol. 315, no. 11, 1982, pages 967-9, XP002139157 page 967, compounds 3a and 3b ---	93,94, 97, 100-102, 106
X	J. ROSEVAER ET. AL.: "The Preparation of Some 2-nitroacridines and Related Compounds." AUSTRALIAN JOURNAL OF CHEMISTRY, vol. 34, no. 4, 1981, pages 839-53, XP000909696 page 841, compounds 32, 35, 36 ---	1,2,5-9, 18
X	D. ST.C BLACK ET. AL.: "Metal Template Reactions IV. The Attempted Dimerization of alpha-omega-Amino Aldehydes Around Nickel Ions. " AUSTRALIAN JOURNAL OF CHEMISTRY, vol. 23, no. 10, 1970, pages 2055-65, XP000909669 page 2056, compounds 2 and 5; page 2058, compounds 8, 10 and 11; page 2060, compound 15 --- -/--	1,2,5-9, 12,13,18

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/21156

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	J.S. BAUM ET. AL.: "Nickel-Catalysed Transformations of 2,1-Benzoxazoles with Organozinc Reagents." JOURNAL OF ORGANIC CHEMISTRY, vol. 52, no. 14, 10 July 1987 (1987-07-10), pages 2983-8, XP000909657 pages 2984-5, Schemes I-V. ---	1,2,5-9, 18,93, 97, 100-102
X	M. FISCHER: "Lichtreaktionen von N-Aryl-oxindolen mit nucleophilen Agienten." CHEMISCHE BERICHTE, vol. 102, 1969, pages 3495-9, XP000909722 page 3496, compounds 5a and 5c-g ---	93,97, 100-102, 106
X	H. ISHII ET. AL.: "Fischer Indolization and Its Related Compounds. XXIII. Fischer Indolization of Ethyl Pyruvate 2(2,6-Dimethoxyphenyl)phenylhydrazone." CHEMICAL AND PHARMACEUTICAL BULLETIN , vol. 38, no. 8, 1990, pages 2118-26, XP000887390 page 2121, compound 26 ---	1,2,5-9, 18
X	CHEMICAL ABSTRACTS, vol. 98, no. 15, 11 April 1983 (1983-04-11) Columbus, Ohio, US; abstract no. 125625n, NISSAN CHEMICAL INDUSTRIES: "Anthranilaldehyde derivatives" page 596; column 1; XP002139158 abstract & JP 57 139047 A (NISSAN CHEMICAL INDUSTRIES) 27 August 1982 (1982-08-27) ---	1,2,5-9, 18
X	CHEMICAL ABSTRACTS, vol. 70, no. 15, 14 April 1969 (1969-04-14) Columbus, Ohio, US; abstract no. 67938a, A. SALLMANN ET. AL.: "Analgesic cinnamic acid derivatives." page 331; column 2; XP002139159 abstract & ZA 6 705 990 A (GEIGY, J.R. AG.) 23 July 1968 (1968-07-23) ---	1,2,5-9, 18
A	WO 98 30609 A (DU PONT) 16 July 1998 (1998-07-16) page 1 -page 13; claims; examples ---	1-190
	-/--	

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/21156

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 54337 A (SYMYX TECHNOLOGIES) 28 October 1999 (1999-10-28) cited in the application page 1 -page 4; claims; examples -----	1-190
A	WO 99 05154 A (SYMYX TECHNOLOGIES) 4 February 1999 (1999-02-04) claims; examples -----	1-190

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/21156

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2900260 A	12-07-1979	JP 54095533 A CA 1113120 A CH 637365 A FR 2414037 A GB 2011897 A, B NL 7812595 A US 4188343 A	28-07-1979 24-11-1981 29-07-1983 03-08-1979 18-07-1979 11-07-1979 12-02-1980
US 5143929 A	01-09-1992	NONE	
US 4981865 A	01-01-1991	US 5112846 A US 5075330 A	12-05-1992 24-12-1991
WO 9817650 A	30-04-1998	AU 4713697 A AU 717724 B AU 4713797 A CZ 9901271 A CZ 9901351 A EP 0934277 A EP 0934278 A WO 9817649 A GB 2333293 A GB 2334032 A NO 991833 A NO 991835 A PL 332728 A PL 332877 A ZA 9709328 A	15-05-1998 30-03-2000 15-05-1998 15-09-1999 15-09-1999 11-08-1999 11-08-1999 30-04-1998 21-07-1999 11-08-1999 03-06-1999 16-06-1999 11-10-1999 25-10-1999 06-07-1998
WO 9727179 A	31-07-1997	AU 1592197 A	20-08-1997
JP 57139047 A	27-08-1982	NONE	
ZA 6705990 A		NONE	
WO 9830609 A	16-07-1998	AU 5915098 A EP 0952997 A NO 993295 A PL 334836 A	03-08-1998 03-11-1999 01-09-1999 27-03-2000
WO 9954337 A	28-10-1999	AU 3558499 A EP 0989988 A	08-11-1999 05-04-2000
WO 9905154 A	04-02-1999	US 6030917 A AU 4673497 A AU 4749397 A AU 4812097 A AU 4902497 A AU 7801698 A AU 8499798 A EP 0934515 A EP 0920436 A EP 0950114 A EP 1000074 A WO 9815969 A WO 9815813 A WO 9815501 A WO 9815805 A	29-02-2000 05-05-1998 05-05-1998 05-05-1998 05-05-1998 30-12-1998 16-02-1999 11-08-1999 09-06-1999 20-10-1999 17-05-2000 16-04-1998 16-04-1998 16-04-1998 16-04-1998

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/21156

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9905154 A		WO 9856796 A	17-12-1998
		WO 9905318 A	04-02-1999
		US 5959297 A	28-09-1999
		US 6034775 A	07-03-2000