WO2007/136493 discloses a process for the polymerization of propylene, optionally ethylene, and further, optionally, one or more C_{4-30} α-olefins and/or one or more conjugated or nonconjugated dienes, under continuous, solution polymerization conditions, to prepare a high molecular weight polymer or interpolymer. The process comprising conducting the polymerization in the presence of a catalyst composition comprising a hafnium complex of a polyvalent aryloxyether.

International Publication WO2007/136495 discloses a catalyst composition comprising a zirconium complex of a polyvalent aryloxyether, and an alumoxane, and polymerization processes employing the same, and especially the continuous, solution polymerization of ethylene and one or more C_{3-30} olefins or diolefins, to prepare copolymers having reduced cocatalyst by-product content. International Publication WO2007/136506 discloses a catalyst composition comprising a zirconium complex of a polyvalent aryloxyether, and a polymerization process employing the same, and especially a continuous, solution polymerization of ethylene and one or more C_{3-30} olefins or diolefins, to prepare interpolymers having improved processing properties. See also the following references for polymerization processes, catalysts and/or polymer products: WO2011/002998, WO2011/002986, WO2009/067337, WO/2011/008837, and WO/2010/033601.

However, there remains a need for new polymerization processes that can be used to form high molecular weight ethylene-based polymers with good comonomer incorporation. There is a further need for such processes that can operate at higher temperatures (T > 170°C), enabling higher molecular weight polymers to be produced at lower, in-reactor viscosities. These needs have been met by the following invention.

SUMMARY

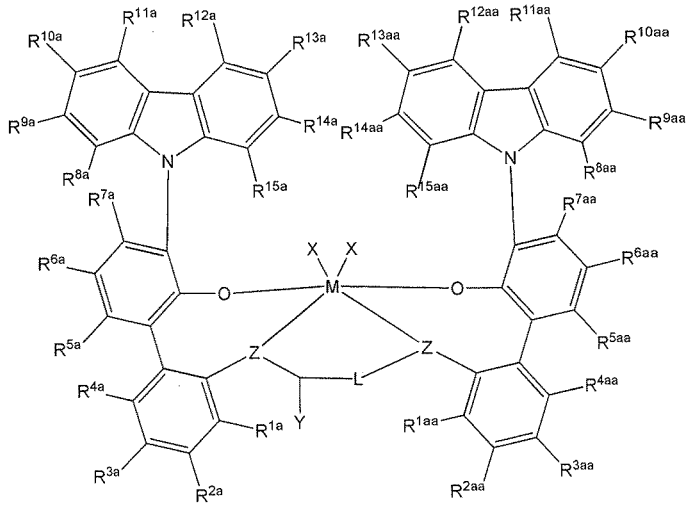
~~In an aspect, t~~There is provided a process to form an ethylene-based polymer, said process comprising at least the following:

polymerizing ethylene in the presence of a metal complex selected from Structure I below:

wherein each heteroatom substituent is independently selected from the following: $-O(R^{XVI})$, $-N(R^{XVII}R^{XVIII})$, $-S(R^{XIX})$, or $-P(R^{XX}R^{XXI})$; and wherein each R^{XVI}, R^{XVII}, R^{XVIII}, R^{XIX}, R^{XX} and R^{XXI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl.

In an aspect, there is provided a process to form an ethylene-based polymer, said process comprising at least the following:

polymerizing ethylene in the presence of a metal complex selected from Structure I below:



(I)

(Structure I),

wherein:

M is a metal selected from Group 3, Group 4, Group 5 or Group 6 of the Periodic Table of the Elements;

R1a, R1aa, R2a, R2aa, R3a, R3aa, R4a, R4aa, R5a, R5aa, R6a, R6aa, R7a, R7aa, R8a, R8aa, R9a, R9aa, R10a, R10aa, R11a, R11aa, R12a, R12aa, R13a, R13aa, R14a, R14aa, R15a, R15aa, independently in each occurrence, is hydrogen, halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilylhydrocarbyl, -O(R), -N(R'R"), -S(R"'), or $-P(R^{IV}R^{V})$; and wherein each R, R', R", R"', R^{IV} and R^{V} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl;

each X is independently selected from halo, hydrocarbyl, or trihydrocarbylsilyl group;

each Z is independently selected from O, S, N(C1-C40)hydrocarbyl, or P(C1-C40)hydrocarbyl;

Y is selected from halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilyl-hydrocarbyl, $-O(R^{VI})$, $-N(R^{VII}R^{VIII})$, $-S(R^{IX})$, or $-P(R^{X}R^{XI})$; and wherein each R^{VI}, R^{VII}, R^{VIII}, R^{IX}, R^{X} and R^{XI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl or a C1-C18 heterohydrocarbyl;

L is selected from linear (C1-C40)hydrocarbylene or (C1-C40)heterohydrocarbylene, and wherein the (C1-C40)heterohydrocarbylene comprises at least one heteroatom substituent, and

wherein each heteroatom substituent is independently selected from the following: –O-, -S-, -S(O)-, -S(O)$_2$-, -Si($R^{XII}R^{XIII}$)-, -P(R^{XIV})-, -N(R^{XV})-; wherein each R^{XII}, R^{XIII}, R^{XIV}, R^{XV} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl; or

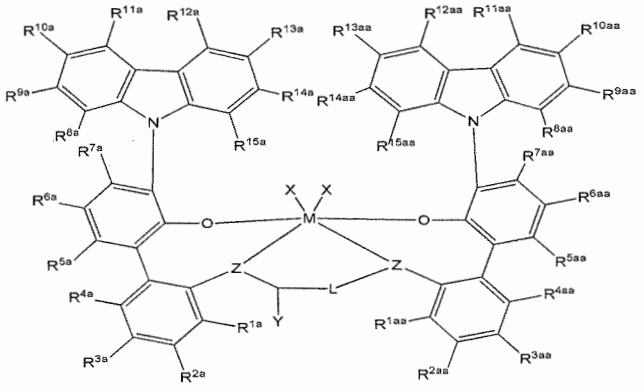
wherein each heteroatom substituent is independently selected from the following: -O(R^{XVI}), -N($R^{XVII}R^{XVIII}$), -S(R^{XIX}), or -P($R^{XX}R^{XXI}$); and wherein each R^{XVI}, R^{XVII}, R^{XVIII}, R^{XIX}, R^{XX} and R^{XXI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl.

In another aspect, there is provided an ethylene-based polymer formed from the process as defined above.

In a further aspect, there is provided a composition comprising the ethylene-based polymer as defined above.

In yet another aspect, there is provided an article comprising at least one component formed from the composition as defined above.

The disclosure also provides a metal complex selected from Structure I below:

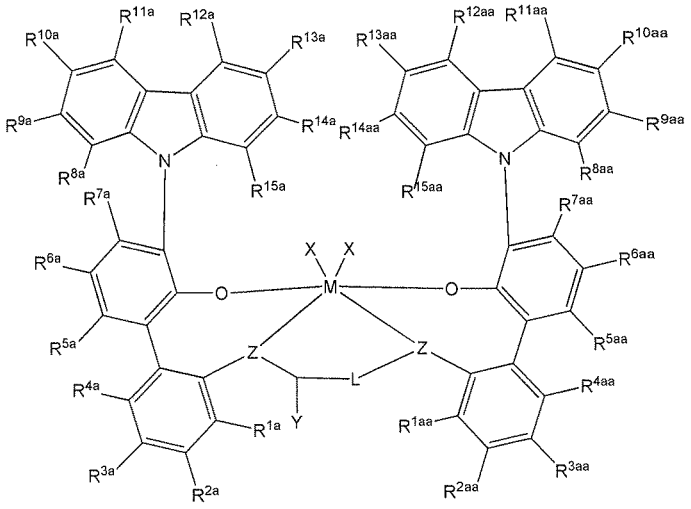


(I)

(Structure I),

wherein the metal and substituents are described above.

In a further aspect, there is provided a metal complex selected from Structure I below:



(I)

(Structure I),

wherein:

M is a metal selected from Group 3, Group 4, Group 5 or Group 6 of the Periodic Table of the Elements;

R1a, R1aa, R2a, R2aa, R3a, R3aa, R4a, R4aa, R5a, R5aa, R6a, R6aa, R7a, R7aa, R8a, R8aa, R9a, R9aa, R10a, R10aa, R11a, R11aa, R12a, R12aa, R13a, R13aa, R14a, R14aa, R15a, R15aa, independently in each occurrence, is hydrogen, halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilylhydrocarbyl, -O(R), -N(R'R"), -S(R"'), or -P($R^{IV}R^{V}$); and wherein each R, R', R", R"', R^{IV} and R^{V} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl;

each X is independently selected from halo, hydrocarbyl, or trihydrocarbylsilyl group;

each Z is independently selected from O, S, N(C1-C40)hydrocarbyl, or P(C1-C40)hydrocarbyl;

Y is selected from halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilyl-hydrocarbyl, -O(R^{VI}), -N(R^{VII} R^{VIII}), -S(R^{IX}), or -P($R^{X}R^{XI}$); and wherein each R^{VI}, R^{VII}, R^{VIII}, R^{IX}, R^{X} and R^{XI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl or a C1-C18 heterohydrocarbyl;

L is selected from linear (C1-C40)hydrocarbylene or (C1-C40)heterohydrocarbylene, and wherein the (C1-C40)heterohydrocarbylene comprises at least one heteroatom substituent,

and

wherein each heteroatom substituent is independently selected from the following: –O-, -S-, -S(O)-, -$S(O)_2$-, -Si($R^{XII}R^{XIII}$)-, -P(R^{XIV})-, -N(R^{XV})-; wherein each R^{XII}, R^{XIII}, R^{XIV}, R^{XV} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl; or

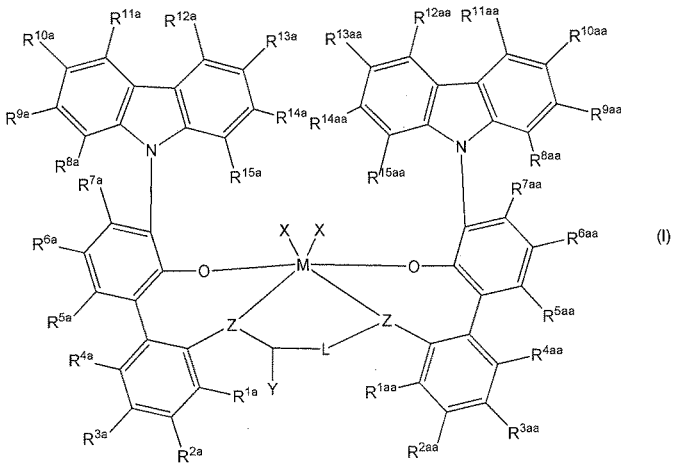
wherein each heteroatom substituent is independently selected from the following: -O(R^{XVI}), -N($R^{XVII}R^{XVIII}$), -S(R^{XIX}), or -P($R^{XX}R^{XXI}$); and wherein each R^{XVI}, R^{XVII}, R^{XVIII}, R^{XIX}, R^{XX} and R^{XXI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl.

DETAILED DESCRIPTION OF THE INVENTION

New polymerization processes have been discovered that use certain bis-phenyl-phenoxy catalysts, and which offer the improvements in molecular weight with high comonomer incorporation, while maintaining high catalyst efficiency.

As discussed above, in a first aspect, the invention provides a process to form an ethylene-based polymer, said process comprising at least the following:

polymerizing ethylene in the presence of a metal complex selected from Structure I below:



(I)

(Structure I),

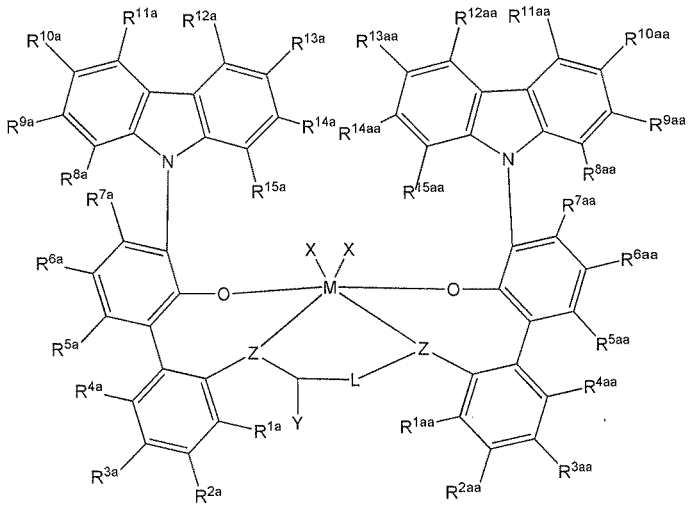
wherein the metal and substituents are described above.

An inventive process may comprise a combination of two or more embodiments as described herein.

CLAIMS:

1. A process to form an ethylene-based polymer, said process comprising at least the following:

polymerizing ethylene in the presence of a metal complex selected from Structure I below:



(I)

(Structure I),

wherein:

M is a metal selected from Group 3, Group 4, Group 5 or Group 6 of the Periodic Table of the Elements;

R1a, R1aa, R2a, R2aa, R3a, R3aa, R4a, R4aa, R5a, R5aa, R6a, R6aa, R7a, R7aa, R8a, R8aa, R9a, R9aa, R10a, R10aa, R11a, R11aa, R12a, R12aa, R13a, R13aa, R14a, R14aa, R15a, R15aa, independently in each occurrence, is hydrogen, halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilylhydrocarbyl, -O(R), -N(R'R"), -S(R"'), or -P($R^{IV}R^{V}$); and wherein each R, R', R", R"', R^{IV} and R^{V} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl;

each X is independently selected from halo, hydrocarbyl, or trihydrocarbylsilyl group;

each Z is independently selected from O, S, N(C1-C40)hydrocarbyl, or P(C1-C40)hydrocarbyl;

Y is selected from halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilyl-hydrocarbyl, -O(R^{VI}), -N(R^{VII} R^{VIII}), -S(R^{IX}), or -P($R^{X}R^{XI}$); and wherein each R^{VI}, R^{VII}, R^{VIII}, R^{IX}, R^{X} and R^{XI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl or a C1-C18 heterohydrocarbyl;

L is selected from linear (C1-C40)hydrocarbylene or (C1-C40)heterohydrocarbylene, and wherein the (C1-C40)heterohydrocarbylene comprises at least one heteroatom substituent, and

Y is selected from halo, hydrocarbyl, trihydrocarbylsilyl, trihydrocarbylsilyl-hydrocarbyl, -O(R^{VI}), -N(R^{VII} R^{VIII}), -S(R^{IX}), or -P($R^{X}R^{XI}$); and wherein each R^{VI}, R^{VII}, R^{VIII}, R^{IX}, R^{X} and R^{XI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl or a C1-C18 heterohydrocarbyl;

L is selected from linear (C1-C40)hydrocarbylene or (C1-C40)heterohydrocarbylene, and wherein the (C1-C40)heterohydrocarbylene comprises at least one heteroatom substituent,

and

wherein each heteroatom substituent is independently selected from the following: –O-, -S-, -S(O)-, -$S(O)_2$-, -Si($R^{XII}R^{XIII}$)-, -P(R^{XIV})-, -N(R^{XV})-; wherein each R^{XII}, R^{XIII}, R^{XIV}, R^{XV} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl; or

wherein each heteroatom substituent is independently selected from the following: -O(R^{XVI}), -N($R^{XVII}R^{XVIII}$), -S(R^{XIX}), or -P($R^{XX}R^{XXI}$); and wherein each R^{XVI}, R^{XVII}, R^{XVIII}, R^{XIX}, R^{XX} and R^{XXI} is independently hydrogen, a C1-C18 aliphatic hydrocarbyl, or a C1-C18 heterohydrocarbyl.