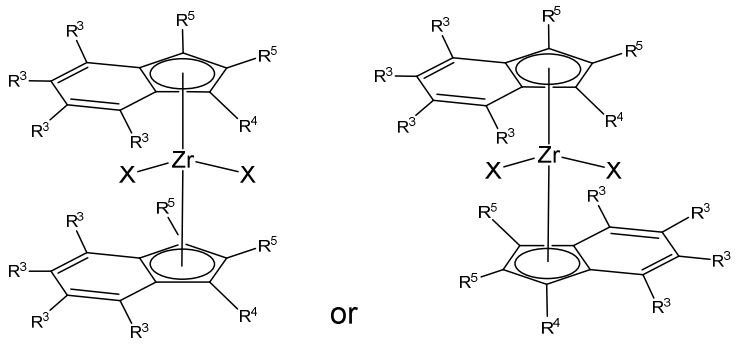
is independently a leaving group selected from a labile hydrocarbyl, a substituted hydrocarbyl, a heteroatom group, or a divalent radical that links to an R^3, R^4, or R^5 group.

[0011a] In one aspect, the present disclosure refers to a method of polymerizing olefins to produce a polyolefin polymer with a multimodal composition distribution, comprising contacting ethylene and a comonomer with a catalyst system, wherein the catalyst system comprises a first catalyst compound and a second catalyst compound that are co-supported to form a commonly supported catalyst system, wherein the first catalyst compound comprises the following formula:

$$(C_5H_aR^1_b)(C_5H_cR^2_d)HfX_2$$

wherein each R^1 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; each R^2 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; a and c are ≥ 3; a+b = c+d = 5; at least one R^1 and at least one R^2 is a hydrocarbyl or substituted hydrocarbyl group; adjacent groups R^1 and R^2 groups may be coupled to form a ring; and each X is independently a leaving group selected from a labile hydrocarbyl, substituted hydrocarbyl, or heteroatom group; and the second catalyst compound is a mixture of two enantiomers:



,

wherein the meso enantiomer is at least 15 parts in the mixture of the two enantioners, and the rac enantiomer is less than 5 parts in the mixture of the two enantiomers, wherein each R^3 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; R^4 is a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; each R^5 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; wherein R^3, R^4, and R^5 may be the same

CLAIMS

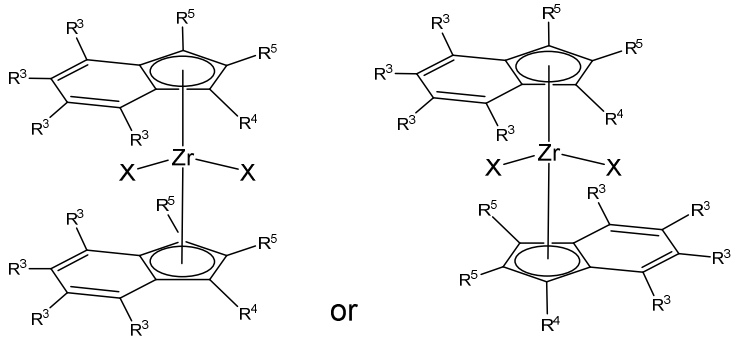
What is claimed is:

1. A method of polymerizing olefins to produce a polyolefin polymer with a multimodal composition distribution, comprising contacting ethylene and a comonomer with a catalyst system, wherein the catalyst system comprises a first catalyst compound and a second catalyst compound that are co-supported to form a commonly supported catalyst system, wherein the first catalyst compound comprises the following formula:

$$(C_5H_aR^1{}_b)(C_5H_cR^2{}_d)HfX_2$$

wherein each R^1 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; each R^2 is independently H, a hydrocarbyl group, a substituted hydrocarbyl

group, or a heteroatom group; a and c are ≥ 3; a+b = c+d = 5; at least one R^1 and at least one R^2 is a hydrocarbyl or substituted hydrocarbyl group; adjacent groups R^1 and R^2 groups may be coupled to form a ring; and each X is independently a leaving group selected from a labile hydrocarbyl, substituted hydrocarbyl, or heteroatom group; and the second catalyst compound is a mixture of two enantiomers:



MESO RAC ,

wherein the meso enantiomer is at least 15 parts in the mixture of the two enantiomers, and the rac enantiomer is less than 5 parts in the mixture of the two enantiomers, wherein each R^3 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; R^4 is a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; each R^5 is independently H, a hydrocarbyl group, a substituted hydrocarbyl group, or a heteroatom group; wherein R^3, R^4, and R^5 may be the same or different; and each X is independently a leaving group selected from a labile hydrocarbyl, a substituted hydrocarbyl, a heteroatom group, or a divalent radical that links to an R^3, R^4, or R^5 group.

2. The method of claim 1, wherein the X group is methyl, and the meso / rac ratio is adjusted by methylation with a solution of 2.3 equivalents of MeLi in ether relative to the catalyst compound.

3. The method of claim 1, comprising forming a product from the polyolefin polymer.

4. The method of claim 1, comprising continuously combining a catalyst component slurry with a catalyst component solution to form the commonly supported catalyst system.

5. The method of claim 4, wherein the catalyst component slurry comprises the first catalyst compound and the catalyst component solution comprises the second catalyst compound.

6. The method of claim 1, comprising adjusting a ratio of the comonomer to ethylene within a polymerization reactor to control a composition distribution, a molecular weight distribution, a melt index (I_2), or a ratio of two melt indices, or any combinations thereof, of the polyolefin polymer.

7. The method of claim 1, comprising adjusting a ratio of the hydrogen to ethylene within a polymerization reactor to control a composition distribution, a molecular weight distribution, a melt index (I_2), or a ratio of two melt indices, or any combinations thereof, of the polyolefin polymer.