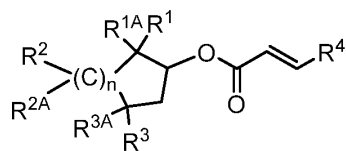


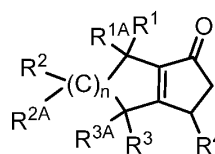
CLAIMS

1. A method of synthesizing a substituted cyclopentadiene compound, the method comprising (A) contacting a compound of formula (1) ("compound (1)"):



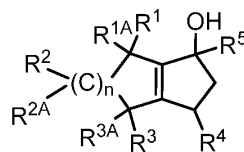
(1), wherein subscript n is 1, 2, 3, or 4; and each of groups

R1, R1A, R2, R2A, R3, R3A, and R4 is independently H or (C₁-C₄)alkyl, or any two adjacent R1 to R3 groups are bonded together to form a (C₁-C₄)alkylene and the remaining group of R1 to R3A is H or (C₁-C₄)alkyl, with an effective amount of a phosphorous pentoxide/methanesulfonic acid reagent (P₂O₅/H₃CSO₃H reagent) and under reaction conditions sufficient to make a compound of formula (2) ("compound (2)"):



(2); wherein subscript n and groups R1 to R4 are as defined above;

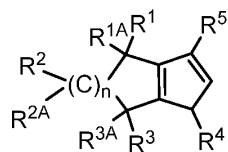
and with the proviso that the contacting step (A) is free of a polyphosphoric acid (PPA); (B) contacting the compound (2) with a metal-R5 reducing agent that is either a hydride-functional reducing agent or a (C₁-C₄)alkyl lithium, under reaction conditions sufficient to



make a compound of formula (3) ("compound (3)"):

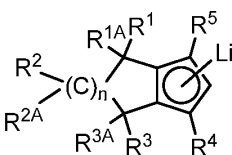
(3), wherein

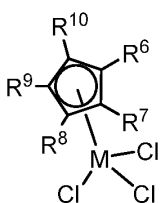
subscript n and groups R1 to R4 are as defined above and R5 is H or (C₁-C₄)alkyl, respectively; and (C) contacting the compound (3) with dehydration reaction conditions to make a substituted cyclopentadiene compound of formula (4) ("compound (4)"):

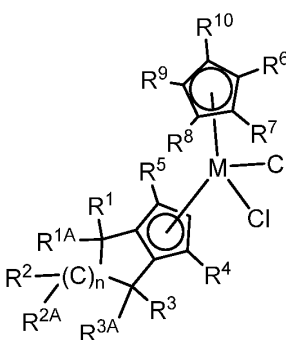


(4), wherein subscript n and groups R1-R5 are as defined above.

2. A method of synthesizing a substituted metallocene compound comprising a metal-(substituted cyclopentadienyl ligand) complex, the method comprising synthesizing the compound (4) according to steps (A) to (C) of claim 1; (D) contacting the compound (4) with an alkyl lithium under reaction conditions sufficient to make a compound of formula (5)

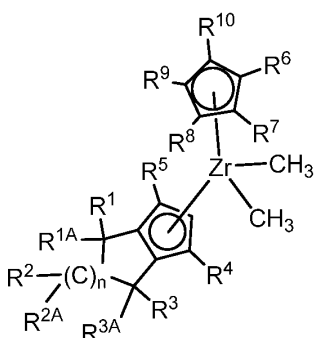
(“compound (5)”):  (5); and (E) contacting the compound (5) with a

compound of formula (6) (“compound (6)”):  (6) under reaction conditions

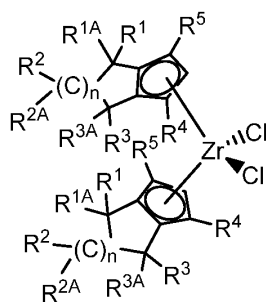
sufficient to make a compound of formula (7) (“compound (7)”): 

(7), wherein subscript n and groups R1 to R5 are as defined above; metal M is a metal of Group 4 of the Periodic Table of the Elements; and each of R6 to R8 is independently H or (C₁-C₄)alkyl and R9 and R10 is independently H or (C₁-C₄)alkyl or R9 and R10 are bonded together and are a (C₃-C₅)alkylene.

3. A method of synthesizing a zirconocene dimethyl complex, the method comprising synthesizing the compound (7) according to steps (A) to (E) of claim 2, wherein M is Zr; and (F) contacting the compound (7) with an effective amount of methyl magnesium bromide under reaction conditions sufficient to make a compound of formula (8) (“compound (8)”):

 (8), wherein subscript n and groups R1 to R10 are as defined above.

4. The method of any one of claims 1 to 3, wherein the ratio of P_2O_5 to H_3CSO_3H used to make the P_2O_5/H_3CSO_3H reagent is from 0.05/1 to 1/1 (weight/weight).
5. The method of any one of claims 1 to 4, wherein the ratio of P_2O_5 to H_3CSO_3H used to make the P_2O_5/H_3CSO_3H reagent is 0.1/1 (weight/weight).
6. The method of any one of claims 1 to 5, wherein the compound (4) is selected from the group consisting of any one of compounds (4a) to (4e):
 compound (4a) is compound (4) wherein subscript n is 2, R1 to R3A is H and each of R4 and R5 is methyl;
 compound (4b) is compound (4) wherein subscript n is 1 and R1-R4 are H and R5 is methyl;
 compound (4c) is compound (4) wherein subscript n is 1 and R1-R3A are H and each of R4 and R5 is methyl;
 compound (4d) is compound (4) wherein subscript n is 3 and R1-R3A are H and each of R4 and R5 is methyl; and
 compound (4e) is compound (4) wherein subscript n is 4 and R1, R1A, two R2, and each R2A are H and two R2 and each of R3, R4 and R5 is methyl.
7. A method of making a dichloro compound of formula (9):



- (9) ("compound (9)"), wherein each subscript n independently is 1, 2, 3, or 4; and each of groups R1, R1A, R2, R2A, R3, R3A, R4, and R5 is independently H or (C₁-C₄)alkyl, or any two adjacent R1 to R3 groups are bonded together to form a (C₁-C₄)alkylene and the remaining group of R1 to R5 is H or (C₁-C₄)alkyl, the method comprising contacting two mole equivalents of the compound (5) with one mole equivalent of $ZrCl_4$, under reaction conditions sufficient to make the compound (9).
8. The method of claim 7 further comprising a step of contacting the compound (9) with an effective amount of methyl magnesium bromide under reaction conditions sufficient to make a dimethyl compound (10) ("compound (10)"), which has a structure identical to that of compound (9) except wherein each Cl atom of compound (9) is replaced by a methyl group (CH₃) in compound (10).

9. A compound of formula (9) made by the method of claim 7 or compound (10) made by the method of claim 8.

10. A method of polymerizing an olefin, the method comprising synthesizing the compound (7) according to the method of claim 2 or synthesizing the compound (8) according to the method of claim 3; contacting the compound (7) or (8) with an activator to make a catalyst; and contacting ethylene and/or an alpha-olefin with the catalyst under conditions sufficient to make a polyolefin polymer comprising a polyethylene homopolymer, an ethylene/alpha-olefin copolymer, or a poly(alpha-olefin) homopolymer; wherein the method is free of platinum, palladium, nickel, rhodium, and ruthenium.

11. The polyolefin polymer made by the method of claim 10 and being free of platinum, palladium, nickel, rhodium, and ruthenium.