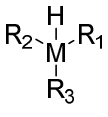
CLAIMS

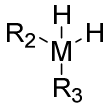
What is claimed is:

1. A method for preventing or reducing low speed pre-ignition in a direct injected, boosted, spark ignited internal combustion engine, said method comprising a step of lubricating the crankcase of the engine with a lubricating oil composition comprising a metal or metalloid hydrogen atom donor compound selected from the group consisting of silicon hydrides, germanium hydrides, and tin hydrides, wherein the metal or metalloid hydrogen atom donor compound has the following formula:


(Formula 1),

wherein R_1, R_2, and R_3 are each independently selected from hydrogen atom, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -O(=O)R_7, or chlorine atom, such that not more than one of R_1, R_2, and R_3 are a hydrogen atom; R_4 is a C_6-C_{14} aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_7 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group; and M is a silicon atom, germanium atom, or tin atom.

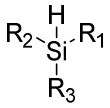
2. The method of claim 1, wherein the metal or metalloid hydrogen atom donor compound has the following formula:



(Formula 2),

wherein R_2 and R_3 are each independently selected from a C6-C14 aryl group, alkyl group, or a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -O(=O)R_7, or chlorine atom, R_4 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_7 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group; and M is a silicon atom, germanium atom, or tin atom.

3. The method of claim 1, wherein the metal or metalloid hydrogen atom donor compound has the following formula:

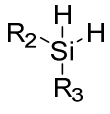


(Formula 3),

wherein R_1, R_2, and R_3 are each independently selected from hydrogen atom, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -O(=O)R_7, or chlorine atom, such that not more than one of R_1, R_2, and R_3 are a hydrogen atom; R_4 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, and R_7 is a

C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group.

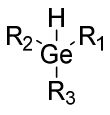
4. The method of claim 3, wherein the metal or metalloid hydrogen atom donor compound has the following formula:



(Formula 4),

wherein where R_2 and R_3 are each independently selected from hydrogen atom, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -O(=O)R_7, or chlorine atom, R_4 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, and R_7 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group.

5. The method of claim 1, wherein the metal or metalloid hydrogen atom donor compound has the following formula:

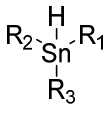


(Formula 5),

wherein R_1, R_2, and R_3 are each independently selected from hydrogen atom, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -O(=O)R_7, or chlorine atom, such that not

more than one of R_1, R_2, and R_3 are a hydrogen atom; R_4 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, and R_7 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group.

6. The method of claim 1, wherein the metal or metalloid hydrogen atom donor compound has the following formula:



(Formula 6),

wherein R_1, R_2, and R_3 are each independently selected from hydrogen atom, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, a C3-C10 cycloalkyl group, -(OR_4), -NR_5R_6, -$O(=O)R_7$, or chlorine atom, such that not more than one of R_1, R_2, and R_3 are a hydrogen atom; R_4 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_5 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, R_6 is H, a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group, and R_7 is a C6-C14 aryl group, saturated or unsaturated C1-C30 alkyl group, or a C3-C10 cycloalkyl group.

7. The method of claim 1, wherein the lubricating oil composition further comprises a detergent selected from calcium detergents, magnesium detergents, sodium detergents, lithium detergents, and potassium detergents.

8. The method of claim 7, wherein the detergent is a carboxylate, salicylate, phenate, or sulfonate detergent.

9. The method of claim 1, wherein the lubricating oil composition further comprises a molybdenum containing compound.

10. The method of claim 1, wherein the lubricating oil composition further comprises at least one other additive selected from an ashless dispersant, an ashless antioxidant, a phosphorus- containing anti-wear additive, a friction modifier, and a polymeric viscosity modifier.

11. The method of claim 1, wherein the lubricating oil composition comprises from 25 to 3000 ppm of metal from the at least one metal or metalloid hydrogen atom donor compound based on the total weight of the lubricating oil composition.

12. A method of preventing or reducing low speed pre-ignition in a direct injected, boosted, spark ignited internal combustion engine, said method comprising the use of at least one metal or metalloid hydrogen atom donor compound selected from the group consisting of silicon hydrides, germanium hydrides, and tin hydrides in a lubricating engine oil composition and lubricating the crankcase of the engine with said lubricating oil composition.

13. The method according to claim 12, wherein the at least one metal or metalloid hydrogen atom donor compound is present at from 25 to 3000 ppm of metal from the metal hydride, based on the total weight of the lubricating oil composition.

14. The method according to claim 12 wherein the engine is a down-sized boosted engine ranging from 0.5 liters to 3.6 liters.