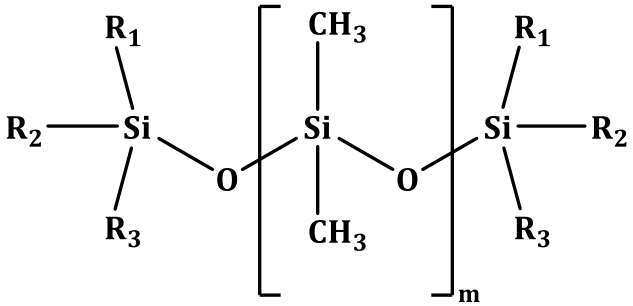
What is Claimed is:

1. A lubricating oil composition formulated for use in a turbocharged gasoline direct-injection engine comprising:

greater than 50 wt.% of a base oil of lubricating viscosity, based on a total weight of the lubricating oil composition, and an additive composition prepared by mixing:

a) an amount of one or more overbased calcium sulfonate detergents to provide at least 1200 ppmw to 2400 ppmw of calcium to the lubricating oil composition, based on the total weight of the lubricating oil composition, and

b) an amount of one or more silicon-containing compound(s) of formula (IA) to provide at least 170 ppmw to 550 ppmw of silicon to the lubricating oil composition, based on the total weight of the lubricating oil composition



(IA)

wherein R_1, R_2, R_3, are each independently selected from an alkyl group comprising from 1 to 20 carbon atoms, m is an integer from 1 to 50; and

wherein a ratio of ppmw of silicon provided by the one or more silicon-containing compound(s) to the lubricating oil composition to the ppmw of calcium provided by the one or more calcium-containing detergent(s) to the lubricating oil composition is at least 0.027; and

the lubricating oil composition is devoid of a calcium salicylate detergent.

2. The lubricating oil composition of claim 1, wherein R_1, R_2 and R_3 are methyl groups.

3. The lubricating oil composition of claim 1, wherein the compound of the Formula (IA) is a polydimethylsiloxane.

4. The lubricating oil composition of claim 1, wherein the compound of the Formula (IA) has a number average molecular weight of from 100 g/mol to 1,000 g/mol, or from 125 g/mol to 800 g/mol, or from 150 g/mol to 600 g/mol, as determined by gel permeation chromatography.

5. The lubricating oil composition of claim 1, wherein the compound of the Formula (IA) has a number average molecular weight of at least 1,000 g/mol, or from 1,000 g/mol to 5,000 g/mol, or from 1,000 g/mol to less than 3866 g/mol, as determined by gel permeation chromatography.

6. The lubricating oil composition of claim 1, wherein the compound of the Formula (IA) has a kinematic viscosity of from 1 cSt to 299 cSt, or from 1 to 50 cSt, or from 1 to 30 cSt, or from 1 to 10 cSt, or from 1 to less than 10 cSt, at 25ºC, as measured according to ASTM-445-19.

7. The lubricating oil composition of claim 1, wherein the compound of Formula (IA) has an elemental ratio of hydrogen atoms to silicon atoms of from 6.115 to 9.

8. The lubricating oil composition of claim 1, wherein the compound of Formula (IA) has an elemental ratio of carbon atoms to silicon atoms of from 2.038 to 3.

9. The lubricating oil composition of claim 1, wherein the compound of Formula (IA) has an elemental ratio of silicon atoms to oxygen atoms of from 1.019 to 2.

10. The lubricating oil composition of any one of claims 1-9, wherein the ratio of the ppmw of silicon provided by the one or more silicon-containing compound(s) to the lubricating oil composition to the ppmw of calcium provided by the one or more calcium-containing detergent(s) to the lubricating oil composition is from 0.027 to 0.75, or from 0.035 to 0.5, or from 0.0375 to 0.45.

11. The lubricating oil composition of any one of claims 1-10, wherein the calcium-containing detergent is present in an amount to provide 1.0 wt% to 10 wt%, or 1.0 wt% to 8 wt%, or 1.0 wt% to 4.0 wt%, or greater than 4 wt% to 8 wt%, based on the total weight of the lubricating oil composition.

12. The lubricating oil composition of any one of claims 1-11, wherein the one or more calcium-containing detergents is an overbased calcium-containing detergent having a TBN of greater than 225 mg KOH/g, or greater than 250 mg KOH/g, or greater than 275 mg KOH/g, or at least 300 mg KOH/g, as measured by ASTM-2896.

13. The lubricating oil composition of any one of claims 1-12, wherein the lubricating oil composition is devoid of detergents selected from the group consisting of phenate-containing detergents.

14. The lubricating oil composition of any one of claims 1-13, wherein the lubricating oil composition provides acceptable stability.

15. The lubricating oil composition of any one of claims 1-14, wherein the lubricating oil composition provides corrosion protection, according to ASTM D6557.

16. The lubricating oil composition of any one of claims 1-15, wherein the lubricating oil composition has a total sulfated ash content of 2 wt% or less, or 1.5 wt% or less, or 1.1 wt% or less, or 1 wt% or less, or 0.8 wt% or less, or 0.5 wt% or less, based on the total weight of the lubricating oil composition.

17. The lubricating oil composition of any one of claims 1-16, wherein the lubricating oil composition is effective to reduce the number of low-speed pre-ignition events relative to the number of low-speed pre-ignition events in the same engine lubricated with the same lubricating oil composition absent the additive composition, as determined in a GM 2.0 Liter, 4 cylinder Ecotec turbocharged gasoline direct injection engine operated at an engine speed of 2,000 rpm and a brake mean effective pressure (BMEP) of 18 bar for 6 segments of 25,000 cycles per segment.

18. A method for reducing low-speed pre-ignition (LSPI) events in a turbocharged gasoline direct-injection engine comprising lubricating the engine with the lubricating oil composition of any one of claims 1-17, wherein the number of low-speed pre-ignition (LSPI) events is reduced relative to a number of low speed pre-ignition events in the same engine lubricated with the same lubricating oil composition absent the additive composition.

19. A method for providing corrosion protection, comprising lubricating an engine with the lubricating oil composition of any one of claims 1-17.

20. The lubricating oil composition of claim 1, wherein the overbased calcium sulfonate detergent is present in an amount sufficient to provide from 1200 ppmw to 2000 ppmw of calcium, based on the total weight of the lubricating oil composition.