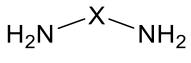
CLAIMS

WHAT IS CLAIMED IS:

1. An olefin copolymer viscosity modifier comprising the reaction product of

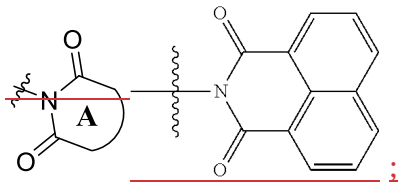
a) an acylated olefin copolymer including an olefin copolymer having grafted thereon through a free radical graft reaction from 0.10 to 0.80 acyl groups per 1,000 number average molecular weight units of olefin copolymer and wherein the olefin copolymer has a number average molecular weight of between about 500 and 40,000;

b) a polyamine compound of Formula I:



; (Formula I)~~;~~ and

c) a dicarboxylic acid or anhydride thereof, which can react with a free primary amine of Formula I to produce a ring moiety A



; (Ring Moiety A)~~;~~

wherein

~~ring moiety A is a 5, 6, or 7 membered heterocyclic ring having up to three rings fused thereon, wherein the ring or rings fused thereon are selected from phenyl, carbocyclic, heterocyclic, heteroaryl, or combinations thereof, and wherein ring A is optionally substituted with one or more substituents selected from halo, -CN, oxo, hydroxyl, haloalkyl, C_{1-4} alkyl, C_{1-4} alkylcarbonyl, C_{1-4} alkoxy, C_{1-4} alkoxycarbonyl, $-NH_2$, $-NH(C_{1-4}$ alkyl), and $N(C_{1-4}$ alkyl)$_2$;~~

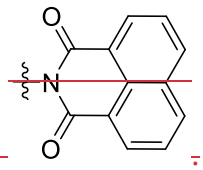
X is a C_2 to C_{50} alkylene linker unit wherein one or more carbon units are optionally and independently replaced with a bivalent moiety selected from the group consisting of -O-, -NR'-, -NR'NR'-, -C(O)-, -C(O)O-, -C(O)NR', and wherein each X is optionally and independently substituted with one or more R" substituents;

each R' is selected from the group consisting of hydrogen, C_{1-6} aliphatic, phenyl, or alkylphenyl; and

each R" is independently selected from the group consisting of C_{1-6} aliphatic, C_{3-7} cycloalkyl, a 3-7 membered heterocycloalkyl, heteroaryl, and phenyl, wherein R" is optionally substituted with halo, cyano, amino, hydroxyl, -OR', -C(O)R', -C(O)OR', or –C(O)NR'$_2$.

2. The viscosity modifier of claim 1, wherein X is a polyalkylamine unit of the formula, –(alkylene-NR')$_n$-alkylene—, and wherein the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and n is an integer from 1 to 20.

3. The viscosity modifier of claim 1, wherein X is a polyalkylene glycol unit of the formula, –(alkylene-O)$_m$-alkylene—, and the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and m is an integer from 1 to 50.

~~4. The viscosity modifier of claim 1, wherein ring moiety A is~~  ~~.~~

~~5.~~4. The viscosity modifier of claim 1, wherein the olefin copolymer is a copolymer of ethylene and an alkylene having 3 to 18 carbon atoms.

5. The viscosity modifier of claim 4, wherein the olefin copolymer has a number average molecular weight of about 3,000 to about 20,000.

6. The viscosity modifier of claim 1, wherein the acyl groups grafted on to the olefin copolymer are obtained from acyl reactions that include at least one carbon-carbon double bond and further comprise at least one carboxylic acid and/or dicarboxylic anhydride group.

7. The viscosity modifier of claim 6, wherein the olefin copolymer has grafted thereon from 0.2 to 0.5 acyl groups per 1000 number average molecular weight units of olefin copolymer.

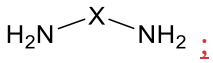
~~6.~~8. An additive concentrate comprising:

a base oil diluent; and

a highly grafted, multi-functional olefin copolymer viscosity modifier comprising the reaction product of

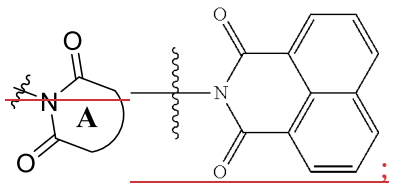
a) an acylated olefin copolymer comprising an olefin copolymer having grafted thereon through a free radical graft reaction from 0.10 to 0.80 acyl groups per 1000 number average molecular weight units of olefin copolymer and wherein the olefin copolymer has a number average molecular weight of between about 500 and 40,000;

b) a polyamine compound of Formula I:



(Formula I)~~;~~ and

c) a dicarboxylic acid or anhydride thereof, which can react with a free primary amine of Formula I to produce a ring moiety A



(Ring Moiety A)~~;~~

wherein

~~ring moiety A is a 5, 6, or 7 membered heterocyclic ring having up to three rings fused thereon, wherein the ring or rings fused thereon are selected from phenyl, carbocyclic, heterocyclic, heteroaryl, or combinations thereof, and wherein ring A is optionally substituted with one or more substituents selected from halo, -CN, oxo, hydroxyl, haloalkyl, C_{1-4} alkyl, C_{1-4} alkylcarbonyl, C_{1-4} alkoxy, C_{1-4} alkoxycarbonyl, $-NH_2$, $-NH(C_{1-4}$ alkyl), and $N(C_{1-4}$ alkyl)$_2$;~~

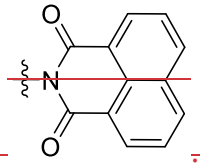
X is a C_2 to C_{50} alkylene linker unit wherein one or more carbon units are optionally and independently replaced with a bivalent moiety selected from the group consisting of -O-, -NR'-, -NR'NR'-, -C(O)-, -C(O)O-, -C(O)NR', and wherein each X is optionally and independently substituted with one or more R" substituents;

each R' is selected from the group consisting of hydrogen, C_{1-6} aliphatic, phenyl, or alkylphenyl; and

each R" is independently selected from the group consisting of C_{1-6} aliphatic, C_{3-7} cycloalkyl, a 3-7 membered heterocycloalkyl, heteroaryl, and phenyl, wherein R" is optionally substituted with halo, cyano, amino, hydroxyl, -OR', -C(O)R', -C(O)OR', or –C(O)NR'$_2$.

~~7.~~9. The additive concentrate of claim ~~8~~6, wherein X is a polyalkylamine unit of the formula, –(alkylene-NR')$_n$-alkylene—, and wherein the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and n is an integer from 1 to 20.

~~8.~~10. The additive concentrate of claim ~~8~~6, wherein X is a polyalkylene glycol unit of the formula, –(alkylene-O)$_m$-alkylene—, and the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and m is an integer from 1 to 50.

9. The additive concentrate of claim 6, wherein ring moiety A is .

11. The additive concentrate of claim 8, wherein the acyl groups grafted on to the olefin copolymer are obtained from acyl reactants that include at least one carbon-carbon double bond and further comprise at least one carboxylic acid and/or dicarboxylic anhydride group.

10.12. The additive concentrate of claim 86, wherein the concentrate includes about 10 to about 60 weight percent of the highly grafted, multi-functional olefin copolymer viscosity modifier in the base oil diluent.

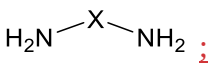
11.13. A lubricating oil composition comprising:

a major amount of a base oil; and

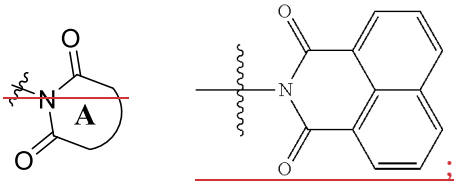
a highly grafted, multi-functional olefin copolymer viscosity modifier comprising the reaction product of

a) an acylated olefin copolymer comprising an olefin copolymer having grafted thereon through a free radical graft reaction from 0.10 to 0.80 acyl groups per 1000 number average molecular weight units of olefin copolymer and wherein the olefin copolymer has a number average molecular weight of between about 500 and 40,000;

b) a polyamine compound of Formula I:

 ; (Formula I); and

c) a dicarboxylic acid or anhydride thereof, which can react with a free primary amine of Formula I to produce a ring moiety A

 ; (Ring Moiety A);

wherein

ring moiety A is a 5, 6, or 7 membered heterocyclic ring having up to three rings fused thereon, wherein the ring or rings fused thereon are selected from phenyl, carbocyclic,

~~heterocyclic, heteroaryl, or combinations thereof, and wherein ring A is optionally substituted with one or more substituents selected from halo, -CN, oxo, hydroxyl, haloalkyl, C_{1-4} alkyl, C_{1-4} alkylcarbonyl, C_{1-4} alkoxy, C_{1-4} alkoxycarbonyl, $-NH_2$, $-NH(C_{1-4}$ alkyl), and $N(C_{1-4}$ alkyl)$_2$;~~

X is a C_2 to C_{50} alkylene linker unit wherein one or more carbon units are optionally and independently replaced with a bivalent moiety selected from the group consisting of -O-, -NR'-, -NR'NR'-, -C(O)-, -C(O)O-, -C(O)NR', and wherein each X is optionally and independently substituted with one or more R" substituents;

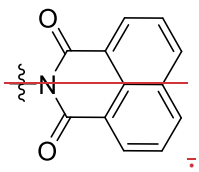
each R' is selected from the group consisting of hydrogen, C_{1-6} aliphatic, phenyl, or alkylphenyl; and

each R" is independently selected from the group consisting of C_{1-6} aliphatic, C_{3-7} cycloalkyl, a 3-7 membered heterocycloalkyl, heteroaryl, and phenyl, wherein R" is optionally substituted with halo, cyano, amino, hydroxyl, -OR', -C(O)R', -C(O)OR', or –C(O)NR'$_2$.

~~12.~~14. The lubricating oil composition of claim 13~~11~~, wherein X is a polyalkylamine unit of the formula, –(alkylene-NR')$_n$-alkylene—, and wherein the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and n is an integer from 1 to 20.

~~13.~~15. The lubricating oil composition of claim 13~~11~~, wherein X is a polyalkylene glycol unit of the formula, –(alkylene-O)$_m$-alkylene—, and the alkylene moieties are C_1-C_6 branched or straight alkylene moieties, and m is an integer from 1 to 50.

~~14.~~16. The lubricating oil composition of claim 13~~11~~, wherein the olefin copolymer has a number average molecular weight of about 3,000 to about 20,000.~~ring moiety A is~~



~~15.~~17. The lubricating oil composition of claim 13~~11~~, wherein the lubricating oil composition includes about 0.01 to about 10 weight percent of the highly grafted, multi-functional olefin copolymer viscosity modifier.