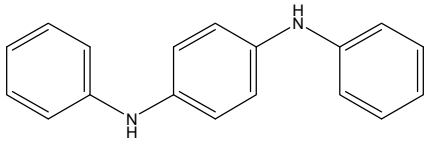
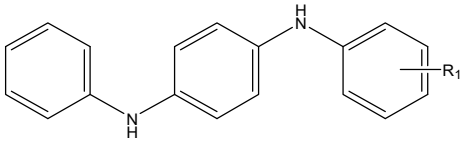
CLAIMS

1. An anti-degradant, consisting of

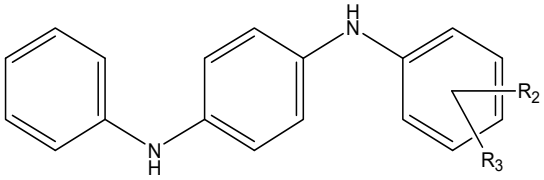
at least two compounds, each of the compounds being selected from a compound of Formula I, a compound of Formula II, or a compound of Formula III-b:



I



II



III-b

wherein the at least two compounds are compounds of different formulae,

R_1 is a C1-C12 alkyl or C3-C8 cycloalkyl; and

R_2 and R_3 are identical or different, each is independently selected from the group consisting of C1-C12 alkyl and C3-C8 cycloalkyl;

with the proviso that the anti-degradant is not an anti-degradant consisting of a compound of Formula I and a compound of Formula II wherein R_1 is a methyl in an ortho-position.

2. The anti-degradant of claim 1, wherein

R_1 is a C1-C12 alkyl in the ortho-position, a C1-C12 alkyl in a para-position or a C3-C8 cycloalkyl in a para-position; and/or

R_2 and R_3 each independently are C1-C6 alkyl.

3. The anti-degradant of claim 2, wherein R_2 is a C1-C4 alkyl in an ortho-position, and R_3 is

a C1-C6 alkyl in a meta- or para-position.

4. The anti-degradant of claim 1, wherein

R_1 is a methyl in an ortho-position or a para-position, a butyl in an ortho-position, a cyclohexyl in a para-position or a 2,4,6-trimethyloctyl in a para-position; and/or

R_2 is a methyl in an ortho-position, and R_3 is an isobutyl in a para-position or 1,3-dimethylbutyl in a meta-position; or R_2 is an ethyl in an ortho-position, and R_3 is an ethyl in a para-position.

5. The anti-degradant of claim 1, wherein

the anti-degradant comprises the compound of Formula I and the compound of Formula II, and a mass ratio of the compound of Formula I to the compound of Formula II is in a range of 1:3 to 3:1; or

the anti-degradant comprises the compound of Formula II and the compound of Formula III-b, and a mass ratio of the compound of Formula II to the compound of Formula III-b is in a range of 3:1 to 1:3; or

the anti-degradant comprises the compound of Formula I, the compound of Formula II, and the compound of Formulae III-b, and a mass percentage of the compound of Formula I is in a range of 5-20%, a mass percentage of the compound of Formula II is in a range of 45-85%, and a mass percentage of the compound of Formula III-b is in a range of 5-45%, based on a total mass of all compounds.

6. The anti-degradant of claim 5, wherein

the mass ratio of the compound of Formula I to the compound of Formula II is in a range of 1:2 to 2:1; or

the mass ratio of the compound of Formula II to the compound of Formula III-b is in a range of 1:2 to 2:1; or

in the anti-degradant comprising the compound of Formula I, the compound of Formula II, and the compound of Formulae III-b, the mass percentage of the compound of Formula I is in a range of 8-18%, the mass percentage of the compound of Formula II is in a range of 48-82%, and

the mass percentage of the compound of Formula III-b is in a range of 8-42%.

7. The anti-degradant of claim 5, wherein in the anti-degradant comprising the compound of Formula I, the compound of Formula II, and the compound of Formulae III-b, the mass percentage of the compound of Formula II is in a range of 50-80%, and the mass percentage of the compound of Formula III-b is in a range of 10-40%.

8. The anti-degradant of claim 1, wherein the anti-degradant comprises the compound of Formula I, the compound of Formula II, and the compound of Formula III-b;

wherein R_1 is methyl in an ortho-position; R_2 is methyl in an ortho-position and R_3 is isobutyl in a para-position; and a mass percentage of the compound of formula I is in a range of 8-12%, a mass percentage of the compound of formula II is in a range of 78-82%, and a mass percentage of the compound of formula III-b is in a range of 8-12%, based on a total mass of all compounds; or

wherein R_1 is methyl in a para-position; R_2 is methyl in an ortho-position and R_3 is 1,3-dimethylbutyl in a meta-position; and a mass percentage of the compound of Formula I is in a range of 15-18%, a mass percentage of the compound of Formula II is in a range of 64-68%, and a mass percentage of the compound of Formula III-b is in a range of 15-18%, based on a total mass of all compounds; or

wherein R_1 is butyl in an ortho-position; R_2 is ethyl in an ortho-position and R_3 is ethyl in a para-position; and a mass percentage of the compound of Formula I is in a range of 8-12%, a mass percentage of the compound of Formula II is in a range of 48-52%, and a mass percentage of the compound of Formula III-b is in a range of 38-42%.

9. A rubber composition, comprising the anti-degradant of any of claims 1-8.

10. The rubber composition of claim 9, wherein a content of the anti-degradant is in a range of 0.1-5 parts by mass per 100 parts by mass of a diene elastomer contained in the rubber composition.

11. The rubber composition of claim 10, wherein the content of the anti-degradant is in a range of 0.1-2.0 parts by mass per 100 parts by mass of a diene elastomer contained in the rubber composition.

12. The rubber composition of claim 10, wherein the content of the anti-degradant is in a range of 0.5-5.0 parts by mass per 100 parts by mass of a diene elastomer contained in the rubber composition.

13. A rubber article prepared using the rubber composition of any one of claims 9 to 12 as a rubber ingredient.

14. The rubber article of claim 13, wherein the rubber article is a tire, or a belt ply or sidewall of the tire.

15. Use of the anti-degradant of any one of claims 1 to 8 in promoting resistance of a rubber to thermo-oxidative aging and ozone aging.

16. Use of the rubber composition of any one of claims 9 to 12 for manufacturing or retreading tires.