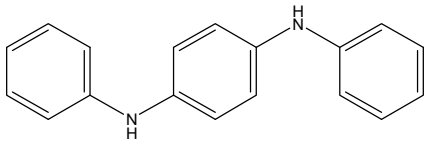
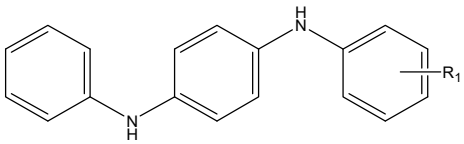
~~WE~~ CLAIMS~~:~~

1. An anti-degradant, ~~comprising~~ consisting of

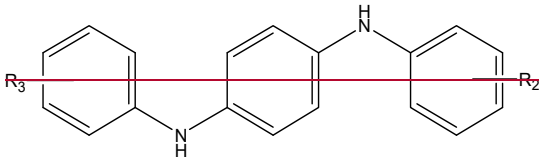
at least two compounds, each of the compounds being selected from a compound of Formula I, a compound of Formula II, ~~a compound of Formula III-a,~~ or a compound of Formula III-b:



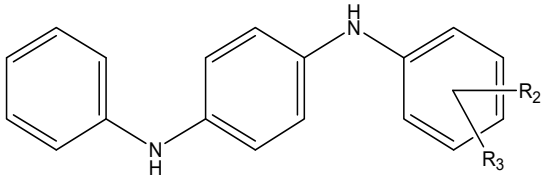
I



II



~~III-a~~



III-b

wherein the ~~selected~~ at least two compounds are compounds of different formulae ~~and are not compounds of Formulae III-a and III-b at the same time when the anti-degradant has only two compounds~~,

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 ~~and a compound of Formula III-a~~ wherein R_1 is a methyl in an ortho-position~~, and R_2 and R_3 are each 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~~; preferably, in the compound of Formula III-a, R_2 is a C1-C4 alkyl in an ortho-position, and R_3 is a C1-C4 alkyl in a meta-position; preferably, in the compound of Formula III-b, 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~~.

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.

~~3~~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

~~in the compound of Formula III-a, R_2 is a methyl in an ortho-position, and R_3 is a methyl or ethyl in a meta-position; and/or~~

~~in the compound of Formula III-b,~~ 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.

~~4~~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 ~~preferably~~ in a range of 1:3 to 3:1~~, preferably 1:2 to 2:1~~; or

the anti-degradant comprises the compound of Formula II and ~~one or both of~~ the compound~~s~~ of Formula~~e III-a and~~ III-b, and a mass ratio of the compound of Formula II to ~~a total of one or both of~~ the compound~~s~~ of Formula~~e III-a and~~ III-b is ~~preferably~~ in a range of 3:1 to 1:3~~, preferably 1:2 to 2:1~~; or

~~the anti-degradant comprises the compound of Formula I, the compound of Formula II, and~~

~~one or both of the compounds of Formulae III-a and III-b, preferably~~ the anti-degradant comprises the compound of Formula I, the compound of Formula II, and the compound of Formulae III-b~~; preferably~~, and a mass percentage of the compound of Formula I is in a range of 5-20%, ~~preferably 8-18%,~~ a mass percentage of the compound of Formula II is in a range of 45-85%, ~~preferably 48-82%, more preferably 50-80%,~~ and a mass percentage of ~~the one or both of~~ the compound~~s~~ of Formula~~e~~ ~~III-a and~~ III-b is in a range of 5-45%~~, preferably 8-42%, more preferably 10-40%~~, based on a total mass of all compounds~~; or~~

~~the anti-degradant comprises the compound of Formula I and the compound of Formula III-a, and preferably a mass ratio of the compound of Formula I to the compound of Formula III-a is in a range of 3:1 to 1:3, preferably 2:1 to 1:2~~.

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%.

~~5~~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%.

~~6~~9. A rubber composition, comprising the anti-degradant of any of claims 1-~~5~~8~~;~~ ~~preferably, content of the anti-degradant is in a range of 0.1-5 parts by mass, preferably 0.1-2.0 parts by mass or 0.5-5.0 parts by mass, per 100 parts by mass of a diene elastomer contained in the rubber composition~~.

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.

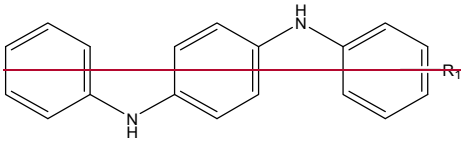
11. The rubber composition of claim 10, wherein the content of the anti-degradant is in a range of 0.1-2.0 parts by mass per 100 parts by mass of a diene elastomer contained in the rubber composition.

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.

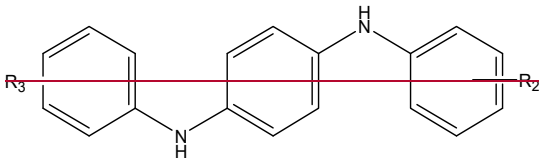
~~7~~13. A rubber article prepared using the rubber composition of any one of claims ~~6~~9 to 12 as a rubber ingredient~~; preferably, the rubber article is a tire, or a belt ply or sidewall of the tire~~.

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

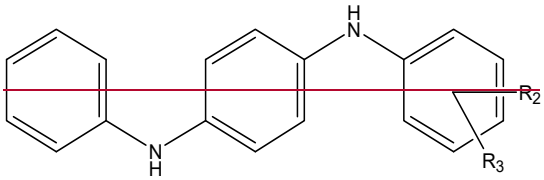
~~8. A compound having a structure as shown in Formula II, III-a or III-b:~~



~~II,~~



~~III-a~~



~~III-b~~

~~wherein R_1 is a C3-C8 cycloalkyl or a C1-C12 alkyl.~~

~~R_2 and R_3 are identical or different, each being independently selected from a C1-C12 alkyl or a C3-C8 cycloalkyl;~~

~~with the provision R_1 is not a methyl in an ortho-position, and R_2 and R_3 are not a methyl in an ortho-position at the same time in Formula III-a.~~

~~9. The compound of claim 8, wherein~~

~~R_1 is a C2-C4 alkyl in the ortho-position, a C1-C12 alkyl in a para-position or a C3-C8 cycloalkyl in a para-position;~~

~~in the compound of Formula III-a, R_2 is a C1-C4 alkyl in an ortho-position, and R_3 is a C1-C4 alkyl in a meta-position;~~

~~in the compound of Formula III-b, 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.~~

~~10~~15. Use of ~~the compound of any of claims 8-9 or~~ the anti-degradant of any one of claims 1~~-5~~ to 8 in promoting resistance of a rubber to thermo-oxidative aging and ozone aging.

~~11~~16. Use of the rubber composition of any one of claim~~s 6~~9 to 12 for manufacturing or retreading tires.