(Patent Document 7) JP-A 2008-503628

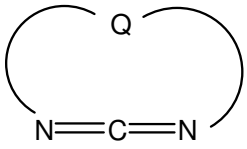
(Patent Document 8) JP-A 2011-068814

SUMMARY

In one aspect of the present disclosure, there is provided a thermosetting resin composition comprising:

(A) an epoxy resin; and

(B) a cyclic carbodiimide compound (component B) including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure:

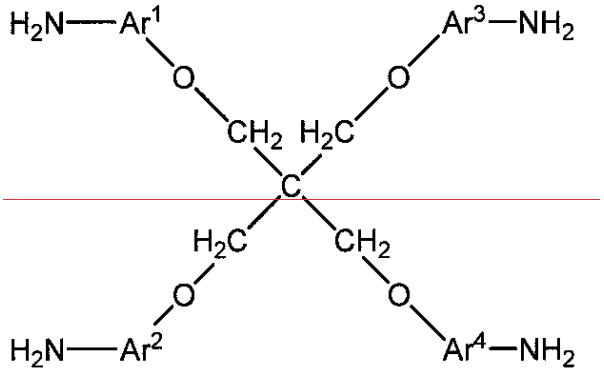


(B-i)

wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group or a combination of these groups, and may contain a hetero atom or substituent; and~~/or~~

(C) a curing agent (component C).

~~(b) a polyvalent amine-based curing agent represented by the following formula (b-i):~~



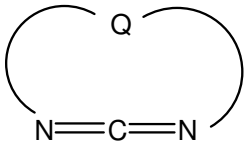
~~(b-i)~~

~~wherein Ar^1 to Ar^4 are each independently a phenylene group or naphthalene-diyl group which may be substituted by a~~

~~substituent.~~

In another aspect of the present disclosure, there is provided a process for producing a cured resin, comprising the step of heating the thermosetting resin composition disclosed herein.

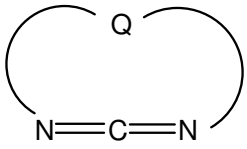
In a further aspect of the present disclosure, there is provided a method of using a cyclic carbodiimide compound including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure as a curing agent for an epoxy resin:



(B-i)

wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group, or a combination of these groups, and may contain a hetero atom or substituent.

In another aspect of the present disclosure, there is provided a method of using a cyclic carbodiimide compound including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure as a curing accelerator for an epoxy resin:



(B-i)

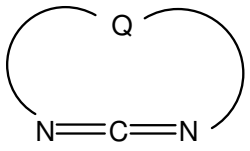
wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group, or a combination of these groups and may contain a hetero atom

CLAIMS

1. A thermosetting resin composition comprising:

(A) an epoxy resin (component A); and

(B) a cyclic carbodiimide compound (component B) including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure:

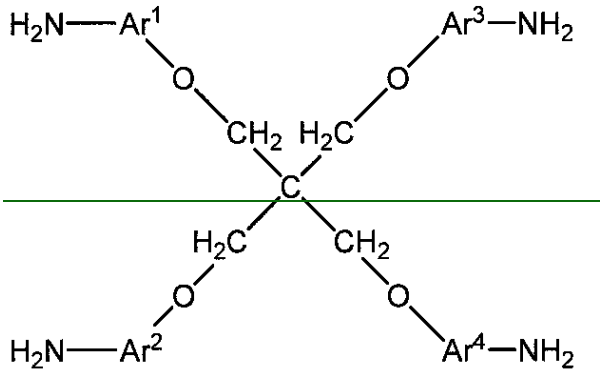


(B-i)

wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group or a combination of these groups, and may contain a hetero atom or substituent; and

(C) a curing agent (component C).~~and/or~~

~~(b) a polyvalent amine-based curing agent represented by the following formula (b-i):~~



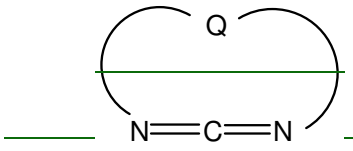
~~(b-i)~~

~~wherein Ar^1 to Ar^4 are each independently a phenylene group or naphthalene-diyl group which may be substituted by a substituent.~~

~~2. The thermosetting resin composition according to claim 1, comprising:~~

~~(A) an epoxy resin; and~~

~~(B) a cyclic carbodiimide compound including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure:~~

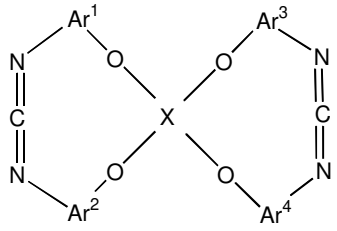


~~(B-i)~~

~~wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group, or a combination of these groups, and may contain a hetero atom or substituent.~~

~~3~~2. The thermosetting resin composition according to claim ~~2~~1, wherein the component (B) is a polyvalent cyclic carbodiimide compound having at least two carbodiimide groups in one molecule.

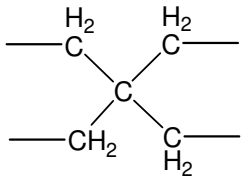
~~4~~3. The thermosetting resin composition according to claim ~~2~~1, wherein the component (B) is a compound represented by the following formula (B-ii):



(B-ii)

wherein X is a tetravalent group represented by the following formula (B-iii). Ar^1 to Ar^4 are each independently an

orthophenylene group or 1,2-naphthalene-diyl group which may be substituted by an alkyl group having 1 to 6 carbon atoms or phenyl group



(B-iii).

~~5~~4. The thermosetting resin composition according to claim ~~2~~1, wherein the content of the cyclic carbodiimide compound is 0.01 to 50 parts by weight based on 100 parts by weight of the epoxy resin.

~~6~~5. The thermosetting resin composition according to claim 1~~2~~, wherein the glass transition temperature of a cured resin is 2°C or more higher than the glass transition temperature of a cured resin obtained by curing a thermosetting resin composition comprising no component (B) under the same conditions.

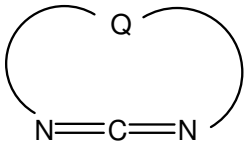
~~7. The thermosetting resin composition according to claim 2, further comprising a curing agent.~~

~~8~~6. The thermosetting resin composition according to claim ~~2~~1, further comprising a curing accelerator.

~~9~~7. A process for producing a cured resin, comprising the step of heating the thermosetting resin composition of claim 1.

~~10~~8. A method of using a cyclic carbodiimide compound including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond

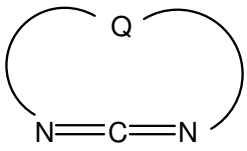
group and having 8 to 50 atoms forming the cyclic structure as a curing agent for an epoxy resin:



(B-i)

wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group, or a combination of these groups, and may contain a hetero atom or substituent.

~~11~~9. A method of using a cyclic carbodiimide compound including a cyclic structure having one carbodiimide group and represented by the following formula (B-i) in which first nitrogen and second nitrogen are bonded together by a bond group and having 8 to 50 atoms forming the cyclic structure as a curing accelerator for an epoxy resin:



(B-i)

wherein Q is bivalent to tetravalent bond group which is an aliphatic group, alicyclic group, aromatic group, or a combination of these groups and may contain a hetero atom or substituent.

10. The thermosetting resin composition according to claim 1, wherein the curing agent (component C) is at least one curing agent selected from the group consisting of polyamine, acid anhydride, polyphenol and polymercaptan.

11. The thermosetting resin composition according to claim 10, wherein the polyamine is any of alicyclic polyamine, aromatic polyamine and modified polyamine.