NON-PATENT DOCUMENT

[0008]

Non-patent document 1: OKUMA Seiichi et al., Japan analyst, Vol. 24, pp. 385-387 (1975)

Non-patent document 2: TSURUGI Jitsuo et al., Journal of the Society of Rubber Science and Technology, Japan, Vol. 43, No. 5, pp. 337-346 (1970)

Non-patent document 3: Jerzy Herbich et al., J. Photochem. Photobiol. A: Chem., 80, pp. 157-160 (1994)

DISCLOSURE ~~OF THE INVENTION~~

PROBLEMS TO BE SOLVED ~~BY THE INVENTION~~

[0009]

Phosgene is generally used for producing a carbonate derivative as described above. Even if phosgene is not used in a certain production method, such a production method has problems that the other toxic compound and an expensive catalyst are used or phosgene must be used for producing a raw material compound.

Accordingly, the objective of the present ~~invention~~disclosure is to provide a method for producing a polycarbonate safely and efficiently.

MEANS FOR SOLVING THE PROBLEMS

[0010]

The inventor of the present ~~invention~~ disclosure repeated intensive studies in order to solve the above-described problems. As a result, the inventor completed the present ~~invention~~ disclosure by finding that a polycarbonate can be amazingly produced in a safe and efficient manner by subjecting a hydrocarbon compound

substituted with a halogeno group and the specific diol compound to a photoreaction in the presence of oxygen and the specific salt. In general, in a photoreaction, it is known that an organic salt forms a pigment, acts as an antioxidant to capture a radical and quenches a fluorescence through a mechanism such as an electron transfer, and that pyridine is decomposable into glutaraldehyde due to ultraviolet rays (Non-patent documents 1 to 3). In addition, it is predicted that an oxidative photodecomposition of a halogenated hydrocarbon is inhibited by an inorganic base aqueous solution, and even if a halogenated hydrocarbon is decomposed, it is known that a decomposed compound such as phosgene is immediately decomposed into carbon dioxide and a salt due to an inorganic base aqueous solution. An organic base and an inorganic base, therefore, may act against a photoreaction as inventions which were developed by the present inventor and which were described in Patent document 3 and Patent document 4. On the one hand, it was very amazing that a polycarbonate can be efficiently produced by a photoreaction in the presence of the specific base.

The present ~~invention~~ disclosure is hereinafter described.

[0011]

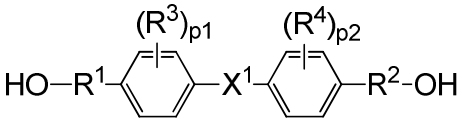
In an aspect, there is provided a method for producing a polycarbonate,

the method comprising the step of irradiating a light to a composition comprising a C_{1-4} halogenated hydrocarbon, a diol compound and a base in the presence of oxygen,

wherein the base is one or more bases selected from the group ~~substantially~~ consisting of a heteroarylamine, a non-nucleophilic strong base having a basicity (pK_{BH+}) in

acetonitrile of 20 or more and an inorganic base, and

wherein the diol compound is any one of the compounds represented by the following formulae (I^1) to (I^6):



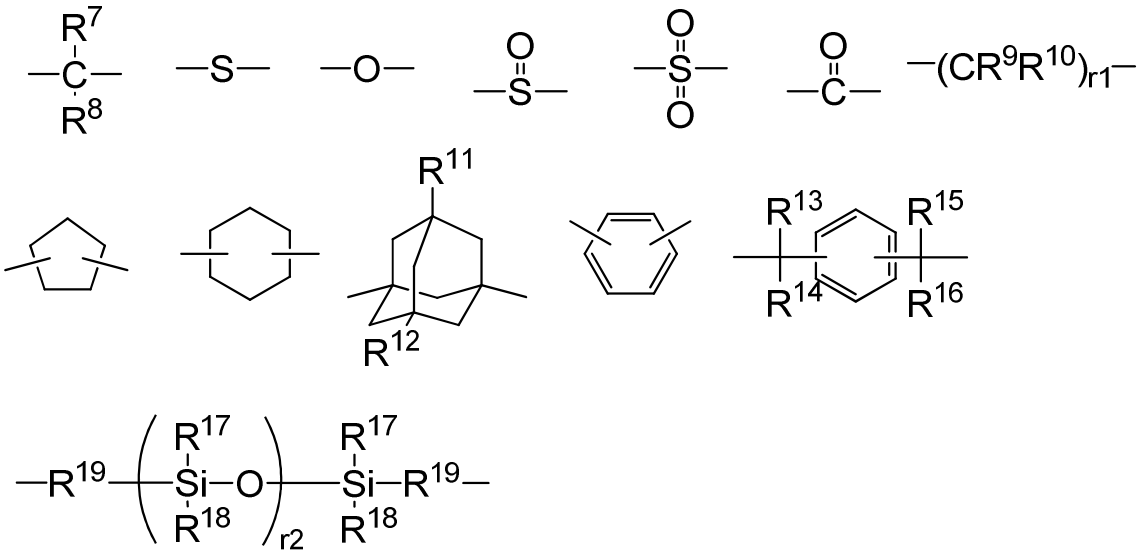
(I^1)

wherein

R^1 and R^2 are independently $-(CR^5R^6)_{q1}-$ or $-(-O-(CR^5R^6)_{q2}-)_{q3}-$ wherein R^5 and R^6 are independently H or a C_{1-6} alkyl group, q1 is an integer of 0 or more and 10 or less, q2 is an integer of 1 or more and 10 or less, q3 is an integer of 1 or more and 10 or less, and when q1 or q2 is an integer of 2 or more, a plurality of R^5 or R^6 may be the same as or different from each other,

R^3 and R^4 are independently one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group, a C_{1-20} alkoxy group, a C_{3-20} cycloalkyl group, a C_{6-20} aromatic hydrocarbon group, a C_{7-20} aralkyl group, a C_{6-20} aromatic hydrocarbon oxy group or a C_{3-20} cycloalkoxy group,

X^1 is the following group:



(wherein

R^7 and R^8 are independently H, one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group optionally having a substituent α, a C_{1-20} alkoxy group optionally having a substituent α, a C_{6-20} aromatic hydrocarbon group optionally having a substituent β, or R^7 and R^8 may bind together to form a C_{3-20} carbon ring or a 5-12 membered hetero ring,

R^9 and R^{10} are independently H or a C_{1-6} alkyl group, and when r1 is integer of 2 or more, a plurality of R^9 or R^{10} may be the same as or different from each other,

R^{11} to R^{18} are independently one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group optionally having a substituent α, a C_{1-20} alkoxy group optionally having a substituent α, or a C_{6-12} aromatic hydrocarbon group optionally having a substituent β,

R^{19} is a C_{1-9} alkylene group optionally having a substituent α,

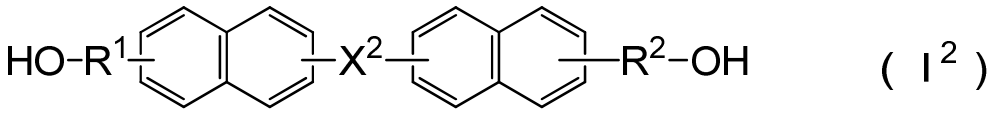
r1 is an integer of 1 or more and 20 or less,

r2 is an integer of 1 or more and 500 or less.)

p1 and p2 are independently integers of 0 or more and 4 or less,

substituent α is one or more substituents selected from a C_{1-6} alkoxy group, a C_{1-7} acyl group, one or more kinds of halogeno groups selected from the group consisting of chloro, bromo and iodo, an amino group, a nitro group, a cyano group and a carbamoyl group,

substituent β is one or more substituents selected from a C_{1-6} alkyl group, a C_{1-6} alkoxy group, a C_{1-7} acyl group, one or more kinds of halogeno groups selected from the group consisting of chloro, bromo and iodo. an amino group, a nitro group, a cyano group and a carbamoyl group,



$$(I^2)$$

wherein R^1 and R^2 have the same meanings as the above, and X^2 has the same meaning as X^1,

$$HO\text{-}R^1\text{-}X^3\text{-}R^2\text{-}OH \qquad (I^3)$$

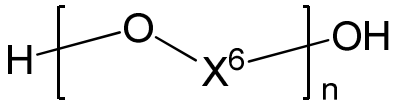
wherein R^1 and R^2 have the same meanings as the above, and X^3 is a C_{15-32} divalent aromatic hydrocarbon group,

$$HO\text{-}R^{20}\text{-}X^4\text{-}R^{21}\text{-}OH \qquad (I^4)$$

wherein R^{20} and R^{21} are independently $-(CR^5R^6)_{m1}-$ or $-(-O-(CR^5R^6)_{m2}-)_{m3}-$ (wherein R^5 and R^6 have the same meanings as the above, m1 is an integer of 1 or more and 10 or less, m2 is an integer of 1 or more and 10 or less, m3 is an integer of 1 or more and 10 or less, and when m1 or m2 is an integer of 2 or more, a plurality of R^5 or R^6 may be the same as or different from each other.), and X^4 is a divalent group comprising one or more hydrocarbon rings or hetero ring,

$HO-R^1-X^5-R^2-OH$ (I^5)

wherein R^1 and R^2 have the same meanings as the above, and X^5 is a divalent saturated heterocycle group,



(I^6)

wherein X^6 is a C_{1-10} alkylene group, and n is an integer of 13 or more and 50 or less.

[1] A method for producing a polycarbonate,

the method comprising the step of irradiating a light to a composition comprising a C_{1-4} halogenated hydrocarbon, a diol compound and a base in the presence of oxygen,

wherein the base is one or more bases selected from the group substantially consisting of a heteroarylamine, a non-nucleophilic strong base and an inorganic base, and

wherein the diol compound is any one of the compounds

[0020]

[10] The method according to any one of the above [1] to [9], wherein two or more kinds of the diol compound are used.

EFFECT ~~OF THE INVENTION~~

[0021]

It is not needed in the presently ~~invention~~ disclosed method that an expensive catalyst and a highly toxic compound such as phosgene and carbon monoxide are used as a raw material compound. The presently ~~invention~~ disclosed method is, therefore, industrially very useful as a technology to safely and efficiently produce a useful polycarbonate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

Fig. 1 is a schematic diagram to demonstrate one example of the constitution of a reaction apparatus usable in the present invention method.

MODE FOR CARRYING OUT THE INVENTION

[0023]

A light is irradiated to a composition comprising a C_{1-4} halogenated hydrocarbon, a diol compound and a specific base in the presence of oxygen in the method for producing a polycarbonate according to the present invention.

[0024]

1. C_{1-4} halogenated hydrocarbon

The C_{1-4} halogenated hydrocarbon may be decomposed due to the irradiated light and oxygen into a halogenated carbonyl or a halogenated carbonyl-like compound and reacted with the diol

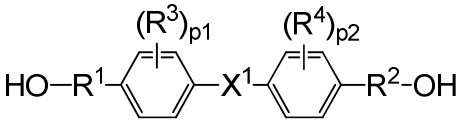
CLAIMS

1. A method for producing a polycarbonate,

the method comprising the step of irradiating a light to a composition comprising a C_{1-4} halogenated hydrocarbon, a diol compound and a base in the presence of oxygen,

wherein the base is one or more bases selected from the group ~~substantially~~ consisting of a heteroarylamine, a non-nucleophilic strong base having a basicity (pK_{BH+}) in acetonitrile of 20 or more and an inorganic base, and

wherein the diol compound is any one of the compounds represented by the following formulae (I^1) to (I^6):



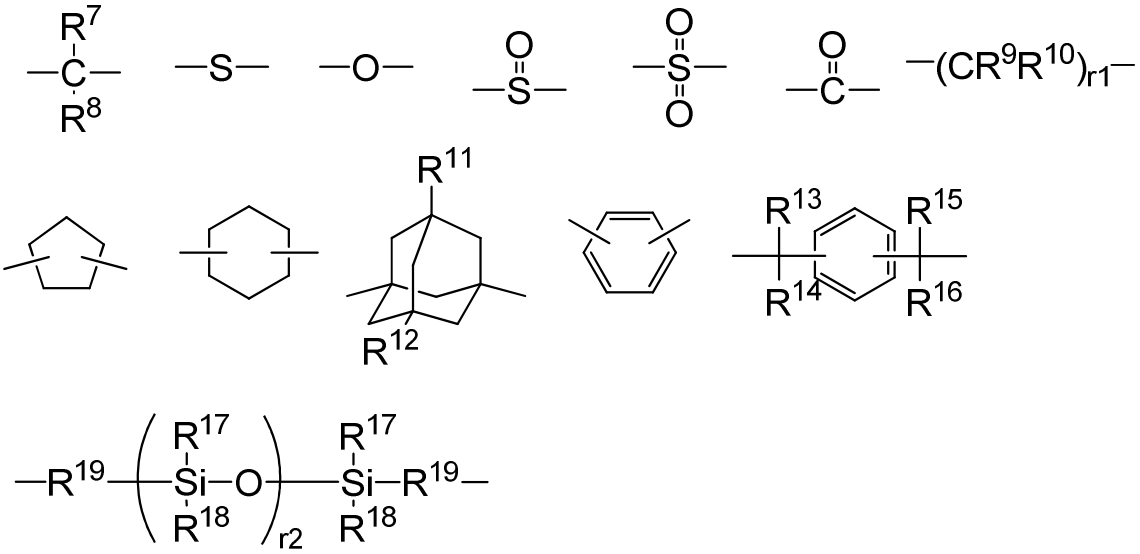
(I^1)

wherein

R^1 and R^2 are independently $-(CR^5R^6)_{q1}-$ or $-(-O-(CR^5R^6)_{q2}-)_{q3}-$ wherein R^5 and R^6 are independently H or a C_{1-6} alkyl group, q1 is an integer of 0 or more and 10 or less, q2 is an integer of 1 or more and 10 or less, q3 is an integer of 1 or more and 10 or less, and when q1 or q2 is an integer of 2 or more, a plurality of R^5 or R^6 may be the same as or different from each other,

R^3 and R^4 are independently one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group, a C_{1-20} alkoxy group, a C_{3-20} cycloalkyl group, a C_{6-20} aromatic hydrocarbon group, a C_{7-20} aralkyl group, a C_{6-20} aromatic hydrocarbon oxy group or a C_{3-20} cycloalkoxy group,

X^1 is the following group:



(wherein

R^7 and R^8 are independently H, one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group optionally having a substituent α, a C_{1-20} alkoxy group optionally having a substituent α, a C_{6-20} aromatic hydrocarbon group optionally having a substituent β, or R^7 and R^8 may bind together to form a C_{3-20} carbon ring or a 5–12 membered hetero ring,

R^9 and R^{10} are independently H or a C_{1-6} alkyl group, and when r1 is integer of 2 or more, a plurality of R^9 or R^{10} may be the same as or different from each other,

R^{11} to R^{18} are independently one or more halogeno groups selected from the group consisting of chloro, bromo and iodo, a C_{1-20} aliphatic hydrocarbon group optionally having a substituent α, a C_{1-20} alkoxy group optionally having a substituent α, or a C_{6-12} aromatic hydrocarbon group optionally having a substituent β,

R^{19} is a C_{1-9} alkylene group optionally having a substituent α,

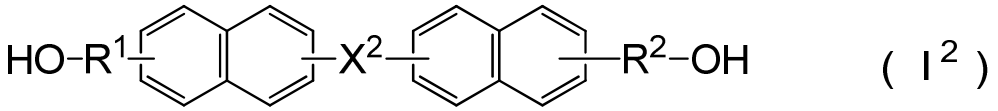
r1 is an integer of 1 or more and 20 or less,

r2 is an integer of 1 or more and 500 or less.)

p1 and p2 are independently integers of 0 or more and 4 or less,

substituent α is one or more substituents selected from a C_{1-6} alkoxy group, a C_{1-7} acyl group, one or more kinds of halogeno groups selected from the group consisting of chloro, bromo and iodo, an amino group, a nitro group, a cyano group and a carbamoyl group,

substituent β is one or more substituents selected from a C_{1-6} alkyl group, a C_{1-6} alkoxy group, a C_{1-7} acyl group, one or more kinds of halogeno groups selected from the group consisting of chloro, bromo and iodo. an amino group, a nitro group, a cyano group and a carbamoyl group,



(I^2)

wherein R^1 and R^2 have the same meanings as the above, and X^2 has the same meaning as X^1,

$HO-R^1-X^3-R^2-OH$ (I^3)

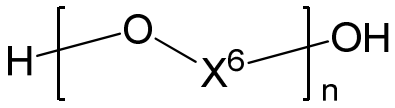
wherein R^1 and R^2 have the same meanings as the above, and X^3 is a C_{15-32} divalent aromatic hydrocarbon group,

$HO-R^{20}-X^4-R^{21}-OH$ (I^4)

wherein R^{20} and R^{21} are independently $-(CR^5R^6)_{m1}-$ or $-(-O-(CR^5R^6)_{m2}-)_{m3}-$ (wherein R^5 and R^6 have the same meanings as the above, m1 is an integer of 1 or more and 10 or less, m2 is an integer of 1 or more and 10 or less, m3 is an integer of 1 or more and 10 or less, and when m1 or m2 is an integer of 2 or more, a plurality of R^5 or R^6 may be the same as or different from each other.), and X^4 is a divalent group comprising one or more hydrocarbon rings or hetero ring,

$HO-R^1-X^5-R^2-OH$ (I^5)

wherein R^1 and R^2 have the same meanings as the above, and X^5 is a divalent saturated heterocycle group,



(I^6)

wherein X^6 is a C_{1-10} alkylene group, and n is an integer of 13 or more and 50 or less.

2. The method according to claim 1, wherein the C_{1-4} halogenated hydrocarbon is a C_{1-4} polyhalogenated hydrocarbon.

3. The method according to claim 1, wherein the C_{1-4} halogenated hydrocarbon is chloroform.

4. The method according to any one of claims 1 to 3, wherein the heteroarylamine is pyridine, picoline or lutidine.

5. The method according to any one of claims 1 to 4, wherein the non-nucleophilic strong base is 1,5,7-triazabicyclo[4.4.0]deca-5-ene, 7-methyl-1,5,7-triazabicyclo[4.4.0]deca-5-ene, 1,8-diazabicyclo[5.4.0]undeca-7-ene or 1,5-diazabicyclo[4.3.0]non-5-ene or 1,1,3,3-tetramethylguanidine.

6. The method according to any one of claims 1 to 5, wherein the inorganic base is an alkali metal hydroxide, an alkali metal hydrogencarbonate salt or an alkali metal carbonate salt.

7. The method according to any one of claims 1 to 6, wherein 0.001 times or more by mole and 1 time or less by mole of the

diol compound to the C_{1-4} halogenated hydrocarbon is used.

8. The method according to any one of claims 1 to 7, wherein 1.5 times or more by mole and 100 times or less by mole of the base to the diol compound is used.

9. The method according to any one of claims 1 to 8, wherein the light irradiated to the composition comprises a light having a wavelength of 180 nm or more and 280 nm or less.

10. The method according to any one of claims 1 to 9, wherein two or more kinds of the diol compound are used.