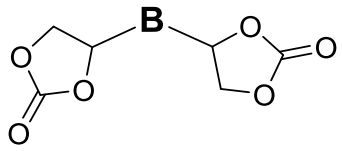
CLAIMS

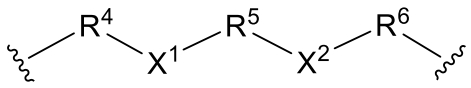
1. A polymer or derivative thereof comprising a plurality of active amine groups in the backbone, wherein the polymer is a reaction product of a reaction between one or more bis-carbonates and one or more amine compounds having at least two terminal amino groups,

wherein the one or more bis-carbonates are represented by general formula (2):

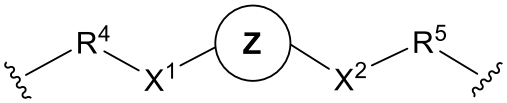


(2)

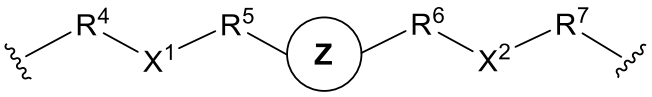
wherein **B** is selected from the following general formula (9), (10) or (11):



(9)



(10)



(11)

wherein in general formula (9),

R^4 and R^6 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^5 is selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl or optionally substituted alkynyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, $–NR^c–$, $–C(=O)–O–$ and $–O–C(=O)–$, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl;

wherein in general formula (10),

R^4, R^5, R^6 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, $–O–$, $–NR^c–$, $–C(=O)–O–$ and $–O–C(=O)–$, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH;

wherein in general formula (11),

R^4 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^5 and R^6 are each independently selected from optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, $–O–$, $–NR^c–$, $–C(=O)–O–$ and $–O–C(=O)–$, wherein R^c is

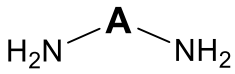
selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and
ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH.

2. The polymer or derivative thereof of claim 1, wherein the polymer is a bio-based polymer and at least one of the bis-carbonates and/or at least one of the amine compounds having at least two terminal amino groups is derived from a bio-based source.

3. The polymer or derivative thereof of claim 2, wherein the content of the polymer derived from a bio-based source ranges from 30% to 90% by weight of the polymer.

4. The polymer or derivative thereof of any one of the preceding claims, wherein the plurality of active amine groups comprise a plurality of different amine functionalities.

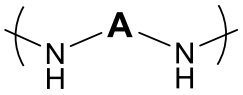
5. The polymer or derivative thereof of any one of the preceding claims, wherein the one or more amine compounds having at least two terminal amino groups are represented by general formula (1):



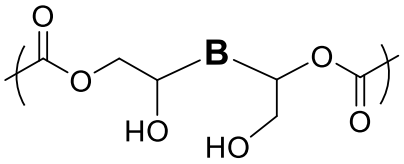
(1)

and wherein
A comprises a linear aliphatic, branched aliphatic, cyclic and/or aromatic hydrocarbons comprising at least one active amine group.

6. The polymer or derivative thereof of any one of the preceding claims, wherein the polymer comprises one or more structural units represented by general formula (3), one or more structural units represented by general formula (4):



(3)

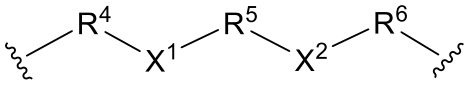


(4)

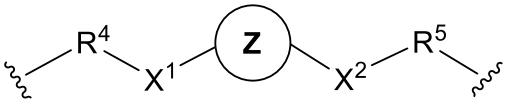
wherein

A comprises a linear aliphatic, branched aliphatic, cyclic and/or aromatic hydrocarbons comprising at least one active amine group; and

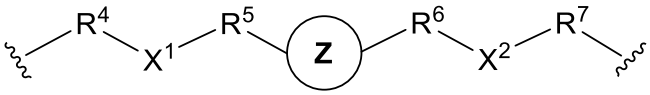
B is selected from the following general formula (9), (10) or (11):



(9)



(10)



(11)

wherein in general formula (9),

R^4 and R^6 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^5 is selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl or optionally substituted alkynyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, –NR^c–, –C(=O)–O– and –O–C(=O)–, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl;

wherein in general formula (10),

R^4, R^5, R^6 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, –O–, –NR^c–, –C(=O)–O– and –O–C(=O)–, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH;

wherein in general formula (11),

R^4 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

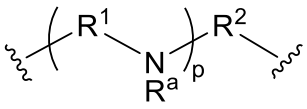
R^5 and R^6 are each independently selected from optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, –O–, –NR^c–, –C(=O)–O– and –O–C(=O)–, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

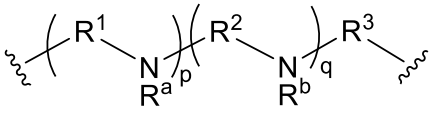
ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH.

7. The polymer or derivative thereof of claim 6, wherein the structural units represented by general formula (3) are linked to structural units represented by general formula (4) via carbamate/urethane linkages.

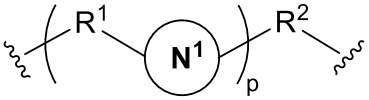
8. The polymer or derivative thereof of any one of claims 5 to 7, wherein **A** is selected from the following general formula (5), (6), (7) or (8):



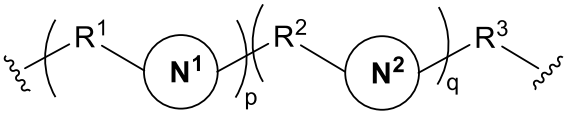
(5)



(6)



(7)



(8)

wherein

R^1, R^2 and R^3 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^a and R^b are each independently selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl;

ring N^1 and N^2 are each independently an optionally substituted 5-membered or 6-membered nitrogen-containing cyclic ring;

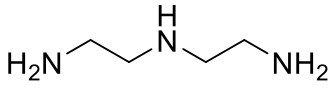
$p \geq 1$; and $q \geq 0$.

9. The polymer or derivative thereof of claim 8, wherein ring N^1 and N^2 are each independently selected from the group consisting of 3-pyrroline, 2-pyrroline, 2H-pyrrole, 1H-pyrrole, 2-pyrazoline, 2-imidazoline, pyrazole, imidazole, 1,2,4-triazole, 1,2,3-triazole, oxazole, isoxazole, isothiazole, thiazole, 1,2,5-oxadiazole, 1,2,3-oxadizole, 1,3,4-thiadiazole, 1,2,5-thiadiazole, diphenylamine, pyridine, pyridazine, pyrimidine, pyrazine, 1,2,4-triazine, 1,3,5-triazine, oxazine, thiazine, pyrazolidine, imidazolidine, piperidine, *N*-methylpiperidine, *N*-phenylpiperidine, pyrrolidine, piperazine, morpholine, thiomorpholine, 1,4-diazepane, quinoline, acridine and combinations thereof.

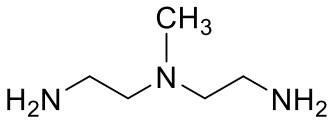
10. The polymer or derivative thereof of any one of claims 1 to 9, wherein R^1 to R^7 are each independently selected from a single bond, optionally substituted C_1-C_{20} alkyl, C_1-C_{20} optionally substituted alkenyl, C_1-C_{20} optionally substituted alkynyl, C_1-C_{20} optionally substituted cycloalkyl and C_1-C_{20} optionally substituted cycloalkenyl; and R^a and R^b are each independently selected from the group consisting of H, optionally substituted C_1-C_{20} alkyl, optionally substituted C_1-C_{20} alkenyl and optionally substituted C_1-C_{20} alkynyl.

11. The polymer or derivative thereof of any one of the preceding claims, wherein the one or more amine compounds having at least two terminal amino groups are selected from the group consisting of diethylenetriamine (DETA), diamino-N-methyldiethylamine (DMA), triethylenetetramine (TETA), diamino-N-methyldipropylamine (DMPA),

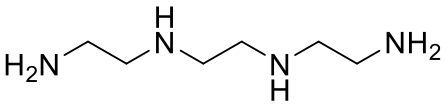
pentaethylenehexamine (PEHA), bis(3-aminopropyl)piperazine (BAP), spermine, norspermidine, lysine salt (LyS) and diaminopentane (DAP):



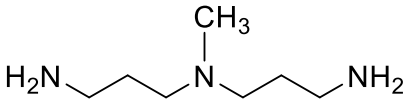
DETA



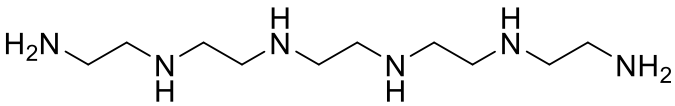
DMA



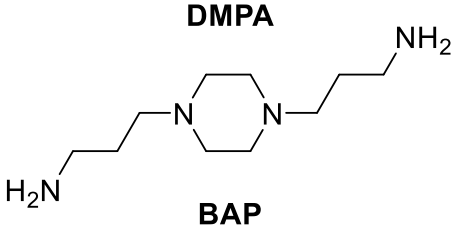
TETA



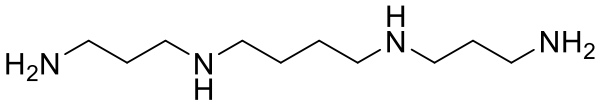
DMPA



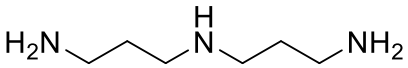
PEHA



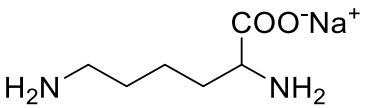
BAP



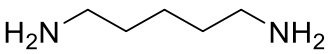
spermine



norspermidine

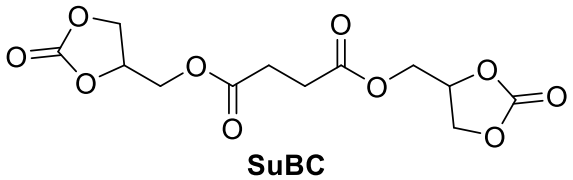


LyS

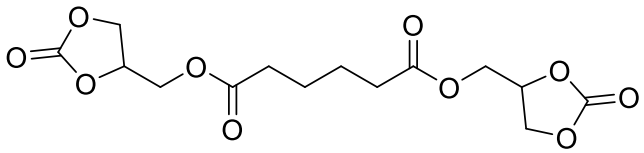


DAP

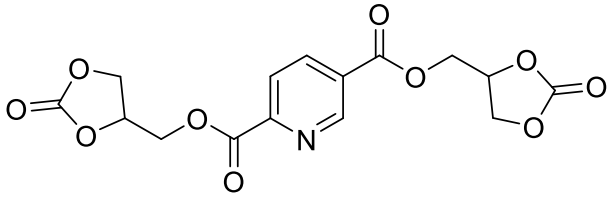
12. The polymer or derivative thereof of any one of the preceding claims, wherein the one or more bis-carbonates are selected from the group consisting of succinic bis-carbonate (SuBC), adipic bis-carbonate (ABC), pyridine bis-carbonate (PBC1), (PBC2), (PBC3), (PBC4), (PBC5) and/or (PBC6):



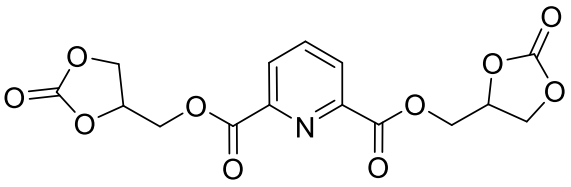
SuBC



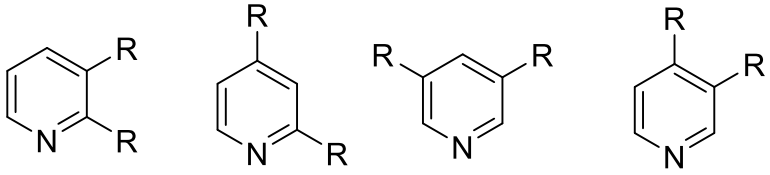
ABC



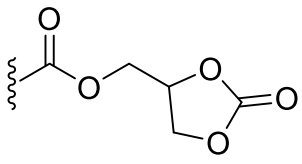
PBC1



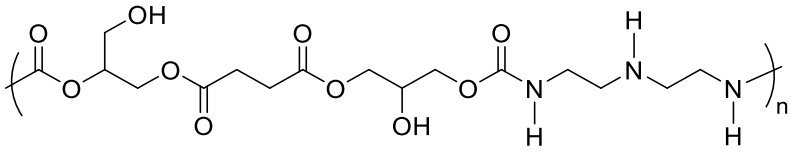
PBC2



PBC3 **PBC4** **PBC5** **PBC6**

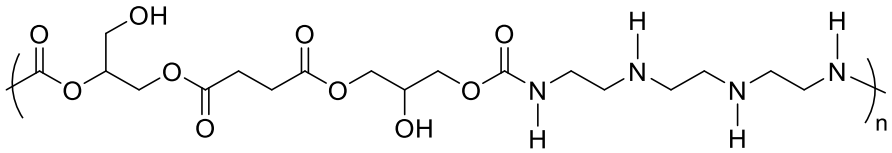
wherein R = 

13. The polymer or derivative of any one of the preceding claims selected from the following:



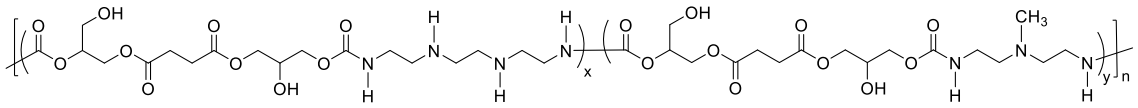
R-5

Polymer R-5 (SuBC + DETA)



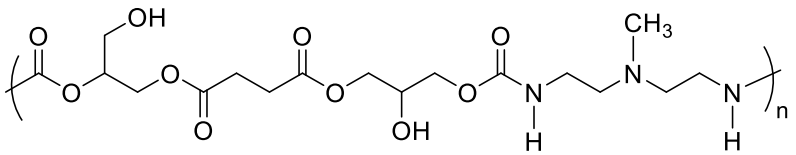
R-6

Polymer R-6 (SuBC + TETA)



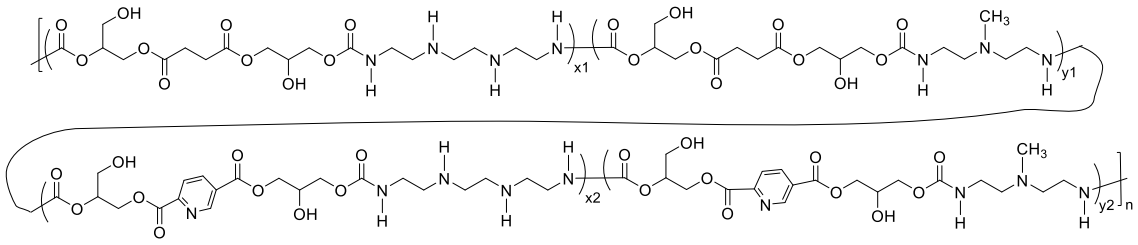
R-8

Polymer R-8 (SuBC + TETA + DMA)



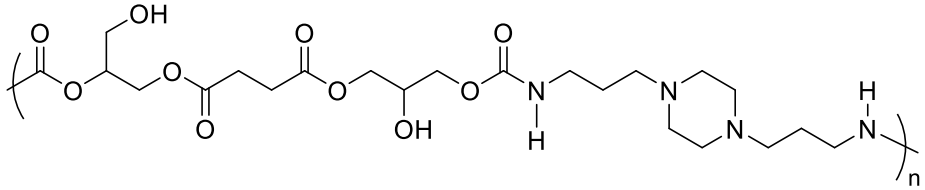
R-9

Polymer R-9 (SuBC + DMA)



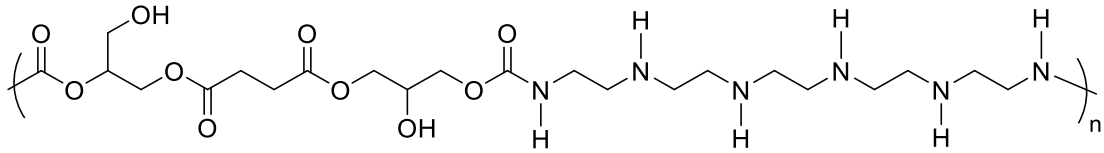
R-12

Polymer R-12 (SuBC + PBC2 + TETA + DMA)



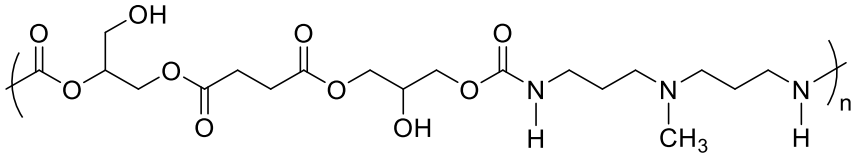
R-13 or R-22

Polymer R-13 or R-22 (SuBC + BAP)



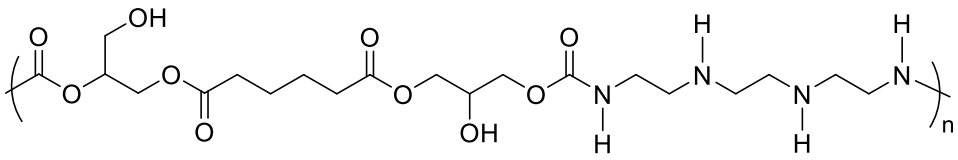
R-14

Polymer R-14 (SuBC + PEHA)



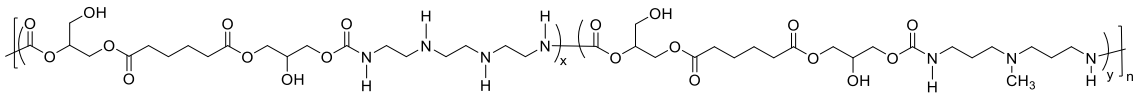
R-15

Polymer R-15 (SuBC + DMPA)



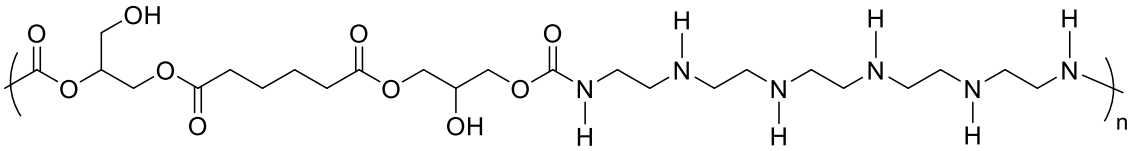
R-23

Polymer R-23 (ABC + TETA)



R-24

Polymer R-24 (ABC + TETA + DMPA)



R-25

Polymer R-25 (ABC + PEHA)

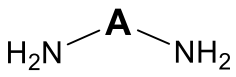
14. The polymer or derivative thereof of any one of the preceding claims, wherein the polymer or derivative thereof further comprises at least one of a hydroxyl group and an active amine group originally present in the polymer that has been functionalized.

15. The polymer or derivative thereof of any one of the preceding claims, wherein the polymer or derivative thereof is a grafted polymer obtained by grafting the polymer on a substrate or another polymer.

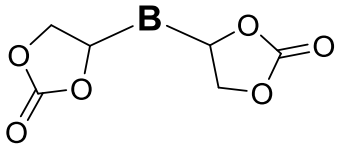
16. The polymer or derivative thereof of any one of the preceding claims, wherein the polymer or derivative thereof has one or more of the following properties: water-soluble; hydrolysable; biodegradable; and biocompatible.

17. Use of the polymer or derivative thereof of any one of the preceding claims as an anti-redepositioning agent, an anti-bacterial agent, an adhesive, an adhesion promoter, a fiber modifier, a pigment dispersant, a chelating agent, a flocculating agent, a wet strength improving additive, a pour point depressant, or a carbon dioxide capture agent.

18. A method of preparing the polymer of any one of the preceding claims or a derivative thereof, the method comprising: polymerizing one or more diamines represented by general formula (1) with one or more biscarbonates represented by general formula (2) to obtain the polymer:



(1)

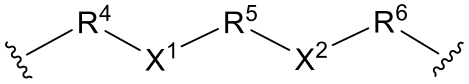


(2)

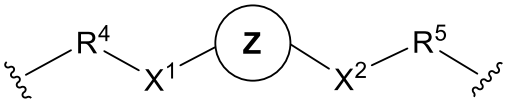
wherein

A comprises a linear aliphatic, branched aliphatic, cyclic and/or aromatic hydrocarbons comprising at least one active amine group; and

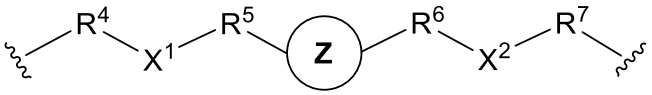
B is selected from the following general formula (9), (10) or (11):



(9)



(10)



(11)

wherein in general formula (9),

R^4 and R^6 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^5 is selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl or optionally substituted alkynyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, $–NR^c–$, $–C(=O)–O–$ and $–O–C(=O)–$, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl;

wherein in general formula (10),

R^4, R^5, R^6 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, $–O–$, $–NR^c–$, $–C(=O)–O–$ and $–O–C(=O)–$, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH;

wherein in general formula (11),

R^4 and R^7 are each independently selected from a single bond, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

R^5 and R^6 are each independently selected from optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted cycloalkyl or optionally substituted cycloalkenyl;

X^1 and X^2 are each independently selected from the group consisting of a single bond, –O–, –NR^c–, –C(=O)–O– and –O–C(=O)–, wherein R^c is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl; and

ring Z is an optionally substituted 5-membered hydrocarbon cyclic ring or an optionally substituted 5-membered or 6-membered heterocyclic ring having up to three heteroatoms independently selected from the group consisting of O, N, S and NH.

19. The method of claim 18, wherein the method comprises a) mixing one or more diamines represented by general formula (1) with one or more biscarbonates represented by general formula (2) to obtain a reaction mixture; and b) precipitating the polymer.

20. The method of any one of claims 18 to 19, wherein the method further comprises a step of functionalising at least one of a hydroxyl group and an active amine group present in the polymer.

21. The method of any one of claims 18 to 19, wherein the method further comprises a step of grafting to at least one of a hydroxyl group and an active amine group present in the polymer to another polymer or substrate.