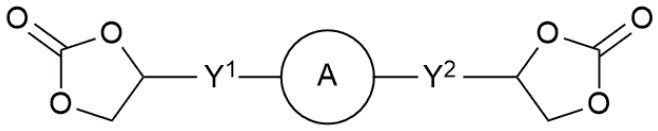
CLAIMS

1. A compound represented by general formula (Ib):



(Ib)

wherein

ring A is selected from the group consisting of thiophene, pyrrole, oxazole, isoxazole, isothiazole, tetrahydrofuran, tetrahydrothiophene, pyrrolidine, pyridine, pyrone, pyridazine, pyrimidine, pyrazine, triazine, piperidine and piperazine;

Y^1 and Y^2 are each independently selected from the group consisting of:

a single bond,

–Z–O–Z–,

–Z–NR^b–Z–,

–Z–O–C(=O)–Z–, –Z–C(=O)–O–Z–,

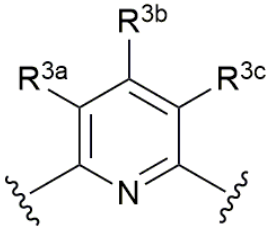
–Z–NR^b–C(=O)–Z–, –Z–C(=O)–NR^b–Z–,

–Z–NR^b–C(=O)–O–Z–, –Z–O–C(=O)–NR^b–Z–;

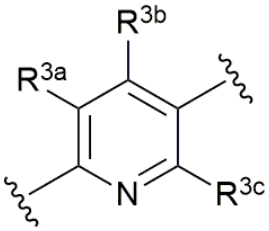
where each Z is independently selected from the group consisting of a single bond, optionally substituted saturated aliphatic chain and optionally substituted unsaturated aliphatic chain; and

where R^b is H or C_1-C_6 alkyl.

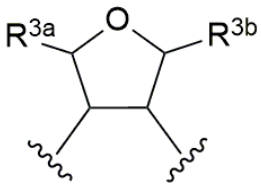
2. The compound according to claim 1, wherein ring A is selected from any one of the general formulae (III) to (V):



(IV)



(III)



(V)

wherein

R^{3a}, R^{3b} and R^{3c} are each independently selected from the group consisting of a hydrogen, hydroxy, halogen, cyano, amino, nitro, carboxyl, alkyl, alkenyl, alkynyl, alkoxy, haloalkyl, haloalkoxy, cycloalkyl, cycloalkenyl, alkylcarbonyl and alkoxycarbonyl.

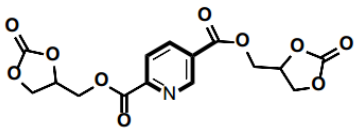
3. The compound according to claim 1, wherein

Y^1 is selected from the group consisting of –Z–O–Z– and –Z–O–C(=O)–Z–;

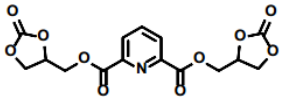
Y^2 is selected from the group consisting of –Z–O–Z– and –Z–C(=O)–O–Z–;

each Z is independently selected from the group consisting of a single bond and C_1-C_6 alkyl.

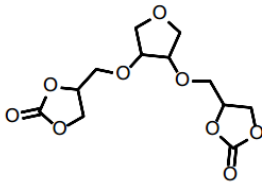
4. The compound according to any one of claims 1 to 3 selected from the following:



bis((2-oxo-1,3-dioxolan-4-yl)methyl)pyridine-2,5-dicarboxylate (**PBC**);



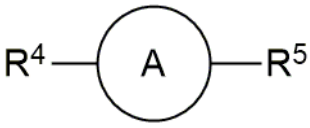
bis((2-oxo-1,3-dioxolan-4-yl)methyl)pyridine-2,6-dicarboxylate (**PBC-2**); and



4,4'-(((tetrahydrofuran-3,4-diyl)bis(oxy))bis(methylene))bis(1,3-dioxolan-2-one) (**HFBC**).

5. A method of preparing the compound according to any one of claims 1 to 4, the method comprising:

converting a precursor compound represented by general formula (VI) to the compound of any one of claims 1-4 through one or more chemical reactions:



(VI)

wherein

ring A is selected from the group consisting of disubstituted thiophene, disubstituted pyrrole, disubstituted oxazole, disubstituted isoxazole, disubstituted isothiazole, disubstituted tetrahydrofuran, disubstituted

tetrahydrothiophene, disubstituted pyrrolidine, disubstituted pyridine, disubstituted pyrone, disubstituted pyridazine, disubstituted pyrimidine, disubstituted pyrazine, disubstituted triazine, disubstituted piperidine and disubstituted piperazine;

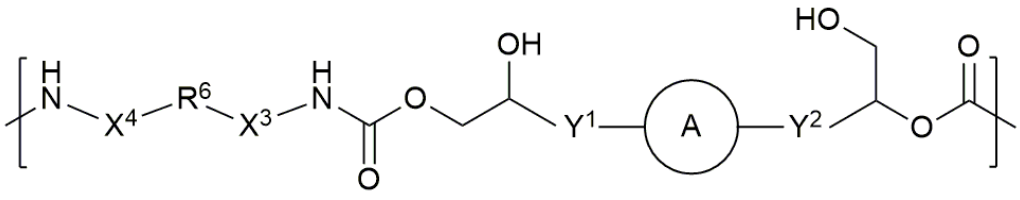
R^4 and R^5 are each independently selected from the group consisting of –OH, –C(=O)H, –C(=O)–OH, $–NR^cR^d$, $–C(=O)–NR^cR^d$, $–(C_1\text{-}C_6$ alkyl)–OH, $–(C_1\text{-}C_6$ alkyl)–C(=O)H, $–(C_1\text{-}C_6$ alkyl)–C(=O)–OH, $–(C_1\text{-}C_6$ alkyl)$–NR^cR^d$ and $–(C_1\text{-}C_6$ alkyl)$–C(=O)–NR^cR^d$,

where R^c and R^d are independently selected from the group consisting of H or $C_1\text{-}C_6$ alkyl, and

wherein at least one of the one or more chemical reactions is carried out in the presence of a halogenated compound.

6. The method according to claim 5, wherein the precursor compound is selected from the group consisting of pyridine-2,5-dicarboxylic acid, pyridine-2,6-dicarboxylic acid and 1,4-anhydroerythritol.

7. A reaction product of the reaction between one or more compounds according to any one of claims 1 to 4 and one or more amine containing compounds, the reaction product having hydroxyl groups and urethane/carbamate linkages, wherein the reaction product is a polymer having a repeating unit represented by general formula (VIIb) or a derivative thereof:



(VIIb)

wherein

ring A is selected from the group consisting of thiophene, pyrrole, oxazole, isoxazole, isothiazole, tetrahydrofuran, tetrahydrothiophene, pyrrolidine, pyridine, pyrone, pyridazine, pyrimidine, pyrazine, triazine, piperidine and piperazine;

Y^1 and Y^2 are each independently selected from the group consisting of:

a single bond,

–Z–O–Z–,

–Z–NR^b–Z–,

–Z–O–C(=O)–Z–, –Z–C(=O)–O–Z–,

–Z–NR^b–C(=O)–Z–, –Z–C(=O)–NR^b–Z–,

–Z–NR^b–C(=O)–O–Z–, –Z–O–C(=O)–NR^b–Z–;

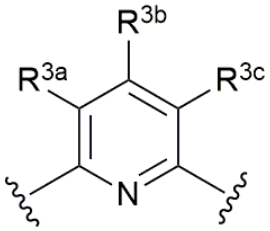
where each Z is independently selected from the group consisting of a single bond, optionally substituted saturated aliphatic chain and optionally substituted unsaturated aliphatic chain;

where R^b is H or C_1-C_6 alkyl;

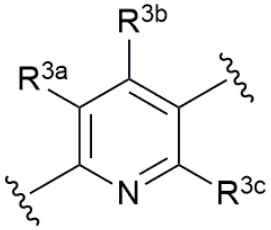
R^6 is selected from the group consisting of optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted polyether, optionally substituted 5-membered or 6-membered hydrocarbon cyclic ring and an optionally substituted 5-membered or 6-membered heterocyclic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

X^3 and X^4 are each independently selected from the group consisting of a single bond and –(C_1-C_6 alkyl).

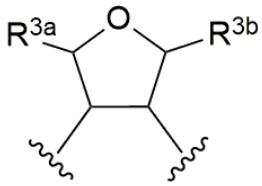
8. The reaction product according to claim 7, wherein ring A is selected from any one of the general formulae (III) to (V):



(IV)



(III)



(V)

wherein

R^{3a}, R^{3b} and R^{3c} are each independently selected from the group consisting of a hydrogen, hydroxy, halogen, cyano, amino, nitro, carboxyl, alkyl, alkenyl, alkynyl, alkoxy, haloalkyl, haloalkoxy, cycloalkyl, cycloalkenyl, alkylcarbonyl and alkoxycarbonyl.

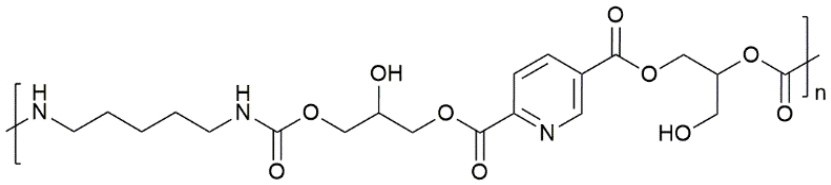
9. The reaction product according to any one of claims 7 to 8, wherein

Y^1 is selected from the group consisting of –Z–O–Z– and –Z–O–C(=O)–Z–;

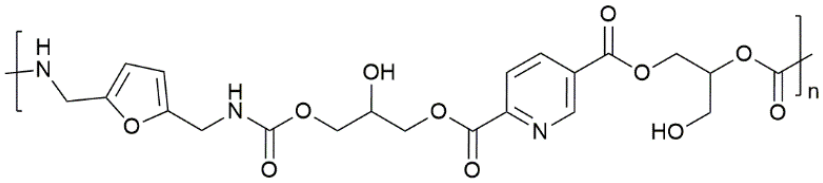
Y^2 is selected from the group consisting of –Z–O–Z– and –Z–C(=O)–O–Z–;

each Z is independently selected from the group consisting of a single bond and C_1-C_6 alkyl.

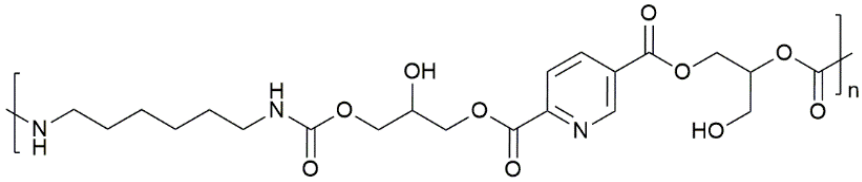
10. The reaction product according to any one of claims 7 to 9 selected from the following:



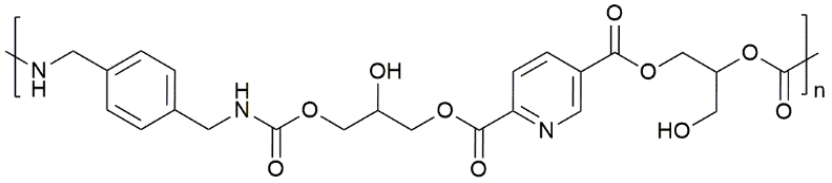
(9)



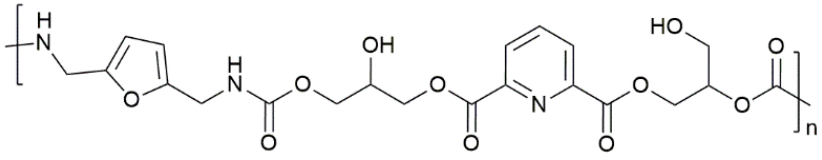
(10)



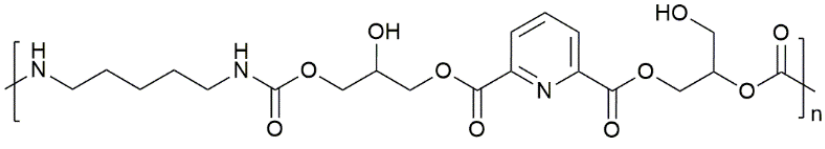
(11)



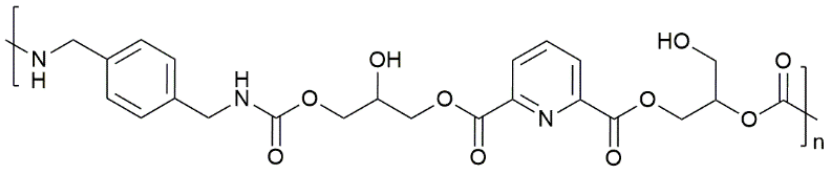
(12)



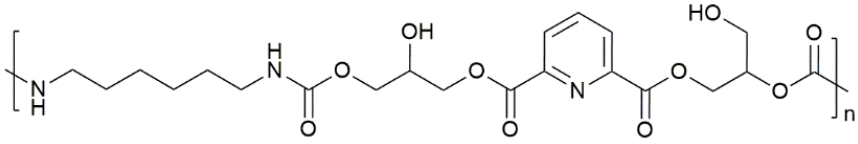
(13)



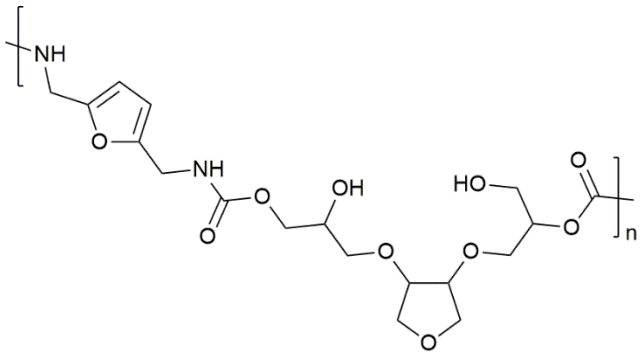
(14)



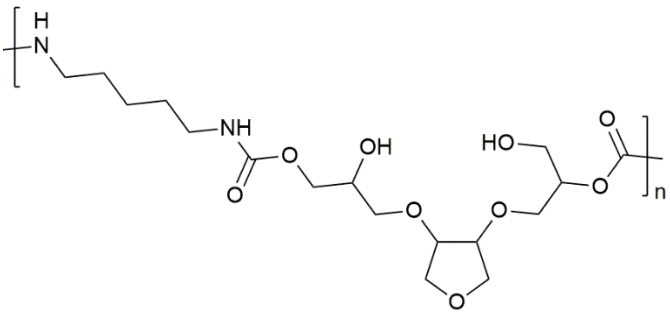
(15)



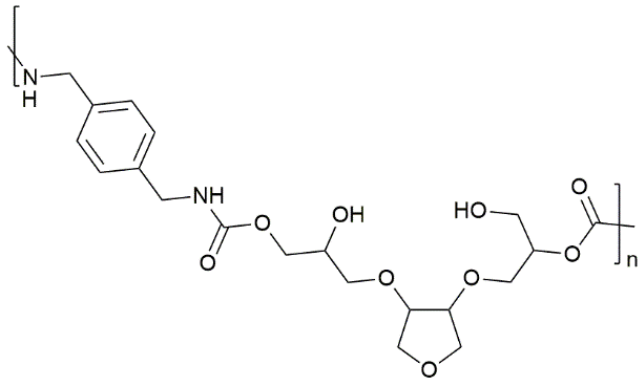
(16)



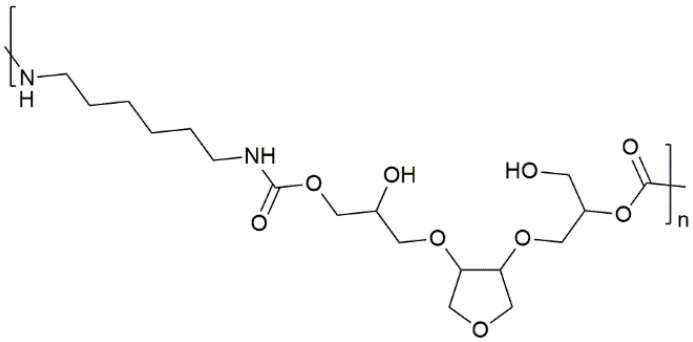
(17)



(18)



(19)



(20)

or a derivative thereof.

11. The reaction product according to any one of claims 7 to 10, wherein the product has one or more of the following properties: number average molecular weight (Mn) in the range of 2,000 g/mol to 50,000 g/mol, peak molecular weight (Mp) in the range of 1,500 g/mol to 60,000 g/mol and the polydispersity index (PDI) is in the range of 1.0 to 5.0, wherein the number average molecular weight, peak molecular weight and polydispersity index are determined by gel permeation chromatography using polymethyl methacrylate (PMMA) calibration.

12. A method of preparing the reaction product according to any one of claims 7 to 11, the method comprising:

reacting one or more compounds according to any one of claims 1 to 4 with one or more amine containing compounds to obtain the reaction product.

13. The method according to claim 12, wherein the amine containing compound comprises at least two amine functional groups.

14. The method according to claim 12, wherein the amine containing compound is selected from the group consisting of furan-2,5-diyldimethanamine (FBA), xylene diamine (XDA), diaminopentane

(DAP), hexamethylenediamine (HDA), ethylenediamine, diaminopropane, diaminobutane, ether diamine, polyether diamine, dimer diamine, lysine, isophorone diamine and phenylenediamine.

15. The method according to any one of claims 5 to 6 and 12 to 14, wherein the method is devoid of a step containing the use of isocyanates as a reactant.

16. The method according to any one of claims 12 to 14, further comprising a step of functionalising one or more hydroxyl groups present in the reaction product.

17. The method according to any one of claims 12 to 14, further comprising a step of grafting a polymer to one or more hydroxyl groups present in the reaction product.

18. The method according to any one of claims 12 to 14, further comprising a step of grafting one or more molecular entities or polymers to one or more furan rings present in the reaction product.

19. A functionalised or grafted product obtained according to any one of claims 16 to 18, wherein the functionalised or grafted polymer has one or more of the following properties: solubility or dispersibility in water, solubility or dispersibility in oil, photo or thermo or redox or pH response and crosslinking ability under air, photo, thermal, redox or ionic conditions.