**CLAIMS**

1. A method of converting a polymer comprising benzenoid rings into oxidation product(s), the method comprising:

a step of oxidizing a benzenoid-based polymer source by adding a $NO_x$ source to the benzenoid-based polymer source to oxidize the polymer comprising benzenoid rings,

optionally wherein the oxidation product(s) comprises organic acid functional group.

2. The method of claim 1, wherein the $NO_x$ source is selected from the group consisting of nitrous acid, nitrite salts, nitric acid, nitrate salts and combinations thereof, optionally wherein the $NO_x$ source is selected from the group consisting of nitric acid ($HNO_3$), sodium nitrate ($NaNO_3$), potassium nitrate ($KNO_3$), magnesium nitrate ($Mg(NO_3)_2$), calcium nitrate ($Ca(NO_3)_2$), barium nitrate ($Ba(NO_3)_2$), aluminium nitrate $Al(NO_3)_3$, copper(II) nitrate ($Cu(NO_3)_2$), zinc nitrate ($Zn(NO_3)_2$), tetra-*n*-butylammonium nitrate, cerium(III) nitrate ($Ce(NO_3)_3$), cerium(IV) ammonium nitrate (CAN) ($(NH_4)_2[Ce(NO_3)_6]$), iron(III) nitrate ($Fe(NO_3)_3$), lanthanum nitrate ($La(NO_3)_3$) and combinations thereof.

3. The method of any one of the preceding claims, wherein the step of oxidizing is carried out in the presence of:

(i) an oxygen-containing gas, optionally wherein the oxygen-containing gas comprises an oxygen content that is from 20.5 vol% to 100 vol%;

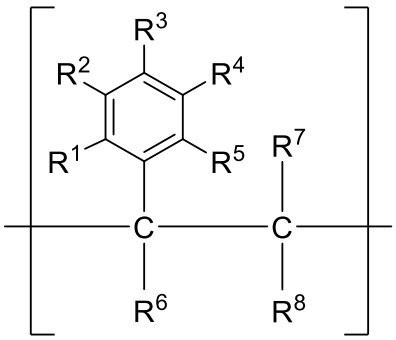
(ii) optionally an environmentally benign solvent; and

(iii) optionally a catalyst.

4. The method of any one of the preceding claims, wherein the polymer comprising benzenoid rings comprises:

(R1) one or more benzenoid repeating units represented by general formula (1A); and

(R2) optionally one or more non-benzenoid repeating units:



(1A)

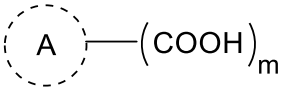
wherein

$R^1$ to $R^5$ are each independently selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, $SO_3H$, and halogen atoms;

$R^6$ is H; and

$R^7$ to $R^8$ are each independently selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl and optionally substituted alkynyl.

5. The method of any one of the preceding claims, wherein the oxidation product(s) comprises one or more compounds represented by general formula (2):



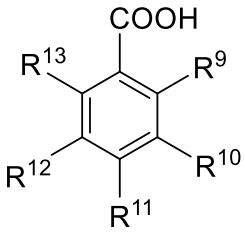
(2)

wherein

A is selected from the group consisting of H, optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, optionally substituted 5-membered ring and optionally substituted 6-membered ring; and

m = 1 to 6,

optionally wherein A is optionally substituted 6-membered ring and the oxidation product(s) comprises one or more compounds having general formula (2B):




(2B)

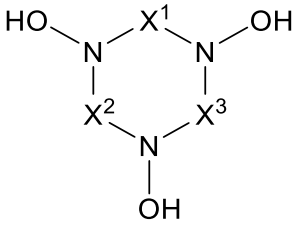
wherein

$R^9$ to $R^{13}$ are each independently selected from the group consisting of hydrogen (–H), nitro (–$NO_2$), carboxylic acid (–COOH), cyano (–CN), ester (–COOR), halogen (e.g., –F, –Cl, –Br, –I), hydroxy (–OH), alkoxy (–OR), sulfonic acid (–$SO_3H$), optionally substituted alkyl, optionally substituted alkenyl, and optionally substituted alkynyl, where R is an organic group.

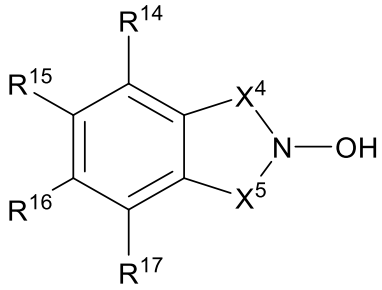
6. The method of claim 5, wherein the oxidation product(s) comprises one or more of the following: terephthalic acid, phthalic acid, isophthalic acid, benzoic acid, nitrobenzoic acid and formic acid.

7. The method of any one of claims 3 to 6, wherein the catalyst is present and comprises N-hydroxyl (–N–OH) groups.

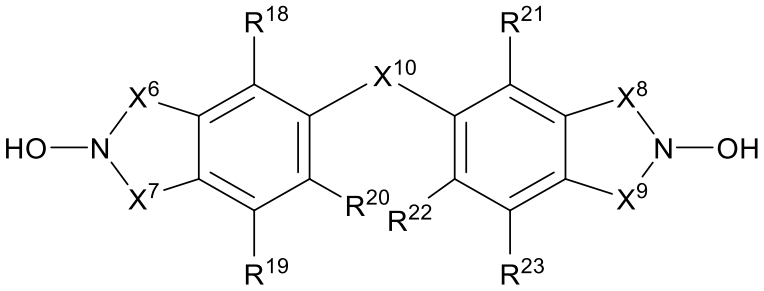
8. The method of claim 7, wherein the catalyst comprises a structure selected from general formula (3), (4) and/or (5):



(3)



(4)



(5)

wherein

$X^1$ to $X^{10}$ are each independently selected from the group consisting of $CH_2$, $C(=O)$, $S(=O)_2$ and combinations thereof; and

$R^{14}$ to $R^{23}$ are each independently selected from the group consisting of hydrogen (–H), nitro ($–NO_2$), carboxylic acid (–COOH), cyano (–CN), ester (–COOR), amine ($–NR_2$), halogen (e.g., –F, –Cl, –Br, –I), hydroxy (–OH), alkoxy (–OR), optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, and combinations thereof, where R is an organic group.

9. The method of any one of claims 3 to 8, wherein the environmentally benign solvent is present and comprises a weak acid.

10. The method of claim 9, wherein the environmentally benign solvent comprises acetic acid.

11. The method of any one of the preceding claims, wherein the step of oxidizing is performed at a pressure that is from 0.5 bar to 10 bar;
and/or the step of oxidizing is performed at a temperature that is no more than 200°C;
and/or the step of oxidizing is performed in the presence of from 0 mol% to 20 mol% of the catalyst with respect to the reaction mixture;
and/or the step of oxidizing is performed in the presence of from 0 mol% to 99.9 mol% of the environmentally benign solvent with respect to the reaction mixture.

12. The method of any one of the preceding claims, wherein the step of oxidizing comprises adding from 0.10 mol% to 99.9 mol% of the benzenoid-based polymer source with respect to the reaction mixture;
and/or the step of oxidizing comprises adding from 1 molar equivalent to 10 molar equivalent of $NO_x$ source with respect to the number of repeating units present in the benzenoid-based polymer.

13. The method of any one of the preceding claims, wherein the $NO_x$ source is mixed with the solvent in a molar ratio of from 1:1 to 1:20.

14. The method of any one of the preceding claims, wherein the yield of the oxidation product(s) is modulated by adding the $NO_x$ source at different time points.

15. The method of any one of the preceding claims, wherein the benzenoid-based polymer source comprises waste polystyrene.