Claims

1. A process for preparing covalently grafted carbonaceous material, comprising the steps of:

   (a) providing carbonaceous material;

   (b) providing at least one reactant;

   (c) mixing the carbonaceous material with the reactant, thereby obtaining a mixture; and

   (d) irradiating the mixture obtained in step (c) under IR radiation;

   thereby obtaining covalently grafted carbonaceous material;

   wherein the reactant is selected from the group consisting of: R^1-NH_2, R^2-$CH=CH_2$, R^3-$Si(OR^4)_3$, $(R^5)_3$-$SiOR^6$, and R^7-$N^+\equiv N$ X^-, lactide, polylactide;

   wherein R^1 is selected from the group consisting of C_{6-10}aryl, C_{2-24}alkenyl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^1 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen;

   wherein R^2 is selected from the group consisting of C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^2 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen;

   wherein R^3 is selected from the group consisting of C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^3 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, hydrogen, and halogen;

   wherein each R^4 is independently C_{1-6}alkyl optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen;

   wherein each R^5 is independently selected from the group consisting of: C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^5 may be optionally substituted with one or more substituents each independently selected from the

group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, hydrogen, and halogen;

wherein R^6 is C_{1-6}alkyl, and is optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen;

wherein R^7 is selected from the group consisting of C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^7 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen; and

wherein X^- is an organic or inorganic anion, preferably a halogen or tetrafluoroborate.

2. The process according to claim 1, wherein the carbonaceous material is selected from the group consisting of carbon nanotubes, fullerenes, carbon black, nanographene, and nanographite.

3. The process according to claim 1 or 2, wherein the carbonaceous material comprises carbon nanotubes, preferably wherein the carbonaceous material comprises multi-walled carbon nanotubes.

4. The process according to any of claims 1 to 3, wherein the reactant is R^1-NH_2 or R^7-$N^+{\equiv}N$ X;

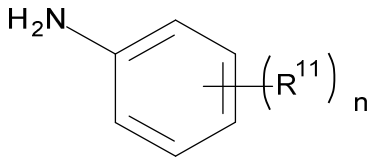
wherein R^1 is selected from the group consisting of C_{6-10}aryl, C_{2-24}alkenyl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^1 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen;

wherein R^7 is selected from the group consisting of C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl and C_{1-6}alkyl-C_{6-10}aryl, and wherein R^7 may be optionally substituted with one or more substituents each independently selected from the group consisting of -OH, haloC_{1-10}alkyl, C(O)OH, -SH, -NO_2, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, and halogen; and

wherein X^- is an organic or inorganic anion, preferably a halogen or tetrafluoroborate.

5. The process according to any of claims 1 to 4, wherein the reactant is selected from the group consisting of substituted aniline, aniline, diazonium salts, primary aliphatic amines, styrene, and lactide.

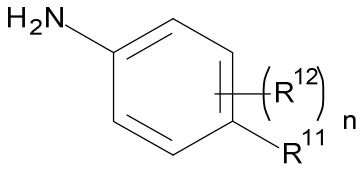
6. The process according to any of claims 1 to 5, wherein the reactant is a substituted aniline, preferably wherein the reactant is a compound of formula (I):



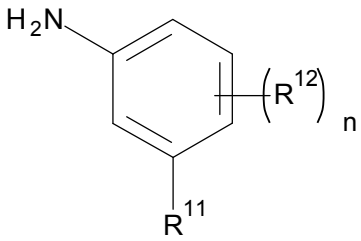
(I)

wherein each R^{11} is independently hydrogen, halogen, or $-NO_2$, or is a group selected from the group consisting of -OH, haloC_{1-10}alkyl, -C(O)OH, -SH, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, each group being optionally substituted by one or more substituents each independently selected from halogen, or C_{1-6}alkyl, wherein n is an integer selected from 1, 2, 3, 4 or 5.

7. The process according to any of claims 1 to 6, wherein the reactant is a compound of formula (II) or (III), preferably of formula (II):



(II)



(III)

wherein R^{11} is hydrogen, halogen, or $-NO_2$, or is a group selected from the group consisting of -OH, haloC_{1-10}alkyl, -C(O)OH, -SH, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, each group being optionally substituted by one or more substituents each independently selected from halogen, or C_{1-6}alkyl,

each R^{12} is independently hydrogen, halogen, or $-NO_2$, or is a group selected from the group consisting of -OH, haloC_{1-10}alkyl, -C(O)OH, -SH, heteroaryl, C_{1-24}alkyl, C_{2-24}alkenyl, C_{6-10}aryl, C_{6-10}aryl-C_{1-6}alkyl, C_{1-6}alkyl-C_{6-10}aryl, each group being optionally substituted by one or more substituents each independently selected from halogen, or C_{1-6}alkyl,

and wherein n is an integer selected from 1, 2, 3, or 4.

8. The process according to any of claims 1 to 7, wherein the IR radiation has a wavelength of at least 0.75 μm and at most 3.00 μm, preferably of about 1.50 μm.

9. The process according to any of claims 1 to 8, wherein step (d) has a duration of at least 10 minutes and at most 240 minutes, preferably for at least 20 minutes and at most 180 minutes, preferably for at least 40 minutes and at most 120 minutes, for example for about 60 minutes.

10. The process according to any of claims 1 to 9, wherein step (c) further comprises the step of mixing the carbonaceous material with a co-reactant, preferably wherein the co-reactant is a nitrite, preferably wherein the co-reactant is sodium nitrite or isoamyl nitrite.

11. The process according to any of claims 1 to 10, wherein step (c) further comprises the step of mixing the carbonaceous material with liquid or gaseous solvent, preferably with a liquid solvent.

12. The process according to claim 11, wherein the solvent is selected from the group consisting of: water, acetonitrile, ethanol, pyridine, aliphatic hydrocarbons, aromatic hydrocarbons, nitrogen, argon, and helium, preferably wherein the solvent is selected from the group consisting of: water, acetonitrile, ethanol, and pyridine.

13. The process according to any of claims 1 to 12, wherein step (c) further comprises mixing the carbonaceous material with liquid or gaseous co-solvent, preferably with a gaseous co-solvent, preferably wherein the co-solvent is an organic or inorganic acid.

14. A process for preparing a polymeric composite, comprising the steps of:

    (a) providing a polymer composition comprising at least one polymer selected from the group consisting of polyolefin, polylactic acid, polystyrene, polyethylene terephthalate, polyurethane, and blends thereof;
    (b) providing at least 0.001% by weight of covalently grafted carbonaceous material prepared according to the process of any of claims 1 to 13, relative to the total weight of the polymeric composite;
    (c) blending the covalently grafted carbonaceous material with the polymer composition, thereby obtaining a polymeric composite.