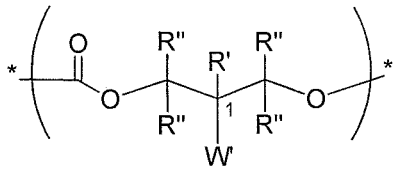
SUMMARY

[0006] Accordingly, a polymer is disclosed, comprising:

a radical repeat unit having a structure according to formula (1):



(1),

wherein

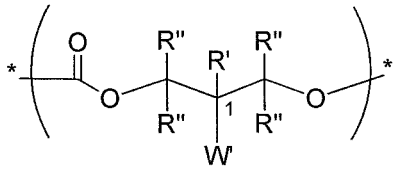
R' is monovalent group selected from the group consisting of hydrogen (H-*) and groups comprising 1-5 carbons,

each R" is an independent monovalent group selected from the group consisting of hydrogen (H-*) and methyl (Me-*), and

W' is a monovalent moiety comprising a paramagnetic organic radical, wherein the organic radical comprises an unpaired electron of a carbon, oxygen, nitrogen, and/or sulfur.

[0006a] In an aspect, there is provided a polymer comprising:

a radical repeat unit having a structure according to formula (1):



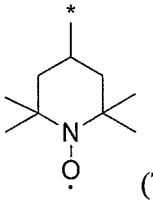
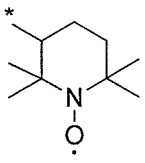
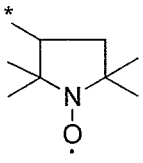
(1),

wherein

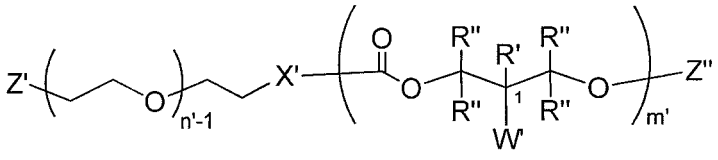
R' is monovalent group selected from the group consisting of hydrogen (H-*) and groups comprising 1-5 carbons,

each R" is an independent monovalent group selected from the group consisting of hydrogen (H-*) and methyl (Me-*), and

W' is a monovalent moiety comprising a nitroxide radical selected from the group consisting of


(TEMPO-A),

(TEMPO-B), and

(PROXYL).

[0007] Also disclosed is a block polymer of formula (4):


(4),

wherein

n' represents the number of ethylene oxide repeat units, and has an average value of about 10 to about 250,

m' represents the number of radical repeat units, and has an average value of 1 to about 100,

each R' is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and groups comprising 1 to 5 carbons,

each R" is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and methyl (Me-*),

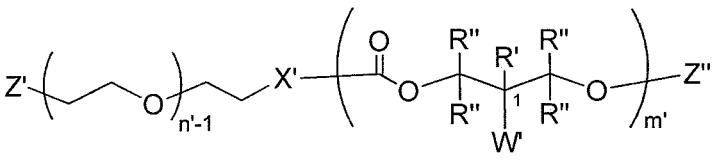
X' is a divalent linking group selected from the group consisting of oxygen (*-O-*), *-N(H)-*, and sulfur (*-S-*),

each W' is a monovalent moiety comprising a nitroxide radical,

each Z' is a monovalent first end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons, and

each Z" is a monovalent second end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons.

[0007a] In another aspect, there is provided a block polymer of formula (4):



(4),

wherein

n' represents the number of ethylene oxide repeat units, and has an average value of about 10 to about 250,

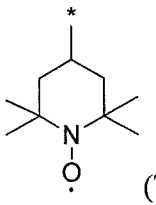
m' represents the number of radical repeat units, and has an average value of 1 to about 100,

each R' is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and groups comprising 1 to 5 carbons,

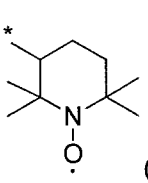
each R" is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and methyl (Me-*),

X' is a divalent linking group selected from the group consisting of oxygen (*-O-*), *-N(H)-*, and sulfur (*-S-*),

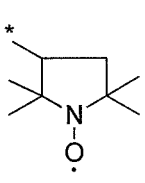
each W' is a monovalent moiety comprising a nitroxide radical selected from the group consisting of



(TEMPO-A),



(TEMPO-B), and



(PROXYL),

each Z' is a monovalent first end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons, and

each Z" is a monovalent second end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons.

[0008] In another aspect, there is provided a composition comprising water and an above-described block polymer, wherein the composition is suitable for enhancing contrast in a medical imaging application.

[0009] In another aspect, there is provided a method, comprising:

forming a first mixture comprising water and an above-described block polymer;

forming a second mixture comprising i) a solvent selected from the group consisting of organic solvents, water, and combinations thereof and ii) a medically useful material;

combining the first mixture and the second mixture, thereby forming a third mixture; and

removing organic solvent from the third mixture, thereby forming a composition comprising particles, the particles comprising the block polymer and the medically useful material bound by non-covalent interactions.

[0010] Also disclosed is a method, comprising:

contacting living tissue with an above-described polymer, thereby enhancing contrast in a medical imaging application used to view the tissue and/or administering a medical treatment to the tissue, wherein the polymer is water soluble, non-toxic, biodegradable, and paramagnetic.

[0010a] In an aspect, there is provided a method, comprising:

enhancing contrast in a medical imaging application used to view a living tissue that has been contacted with the above-described polymer, wherein the polymer is water soluble, non-toxic, biodegradable, and paramagnetic.

[0011] The above-described and other features and advantages of the present disclosure will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

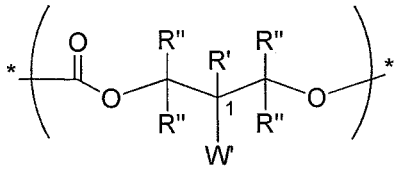
BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

CLAIMS

What is claimed is:

1. A polymer comprising:

a radical repeat unit having a structure according to formula (1):



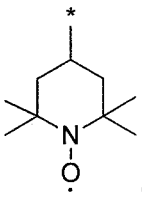
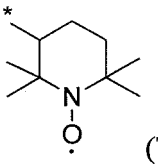
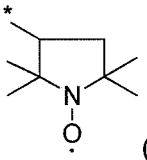
(1),

wherein

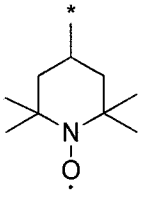
R' is monovalent group selected from the group consisting of hydrogen (H-*) and groups comprising 1-5 carbons,

each R" is an independent monovalent group selected from the group consisting of hydrogen (H-*) and methyl (Me-*), and

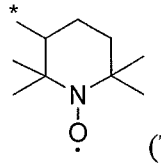
W' is a monovalent moiety comprising a nitroxide radical selected from the group consisting of

 (TEMPO-A),  (TEMPO-B), and  (PROXYL).

2. The polymer of claim 1, wherein the nitroxide radical is

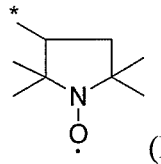
 (TEMPO-A).

3. The polymer of claim 1, wherein the nitroxide radical is



(TEMPO-B).

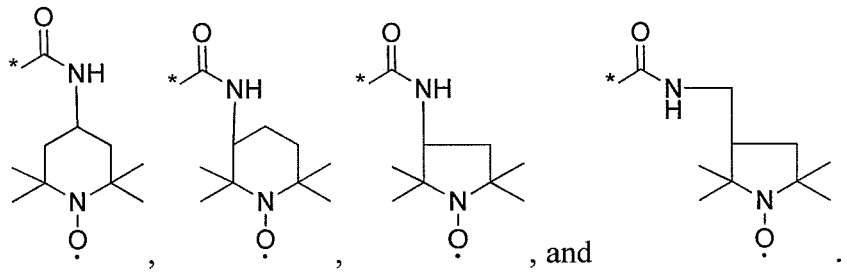
4. The polymer of claim 1, wherein the nitroxide radical is



(PROXYL).

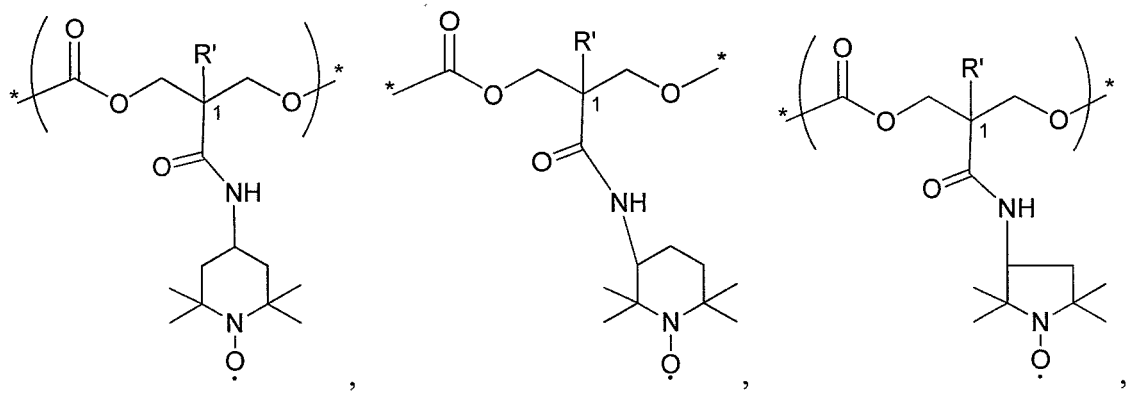
5. The polymer of claim 1, wherein each R" is hydrogen (H-*).

6. The polymer of claim 1, wherein W' is selected from the group consisting of

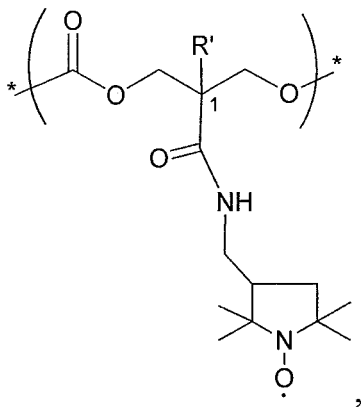


, , , and .

7. The polymer of claim 1, wherein the radical repeat unit is selected from the group consisting of



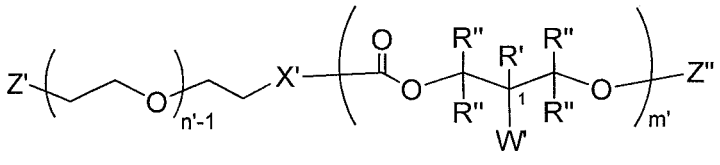
, , ,



and ,

wherein R' is monovalent group selected from the group consisting of hydrogen (H-*) and groups comprising 1-5 carbons.

8. A block polymer of formula (4):



(4),

wherein

n' represents the number of ethylene oxide repeat units, and has an average value of about 10 to about 250,

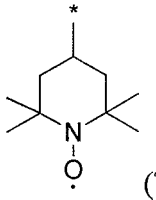
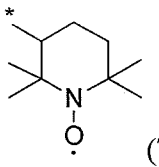
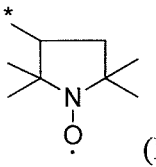
m' represents the number of radical repeat units, and has an average value of 1 to about 100,

each R' is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and groups comprising 1 to 5 carbons,

each R" is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and methyl (Me-*),

X' is a divalent linking group selected from the group consisting of oxygen (*-O-*), *-N(H)-*, and sulfur (*-S-*),

each W' is a monovalent moiety comprising a nitroxide radical selected from the group consisting of

 (TEMPO-A),  (TEMPO-B), and  (PROXYL),

each Z' is a monovalent first end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons, and

each Z" is a monovalent second end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons.

9. The block polymer of claim 8, wherein n' has an average value of about 50 to about 200, and m' has an average value of about 1 to about 20.

10. The block polymer of claim 8, wherein Z' is an alkoxy or aryloxy group comprising 1 to 15 carbons, X' is oxygen (*-O-*), and Z" is hydrogen (H-*).

11. A composition, comprising:

water; and

the block polymer of claim 8;

wherein

the composition is suitable for enhancing contrast in a medical imaging application.

12. The composition of claim 11, wherein the composition comprises micelles of the block polymer.

13. The composition of claim 11, wherein the composition is suitable for intravenous injection.

14. The composition of claim 11, wherein the composition further comprises a drug.

15. The composition of claim 11, wherein the composition further comprises a contrast enhancing dye.

16. The composition of claim 15, wherein the contrast enhancing dye fluoresces at a

wavelength in the range of about 700 nm to about 900 nm.

17. A method, comprising:

forming a first mixture comprising water and the block polymer of claim 8;

forming a second mixture comprising i) a solvent selected from the group consisting of organic solvents, water, and combinations thereof and ii) a medically useful material;

combining the first mixture and the second mixture, thereby forming a third mixture; and

removing organic solvent from the third mixture, thereby forming a composition comprising particles, the particles comprising the block polymer and the medically useful material bound by non-covalent interactions.

18. The method of claim 17, wherein the medically useful material is a contrast enhancing dye suitable for a medical imaging application.

19. The method of claim 18, wherein the medical imaging application is magnetic resonance imaging.

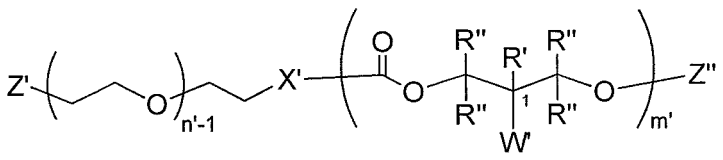
20. The method of claim 17, wherein the medically useful material is a drug.

21. The method of claim 17, wherein an aqueous mixture of the particles is suitable for intravenous injection.

22. A method, comprising:

enhancing contrast in a medical imaging application used to view a living tissue that has been contacted with the polymer of claim 1, wherein the polymer is water soluble, non-toxic, biodegradable, and paramagnetic.

23. The method of claim 22, wherein the polymer is a block polymer of formula (4):



(4),

wherein

n' represents the number of ethylene oxide repeat units, and has an average value of about 10 to about 250,

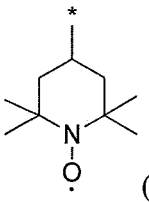
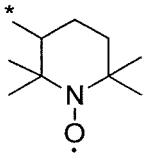
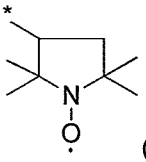
m' represents the number of radical repeat units, and has an average value of 1 to about 100,

each R' is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and groups comprising 1 to 5 carbons,

each R" is an independent monovalent moiety selected from the group consisting of hydrogen (H-*) and methyl (Me-*),

X' is a divalent linking group selected from the group consisting of oxygen (*-O-*), *-N(H)-*, and sulfur (*-S-*),

each W' is a monovalent moiety comprising a nitroxide radical selected from the group consisting of

 (TEMPO-A),  (TEMPO-B), and  (PROXYL),

each Z' is a monovalent first end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons, and

each Z" is a monovalent second end group selected from the group consisting of hydrogen (H-*) and groups comprising 1 or more carbons.

24. The method of claim 22, wherein the polymer is bound by non-covalent interactions to a near infrared fluorescent (NIRF) dye.

25. The method of claim 24, wherein the NIRF dye is 1,1'-dioctadecyltetramethyl indotricarbocyanine iodide (DiR).