antimicrobial agent. In some embodiments, the polymer product comprises at least one metal ion.

[0016] The polymer product may be in the form of a polymeric fiber. The polymeric fiber may subsequently be used to fabricate products of varying complexity and different three-dimensional shapes. The polymer product therefore includes these subsequently products fabricated from polymeric fibers.

[0016a] The present invention also includes a method for preparing a polymer product comprising

i) electrospinning from a dope solution comprising at least one polymer and at least one cross-linking agent, and metal ions to prepare the polymer product,

wherein the cross-linking agent comprises at least one catecholamine,

wherein the metal ions are selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, and manganese ions, and

wherein the metal ions are provided as soluble salts in the dope solution; and

ii) exposing the polymer product to at least one gaseous alkaline reagent.

[0016b] The present invention also includes a polymer product comprising polymeric fibers with a polycatecholamine coating, and metal ions selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, manganese ions, and combinations thereof.

[0016c] The present invention also includes a polymeric dope solution, at least one catecholamine, and metal ions selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, and manganese ions, wherein the metal ions are provided as soluble salts in the polymeric dope solution.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention will be discussed in more detail with reference to the following figures.

[0018] Fig. 1 shows a flow chart exemplifying the method for preparing a polymer product. Two dope solutions are represented in the flow chart.

[0019] Fig. 2 shows scanning electron microscope (SEM) images of polydopamine-coated gelatin prepared by the Tris-HCl method.

[0020] Fig. 3 shows SEM images of different catecholamine-coated gelatin fiber mats and as a control electrospun gelatin fiber mat with no catecholamine (A) with no exposure to and (B) after exposure to gaseous ammonia and carbon dioxide derived from ammonium carbonate. The average diameter ϕ of the polymeric fibers of each respective polymer product is indicated.

[0021] Fig. 4 shows SEM images of different catecholamine-coated collagen fiber mats and as a control electrospun collage fiber mats (A) with no exposure to and (B) after exposure to gaseous ammonia and carbon dioxide derived from ammonium carbonate. The average diameter of the polymeric fibers of each respective polymer product is also indicated.

[0022] Fig. 5 shows confocal microscopy images of human skin fibroblasts cells cultured on (A) coverslip, coverslip respectively coated with (B) electrospun gelatin (C) electrospun dopamine-coated gelatin [ES Gelatin + DA], (D) electrospun polydopamine-coated gelatin after exposure to gaseous ammonia and carbon dioxide from ammonium carbonate [ES Gelatin (ADM)] and (E) coverslip in the presence of 5 μg/mL nocodazole in the culture medium; and (F) a graph of the viability of human skin fibroblasts cells cultured on various fiber mats from the MTS assay.

WHAT IS CLAIMED IS:

1. A method for preparing a polymer product comprising

i) electrospinning from a dope solution comprising at least one polymer, at least one cross-linking agent, and metal ions to prepare the polymer product,

wherein the cross-linking agent comprises at least one catecholamine,

wherein the metal ions are selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, and manganese ions, and

wherein the metal ions are provided as soluble salts in the dope solution; and

ii) exposing the polymer product to at least one gaseous alkaline reagent.

2. The method according to claim 1, wherein the catecholamine comprises at least one catecholamine selected from the group consisting of dopamine, norepinephrine, adrenalone, carbidopa, colterol, L- or D-dihydroxy phenylalanine (dopa), dimethyldopa, dioxifedrine, dioxethedrin, 5-hydroxydopamine hydrochloride, dobutamine, dopexamine, droxydopam, α-methylnorepinephrine, ethylnorepinephrine, etilveodopa, isoetharine, hexaprenaline, N-methyladrenalone, norbudrine, nordefrin, oxidopamine and enterobactin.

3. The method according to claim 1, wherein the electrospun fibers can be collected on a bare metallic collector or on a fabric.

4. The method according to claim 3, wherein the fabric is a non-woven fabric or a bandage gauze.

5. The method according to claim 1, wherein the cross-linking agent further comprises at least one polyphenol.

6. The method according to claim 5, wherein the polyphenol comprises at least one polyphenol selected from the group consisting of hydroquinone, phloroglucinol, pyrogallol, gallic acid, nordihydroguaiaretic acid, γ-mangostin and α-mangostin.

7. The method according to claim 1, wherein the dope solution further comprises at least one polyhydroxy antimicrobial agent, at least one polyamine antimicrobial agent, or a combination thereof.

8. The method according to claim 7, wherein the polyhydroxy antimicrobial agent comprises amphotericin B, natamycin, nystatin, caspofungin, or a combination thereof.

9. The method according to claim 7 or claim 8, wherein the antibacterial agent comprises vancomycin, polymycin B, daptomycin, ramoplanin A2, Ristomycin monosulfate, Bleomycin sulfate, phleomycin, amikacin, streptomycin, gentamycin, kanamycin, tobramycin, azithromycin, dirtythromycin, rifampicin, rifamycin, rifapentine, rifaximin, clarithromycin, clindamycin, kendomycin, bafilomycin, chlortetracycline, doxorubicin, doxycycline, tetracycline, 1-deoxynojirimycin, 1-deoxymannojirimycin, *N*-methyl-1-deoxynojirimycin, daptomycin, collistin, polymyxin B, or a combination thereof.

10. The method according to any one of claims 7 to 9, wherein the polyamine antimicrobial agent comprises ε-polylysine, poly-L-lysine, poly-D-lysine and poly-L-ornithine, linear polyethylenimines, branched polyethylenimines, or a combination thereof.

11. The method according to claim 1, wherein the metal ions are calcium ions.

12. The method according to claim 11, wherein the calcium ions are provided in the dope solution as calcium chloride ($CaCl_2$) or calcium bicarbonate ($Ca(HCO_3)_2$).

13. The method according to claim 1, wherein the polymer in the dope solution comprises a hydrophilic polymer, a water-soluble polymer, a biodegradable polymer, or a combination thereof.

14. The method according to claim 13, wherein the polymer comprises gelatin, collagen, bovine serum albumin, casein, zein, laminin, polyvinyl alcohol (PVA), polyacrylic acid, chitosan, poly lactide (PLA), poly(ε-caprolactone) (PCL), polyethylene oxide (PEO), poly-(lactide-co-glycolide) (PLGA), or a combination thereof.

15. The method according to any one of the preceding claims, wherein the dope solution comprises about 2-30% w/v polymer.

16. The method according to any one of the preceding claims, wherein the amount of cross-linking agent is less than the amount of polymer in the dope solution.

17. The method according to any one of the preceding claims, wherein step ii) comprises exposing the polymer product to at least one gaseous alkaline reagent in the presence of a buffering agent.

18. A polymer product obtainable by a method according to any one of the preceding claims.

19. A polymer product comprising polymeric fibers with a polycatecholamine coating, and metal ions selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, manganese ions, and combinations thereof.

20. The polymer product according to claim 19, comprising a fiber mat.

21. The polymer product according to claim 19 or claim 20, further comprising cross-links of at least one polyhydroxy antimicrobial compound, at least one polyamine antimicrobial compound, or a combination thereof.

22. The polymer product according to any one of claims 19-21, wherein the polymer comprises gelatin, collagen, bovine serum albumin, casein, zein, laminin, polyvinyl alcohol (PVA), polyacrylic acid, chitosan, poly lactide (PLA), poly(ε-caprolactone) (PCL), polyethylene oxide (PEO), poly-(lactide-co-glycolide) (PLGA), or a combination thereof.

23. The polymer product according to any one of claims 19-22, wherein the metal ions are calcium ions.

24. The polymer product according to claim 23, wherein the calcium ions are provided as calcium chloride ($CaCl_2$) or calcium bicarbonate ($Ca(HCO_3)_2$).

25. A polymeric dope solution comprising at least one polymer, at least one catecholamine, and metal ions selected from the group consisting of calcium, zinc, iron, cobalt, magnesium, nickel, silver, gold, copper, and manganese ions, wherein the metal ions are provided as soluble salts in the polymeric dope solution.

26. The polymeric dope solution according to claim 25, wherein the catecholamine comprises at least one catecholamine selected from the group consisting of dopamine, norepinephrine, adrenalone, carbidopa, colterol, L- or D-dihydroxy phenylalanine (dopa), dimethyldopa, dioxifedrine, dioxethedrin, 5-hydroxydopamine hydrochloride, dobutamine, dopexamine, droxydopam, α-methylnorepinephrine, ethylnorepinephrine, etilveodopa, isoetharine, hexaprenaline, N-methyladrenalone, norbudrine, nordefrin, oxidopamine and enterobactin.

27. The polymeric dope solution according to claim 25 or 26, further comprising at least one polyphenol selected from the group consisting of hydroquinone, phloroglucinol, pyrogallol, gallic acid, nordihydroguaiaretic acid, γ-mangostin and α-mangostin.

28. The polymeric dope solution according to any one of claims 25-27, wherein the polymer comprises gelatin, collagen, bovine serum albumin, casein, zein, laminin, polyvinyl alcohol (PVA), polyacrylic acid, chitosan, poly lactide (PLA), poly(ε-caprolactone) (PCL), polyethylene oxide (PEO), poly-(lactide-co-glycolide) (PLGA), or a combination thereof.

29. The polymeric dope solution according to any one of claims 25-28, wherein the metal ions are calcium ions.

30. The polymeric dope solution according to claim 29, wherein the calcium ions are provided in the dope solution as calcium chloride ($CaCl_2$) or calcium bicarbonate ($Ca(HCO_3)_2$).