Claims

1. A medical or veterinary device comprising, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating.
2. The device according to claim 1 wherein said coating is provided on a surface selected from the group comprising: a biomaterial, silicone, polyurethane and titanium.
3. The device according to claim 2 wherein said surface is a medical grade surface.
4. The device according to any one of the preceding claims wherein said coating is provided on at least a part of the device that makes contact with a patient or animal.
5. The device according to any one of the preceding claims wherein said agarose is modified by the introduction of acrylate, methacrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.
6. The device according to claim 5 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.
7. The device according to any one of the preceding claims wherein said coating also comprises heparin.
8. The device according to claim 7 wherein said heparin is modified by the introduction of methacrylate, acrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.
9. The device according to claim 8 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.
10. The device according to any one of the preceding claims wherein said coating is 1-10 μm thick.
11. The device according to claim 10 wherein the thickness of said coating is selected from the group comprising 1, 2, 3, 4 or 5 μm.
12. The device according to claim11 wherein said coating is ~2 μm.
13. The device according to any one of claims 7-11 wherein the amount of heparin in the coating is 1-15 $\mu g/cm^2$

14. The device according to claim 13 wherein the amount of heparin in the coating is selected from the group comprising: 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 or 2.9 $\mu g/cm^2$.

15. The device according to claim 14 wherein the amount of heparin in the coating is ~2.6 $\mu g/cm^2$.

16. The device according to any one of the preceding claims wherein said device is a catheter.

17. The device according to claim 16 wherein said device is selected from the group comprising: a peritoneal dialysis catheter, a central venous catheter and a urinary catheter.

18. A method for manufacturing a medical or veterinary device having, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating, the method comprising:

i. oxidising a surface of said device;

ii. exposing said oxidized surface to modified agarose; and

iii. curing said surface.

19. The method according to claim 18 wherein said agarose is modified by the addition of acrylate, methacrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.

20. The method according to claim 19 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.

21. The method according to any one of claims 18-20 wherein oxidising said surface involves exposing said surface to plasma treatment with gases such as argon, hydrogen, nitrogen or ammonia followed by exposure to air.

22. The method according to any one of claims 18-20 wherein oxidising said surface involves corona discharge treatment or gamma irradiation treatment.

23. The method according to any one of claims 18-22 wherein said agarose is in aqueous solution.

24. The method according to claim 23 wherein said solution comprises said agarose at 5 wt.%.

25. The method according to claims 23 or 24 wherein said solution is dropped or sprayed onto the surface of the device.

26. The method according to claim 25 wherein said solution is deposited using a spin-coating procedure.

27. The method according to claims 23 or 24 wherein a surface of said device is immersed in said solution.
28. The method according to any one of claims 18-27 wherein said curing is undertaken in a degassed environment.
29. The method according to any one of claims 18-28 wherein said curing is undertaken using either Ultra violet (UV) light or heat.
30. The method according to claim 29 wherein, in the instance where UV is used to cure said surface, the surface is exposed to UV for a time period between 15-120 min.
31. The method according to any one of claims 18-30 wherein said oxidised surface is also exposed to modified heparin.
32. The method according to claim 31 wherein said heparin is modified by the introduction of methacrylate, acrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.
33. The method according to claim 32 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.
34. The method according to claims 32 or 33 wherein said heparin is methacrylated.
35. The method according to claims 31-34 wherein the amount of heparin in the coating is between 1-15 $\mu g/cm^2$
36. The method according to any one of claims 35 wherein the amount of methacrylated heparin is ~2.6 $\mu g/cm^2$.
37. The method according to any one of claims 18-36 wherein said coating is deposited to a thickness between 1-10 µm.
38. The method according to claim 37 wherein said coating is ~2 µm.
39. The method according to any one of claims 18-38 wherein said device is a catheter.
40. The method according to claim 39 wherein said device is selected from the group comprising: a peritoneal dialysis catheter, a central venous catheter and a urinary catheter.
41. A catheter having, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating.
42. A catheter having, on at least a part of its surface, a covalently immobilized and cross-linked agarose and heparin coating.
43. The catheter according to claim 42 wherein the amount of heparin is ~2.6 $\mu g/cm^2$.

44. A cross-linked agarose coating as described herein for applying in a covalently immobilized manner to at least a part of a surface of a medical or veterinary device for preventing biofouling, a bacterial or fungal infection.

45. A medical or veterinary device according to claims 1-17, a method according to claims 18-40, a catheter according to claims 41-43 or a coating according to claim 44 as substantially herein described with reference to the accompanying figures.

Claims

1. A medical or veterinary device comprising, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating.
2. The device according to claim 1 wherein said coating is provided on a surface selected from the group comprising: a biomaterial, silicone, polyurethane and titanium.
3. The device according to claim 2 wherein said surface is a medical grade surface.
4. The device according to any one of the preceding claims wherein said coating is provided on at least a part of the device that makes contact with a patient or animal.
5. The device according to any one of the preceding claims wherein said agarose is modified by the introduction of acrylate, methacrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.
6. The device according to claim 5 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.
7. The device according to any one of the preceding claims wherein said coating also comprises heparin.
8. The device according to claim 7 wherein said heparin is modified by the introduction of methacrylate, acrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.
9. The device according to claim 8 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.
10. The device according to any one of the preceding claims wherein said coating is 1-10 μm thick.
11. The device according to claim 10 wherein the thickness of said coating is selected from the group comprising 1, 2, 3, 4 or 5 μm.
12. The device according to claim 11 wherein said coating is ~2 μm.
13. The device according to any one of claims 7-11 wherein the amount of heparin in the coating is 1-15 $\mu g/cm^2$.

14. The device according to claim 13 wherein the amount of heparin in the coating is selected from the group comprising: 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 or 2.9 μg/cm ^{2}.

15. The device according to claim 14 wherein the amount of heparin in the coating is~2.6 μg/cm ^{2}.

16. The device according to any one of the preceding claims wherein said device is a catheter.

17. The device according to claim 16 wherein said device is selected from the group comprising: a peritoneal dialysis catheter, a central venous catheter and a urinary catheter.

18. A method for manufacturing a medical or veterinary device having, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating, the method comprising:

    i. oxidising a surface of said device;

    ii. exposing said oxidized surface to modified agarose; and

    iii. curing said surface.

19. The method according to claim 18 wherein said agarose is modified by the addition of acrylate, methacrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.

20. The method according to claim 19 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.

21. The method according to any one of claims 18-20 wherein oxidising said surface involves exposing said surface to plasma treatment with gases such as argon, hydrogen, nitrogen or ammonia followed by exposure to air.

22. The method according to any one of claims 18-20 wherein oxidising said surface involves corona discharge treatment or gamma irradiation treatment.

23. The method according to any one of claims 18-22 wherein said agarose is in aqueous solution.

24. The method according to claim 23 wherein said solution comprises said agarose at 5 wt.%.

25. The method according to claims 23 or 24 wherein said solution is dropped or sprayed onto the surface of the device.

26. The method according to claim 25 wherein said solution is deposited using a spin-coating procedure.

27. The method according to claims 23 or 24 wherein a surface of said device is immersed in said solution.

28. The method according to any one of claims 18-27 wherein said curing is undertaken in a degassed environment.

29. The method according to any one of claims 18-28 wherein said curing is undertaken using either Ultra violet (UV) light or heat.

30. The method according to claim 29 wherein, in the instance where UV is used to cure said surface, the surface is exposed to UV for a time period between 15-120 min.

31. The method according to any one of claims 18-30 wherein said oxidised surface is also exposed to modified heparin.

32. The method according to claim 31 wherein said heparin is modified by the introduction of methacrylate, acrylate, (meth)acrylamide, silane, thiol, azide, alkyne, vinylpyridine or vinylimidazole groups, or derivatives of these groups.

33. The method according to claim 32 wherein said derivatives are selected from the group comprising: acrylic anhydride, methacrylic chloride, *N*-hydroxyethyl (meth)acrylamide, 1-2-carboxyethyl-4-vinylpyridinium bromide, and 1-hydroxyethyl-3-vinylimidazolium bromide.

34. The method according to claims 32 or 33 wherein said heparin is methacrylated.

35. The method according to claims 31-34 wherein the amount of heparin in the coating is between 1-15 $\mu g/cm^2$.

36. The method according to any one of claims 35 wherein the amount of methacrylated heparin is ~2.6 $\mu g/cm^2$.

37. The method according to any one of claims 18-36 wherein said coating is deposited to a thickness between 1-10 µm.

38. The method according to claim 37 wherein said coating is ~2 µm.

39. The method according to any one of claims 18-38 wherein said device is a catheter.

40. The method according to claim 39 wherein said device is selected from the group comprising: a peritoneal dialysis catheter, a central venous catheter and a urinary catheter.

41. A catheter having, on at least a part of its surface, a covalently immobilized and cross-linked agarose coating.

42. A catheter having, on at least a part of its surface, a covalently immobilized and cross-linked agarose and heparin coating.

43. The catheter according to claim 42 wherein the amount of heparin is ~2.6 $\mu g/cm^2$.