Claims

1. A composite material comprising a substrate coated with a block copolymer brush, where the block copolymer brush comprises:

a first block of a hydrophobic polymer conjugated to a nitric oxide source, where the first block of the hydrophobic polymer is covalently bonded to a surface of the substrate; and

a second block of a hydrophilic polymer, extending from the first block to form an outer surface of the block copolymer brush,

wherein the nitric oxide source is a tertiary S-nitrosothiol.

2. The composite material according to Claim 1, wherein the nitric oxide source is a 3-nitroso-*tert*-thiol-butyl group or a 3-methyl-3-nitrososulfanyl-butyl group.

3. The composite material according to Claim 1 or Claim 2, wherein the block copolymer brush coating is from 0.1 to 20 μm thick, such as from 5 to 15 μm thick, such as about 10 μm thick.

4. The composite material according to any one of the preceding claims, wherein the composite material has a contact angle of less than 40° on a surface of the substrate coated with the block copolymer brush, optionally wherein the composite material has a contact angle of less than 20°, such as from 5 to 19°, on a surface of the substrate coated with the block copolymer brush.

5. The composite material according to any one of the preceding claims, wherein the substrate is formed from a polymeric material, optionally wherein the substrate is selected from one or more of the group consisting of polyurethane, silicone, latex, and polyester polyurethane.

6. The composite material according to Claim 5, wherein the substrate is formed from polyurethane.

7. The composite material according to any one of the preceding claims, wherein the first block is formed from a polymer comprising one or more vinylogous monomers, where at least one of the one or more vinylogous monomers contains a functional group suitable to conjugate to a nitric oxide source.

8. The composite material according to Claim 7, wherein the functional group suitable to conjugate to a nitric oxide source is selected from one or more of the group consisting of an amine, a hydroxyl, a carboxylic acid, a carboxylic acid ester, and an epoxide.

9. The composite material according to Claim 7 or Claim 8, wherein the one or more vinylogous monomers are selected from the group consisting of an acrylate, an alkylacrylate (e.g. a methacrylate), an acrylamide, an alkylacrylamide (e.g. a methacrylamide), an acrylic acid, an alkyl acrylic acid, and an allylic monomer compound.

10. The composite material according to Claim 9, wherein the one or more vinylogous monomers are selected from the group consisting of allyl amine, amino ethyl methacrylate (AEMA), hydroxyl ethyl methacrylate (HEMA), hydroxylethyl acrylate (HEA), hydroxyl ethyl acrylamide (HEAA), hydroxypropyl methacrylate (e.g. 2-hydroxypropyl methacrylate (HPMA)), hydroxybutyl acrylate, N-[Tris(hydroxymethyl)methyl] acrylamide, allyl alcohol, acrylic acid, methacrylic acid, glycidyl methacrylate (GMA), and ally glycidyl ether (AGE).

11. The composite material according to any one of Claims 7 to 10, wherein the first block is formed from a polyacrylate, optionally wherein the first block is formed from one or more monomers selected from the group consisting of hydroxyethyl methacrylate, hydroxyethyl acrylate, hydroxypropyl-methacrylate, and hydroxybutyl acrylate.

12. The composite material according to any one of the preceding claims, wherein the second block is formed from a polymer comprising one or more vinylogous hydrophilic monomers.

13. The composite material according to Claim 12, wherein the one or more vinylogous hydrophilic monomers are selected from the group consisting of a hydrophilic acrylate, a hydrophilic alkylacrylate (e.g. a hydrophilic methacrylate), a hydrophilic acrylamide, a hydrophilic alkylacrylamide (e.g. a hydrophilic methacrylamide), a hydrophilic acrylic acid, a hydrophilic alkyl acrylic acid, and a hydrophilic allylic monomer compound.

14. The composite material according to Claim 13, wherein the one or more vinylogous hydrophilic monomers are selected from the group consisting of methyl terminated poly(ethylene glycol) methacrylate, methyl terminated poly(ethylene glycol) acrylate, allyl poly(ethylene glycol), oligoethyleneglycol methacrylate, a zwitterionic monomer (e.g. [2-(methacryloyloxy) ethyl] dimethyl-(3-sulfopropyl) ammonium hydroxide (SBMA), methacryloyloxyethyl phosphorylcholine (e.g. 2-methacryloyloxyethyl phosphorylcholine

(MPC)), N-(3-methacryloylimino) propyl-N,N-dimethylammonio propanesulfonate (SBMAm), 3-(2'-vinyl-pyridinio) propanesulfonate (VPPS), carboxybetaine methacrylate (CBMA), sulfobetaine methacrylate, sulfobetaineacrylamide, 3-[(3-acrylamidopropyl) dimethylammonio] propanoate, and 3-[[2-(methacryloyloxy) ethyl] dimethylammonio] propionate), and a vinylogous-modified polysaccharide (e.g. dextran methacrylate, hyaluronate methacrylate).

15. The composite material according to Claim 13 or Claim 14, wherein the second block is formed from one or more monomers selected from the group consisting of oligoethyleneglycol methacrylate, methacryloyloxyethyl phosphorylcholine, sulfobetaine methacrylate, sulfobetaineacrylamide, 3-[(3-acrylamidopropyl) dimethylammonio] propanoate, and 3-[[2-(methacryloyloxy) ethyl] dimethylammonio] propionate.

16. The composite material according to any one of the preceding claims, wherein:
the first block is formed from poly(hydroxyethyl methacrylate);
the second block is formed from poly(sulfobetaine methacrylate); and
the nitric oxide source is a tertiary S-nitrosothiol.

17. A method of forming a composite material as described in any one of Claims 1 to 16, the method comprising the steps of:
(a) providing a substrate coated with a polymer brush, where the polymer brush is formed from a hydrophobic polymer covalently bonded to a surface of the substrate;
(b) reacting the hydrophobic polymer in the polymer brush with a hydrophilic monomer in a polymerisation reaction to form a block copolymer brush; and
(c) conjugating a nitric oxide source to the hydrophobic polymer of the block copolymer brush.

18. A method of forming a composite material as described in any one of Claims 1 to 16, said method comprising the steps of:
(ai) providing a substrate coated with a block copolymer brush, where the block copolymer brush is formed from:
a first block of a hydrophobic polymer covalently bonded to a surface of the substrate; and
a second block of a hydrophilic polymer, extending from the first block to form an outer surface of the block copolymer brush; and
(bi) conjugating a nitric oxide source to the hydrophobic polymer of the first block.

19. An article formed from a composite material as described in any one of Claims 1 to 16, wherein a substrate of the composite material has at least one surface that is coated with a block copolymer brush as described in any one of Claims 1 to 16.

20. The article according to Claim 19, wherein the article is a catheter formed from the composite material, where the catheter has an outer surface and an inner surface, and one or both of the outer surface and inner surface have been coated with a block copolymer brush as described in any one of Claims 1 to 16.

21. The article according to Claim 19, wherein the article is a wound dressing formed from the composite material, where the wound dressing has an outer surface and an inner surface, and the inner surface is coated with a block copolymer brush as described in any one of Claims 1 to 16.