Claims

1. A method for adhering a catechol and quinone functionalised layer to a substrate wherein the method comprises the steps of:
    a) providing a substrate,
    b) providing a precursor which comprises a vinyl monomer or a non-vinylic molecule, substituted by an unprotected catechol group, with a vinylic or a non-vinylic co-monomer;

    characterized by the additional step:
    c) applying a plasma to the precursor and the substrate in order to form a coating comprising a catechol and quinone functionalised layer on the substrate.

2. A method according to claim 1, wherein a step of cleaning the substrate by ultrasonic washing is carried out before step (a).

3. A method according to one of claims 1-2, wherein said substrate is an organic or inorganic substrate, preferentially a stainless steel substrate, titanium substrate or an aluminum substrate.

4. A method according to any one of claims 1-3, wherein the method comprises use of a polymerisation initiator agent; preferably the polymerization initiator agent is added in step (b) or in step (c).

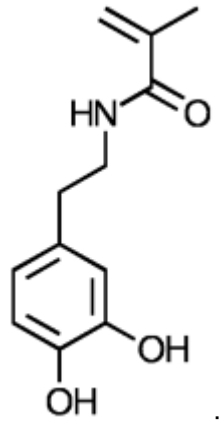
5. A method according to claim 4 wherein said polymerization initiator agent is a free radical initiator.

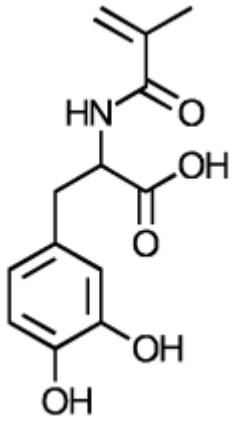
6. A method according to claim 5, wherein said free radical initiator is one of the 4,4'-azobis(4-cyanopentano acid), 2,2'- azobis[2-methyl-*N*-(1,1-bis-(hydroxymethyl)-hydroxyethylpropionamide], 2,2'-azobis(2- methylpropionamidine)dihydrochloride, 2,2'-azobis[2-methyl-*N*-(2-hydroxyethyl)propionamide], 2,2'- azobis(isobutyramidine hydrochloride), 2,2'-azobis[2-methyl-*N*-(1,1-bis(hydroxymethyl)-2-ethyl)-propionamide], 2,2'-azobis[2-(2-imidazolin-2-yl)propane]dihydrochloride, 2,2'-Azobis[*N*-(2- carboxyethyl)-2-methylpropionamidine] hydrate, 2,2'-Azobis{2-[1-(2-hydroxyethyl)-2-imidazolin-2- yl]propane}dihydrochloride, 2,2'-Azobis(1-imino-1-pyrrolidino-2 ethylpropane)dihydro chloride, 2,2'- Azobis{2-methyl-*N*-[1,1-bis(hydroxymethyl)-2-hydroxyethyl]propionamide}, 2,2'-azobis[2-methyl-*N*-(2-hydroxyethylpropionamide], 2,2'-azobis(isobutylamide) dihydrate, or azoinitiators having polyethylene glycol unit.

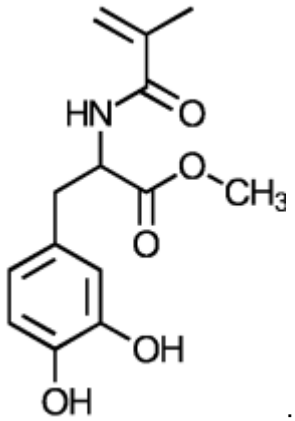
7. A method according to any one of claims 1-6, wherein the plasma used in step (c) is a non-equilibrium plasma process operating at atmospheric pressure.

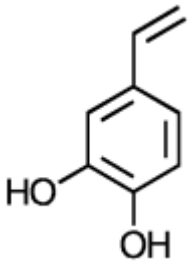
8. A method according to any one of claims 1-7, wherein said plasma of step (c) is generated by an electrical excitation, said electrical excitation comprising preferentially an electrical signal which is delivered in a pulsed wave form.

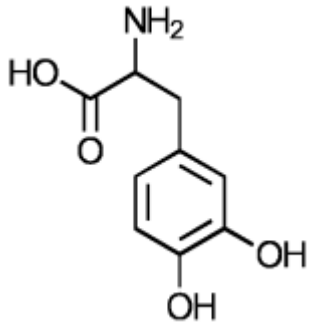
9. A method according to any one of claims 1-8, wherein said vinyl monomer or a non-vinylic molecule with an unprotected catechol group is

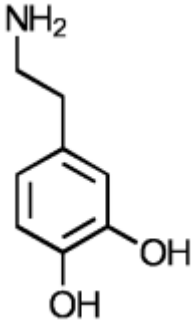


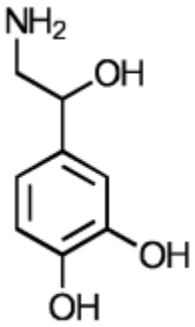
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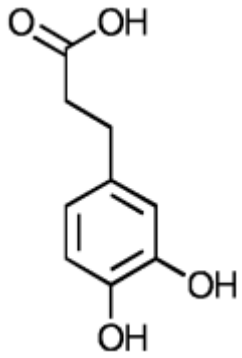
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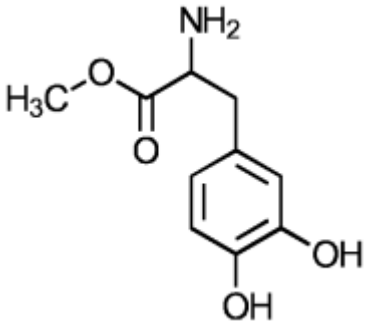
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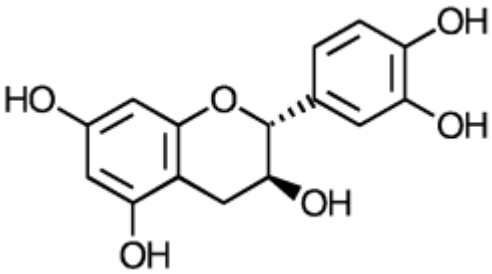
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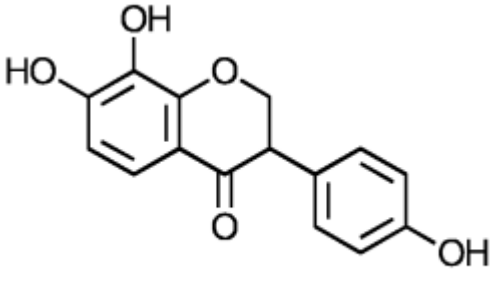
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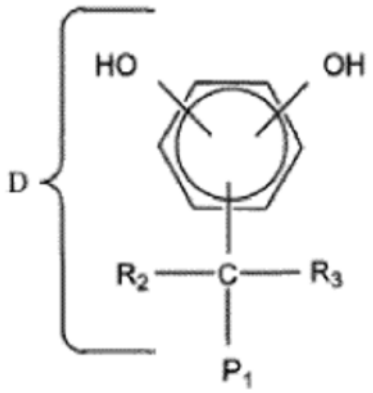
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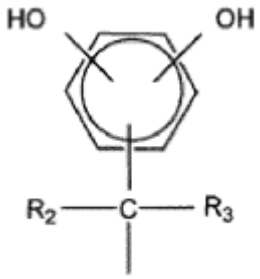
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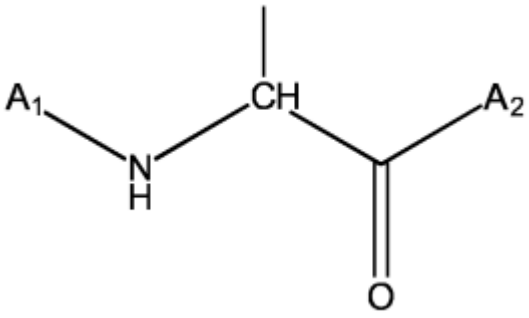
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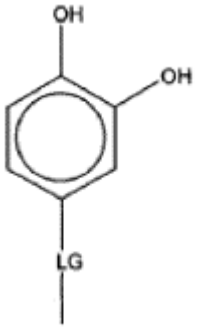
wherein R_2 and R_3 are the same or different, and independently represent a hydrogen atom, a saturated C_{1-4} hydrocarbon group, and wherein P_1 represents separately and independently $–NH_2$, -COOH, -OH, -SH,



wherein R_2 and R_3 are the same or different, and independently represent a hydrogen atom, a saturated C_{1-4} hydrocarbon group,

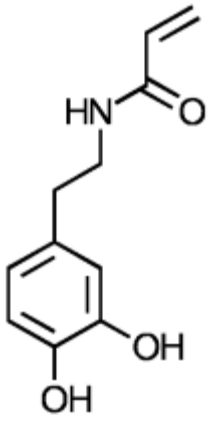


wherein each of A_1 and A_2 independently represents a hydrogen atom; or



wherein LG represents a linking group and is chosen from oligomers having chemical structure $–[C(R_2)(R_3)]_x-P_2$ wherein R_2 and R_3 are the same or different, and independently represent a hydrogen atom, a saturated C_{1-4} hydrocarbon group and wherein P_2 represents $-NH_2$, -COOH, -OH, -SH, an halogen, $-NH-A_5-$, $-C(O)A_6$, $-CH(NHA_5)-c(O)-A_6$ wherein A_5 represents –H, -C and A_6 represents $–OH$, $-NH_2$.

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10. A method according to any one of claims 1-8, wherein said vinyl monomer with an unprotected catechol group is 

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11. A method according to any one of claims 1-10, wherein said vinylic or non-vinylic co-monomer is an acrylate derivative, a methacrylate derivative, a styrene derivative, a vinyl ester, a vinyl amide, acrylonitrile, methacrylonitrile, acrylamide, methacrylamide, an unsaturated vegetable oil, a fatty acid, an acryclic acid, a methacrylic acid, a vinyl alkoxysilanes, ethylene, hexamethyldisiloxane, hexamethyldisilazane, octamethylcyclotetrasiloxane, decamethylcylcopentasiloxane, dodecamethylcyclohexasiloxane, hexaethyldisiloxane, tetraethylorthosilicate, tetramethyldisiloxane, pentamethylcyclopentasiloxane, octamethylcyclooctasiloxane, polydimethylsiloxane and/or derivatives of polydimethylsiloxane.

12. A method according to any one of claims 1-10, wherein said vinylic co-monomer is vinyltrimethoxysilane.

13. A process for immobilizing at least one biomolecule on a substrate with a catechol and quinone functionalized layer, said process comprising a method in accordance with any one of claims 1-12 and a step of immersing the coated substrate in a buffer solution comprising at least one biomolecule.

14. A process according to claim 13, wherein said at least one biomolecule is natamycin and/or an antibacterial peptide, said antibacterial peptide being preferentially nisin, lysozyme, and/or melimine peptide.

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