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Claims

1. A nanoparticle which is characterised by a photoluminescent core having a surface,
5 wherein the core is an amorphous core formed from threonine and polyethylenimine (PEI); and
wherein the surface is functionalised with at least a carbohydrate.
2. The nanoparticle according to claim 1, wherein the photoluminescence from the
10 core is emittable within the range of about 400 nm to about 650 nm.
3. The nanoparticle according to claim 2, wherein the emittable photoluminescence
is at least 1.5 times a comparator nanoparticle which does not comprise both threonine
and PEI.
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4. The nanoparticle according to claim 3, wherein the comparator is selected from
the group consisting of:
 - i) a nanoparticle having a core formed from serine or threonine or PEI;
 - ii) a nanoparticle having a core formed from serine and PEI;
 - 20 iii) a nanoparticle having a core formed from threonine and chitosan;
 - iv) a nanoparticle having a core formed from serine and dextran (DEX);
 - v) a nanoparticle having a core formed from serine and hyaluronic acid (HA);
 - vi) a nanoparticle having a core formed from serine and polyethylene glycol
monomethyl ether (mPEG); and
 - 25 v) a nanoparticle having a core formed from serine and poly(L-lysine) (PLL).
5. The nanoparticle according to any one of claims 1 to 4, wherein the PEI is a
branched PEI.
- 30 6. The nanoparticle according to any one of claims 1 to 5, wherein the core has a
molecular weight of less than 3 kD.
7. The nanoparticle according to any one of claims 1 to 6, wherein the carbohydrate
is mannose.
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8. The nanoparticle according to any one of claims 1 to 7, having a mean diameter of about 1 nm to about 8 nm.
9. The nanoparticle according to any one of claims 2 to 8, having a
5 photoluminescence stability of at least 95% after 30 min irradiation.
10. The nanoparticle according to any one of claims 2 to 9, wherein the photoluminescence is fluorescence.
- 10 11. The nanoparticle according to any one of claims 1 to 10, having a zeta potential of more than about +5 mV.
12. The nanoparticle according to any one of claims 1 to 11, having a minimum inhibitory concentration (MIC) value against bacteria of more than 150 µg/mL.
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13. A method of forming and functionalising a nanoparticle, including the steps of:
a) hydrothermally reacting threonine and PEI to form the nanoparticle having a photoluminescent amorphous core; and
b) reacting at least a carbohydrate with a surface of the nanoparticle core in order
20 to form a surface functionalised nanoparticle with at least a carbohydrate.
14. The method according to claim 13, wherein step (a) is performed at high temperature and pressure.
- 25 15. The method according to claims 13 or 14, wherein step (b) is performed at about 60 °C for about 48 h.
16. The method according to any one of claims 13 to 15, further including a step of filtrating the core from the unreacted threonine and PEI after step (a).
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17. The method according to any one of claims 13 to 16, further including a step of purifying the nanoparticle after step (b).
18. A photoluminescence assay for quantifying a sample comprising bacterial cells,
35 including the steps of:

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- a) incubating the sample with a silica coated magnetic particle for allowing the silica coated magnetic particle to contact the bacterial cells;
 - b) exposing the bacterial cells contacted with the silica coated magnetic particle to an external magnetic field to form a first magnetic pellet and a first supernatant;
 - 5 c) separating the first magnetic pellet from the first supernatant;
 - d) incubating the first magnetic pellet with a nanoparticle for allowing the nanoparticle to contact the bacterial cells, the nanoparticle is characterised by a photoluminescent amorphous core having a surface, wherein the core comprises threonine and polyethylenimine (PEI), and wherein the surface is functionalised with at
10 least a carbohydrate;
 - e) exposing the bacterial cells contacted with the silica coated magnetic particle and the nanoparticle to an external magnetic field to form a second magnetic pellet and a second supernatant; and
 - f) quantifying the emittable photoluminescence from the second magnetic pellet.
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19. The assay according to claim 18, wherein step (a) is performed for at least 10 min.
20. The assay according to claims 18 or 19, wherein the silica coated magnetic
20 particle has a mean particle size of about 15 nm to about 40 nm.
21. The assay according to any one of claims 18 to 20, wherein the silica coated magnetic particle has a silica shell thickness of at least about 5 nm.
- 25 22. The assay according to any one of claims 18 to 21, wherein the silica coated magnetic particle has a magnetic particle core mean particle size of about 10 nm.
23. The assay according to any one of claims 18 to 22, wherein the silica coated magnetic particle has a saturation magnetization of more than about 40 emu/g.
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24. The assay according to any one of claims 18 to 23, wherein the silica coated magnetic particle has negligible remanence.
25. The assay according to any one of claims 18 to 24, wherein the silica coated
35 magnetic particle has a zeta potential of about -5 mV to about +5 mV.

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26. The assay according to any one of claims 18 to 25, wherein the silica coated magnetic particle is at least partially functionalised with an amino moiety.

27. The assay according to any one of claims 18 to 26, wherein the silica coated
5 magnetic particle is conjugated to an antibody for targeting bacterial cells.

28. The assay according to any one of claim 18 to 27, further including a step of resuspending the second magnetic pellet in a solvent after step (e).

10 29. The assay according to any one of claims 18 to 28, further including a step of comparing the emitted photoluminescence with a calibration plot for determining the concentration of bacterial cells in the sample after step (f).

30. The assay according to any one of claims 18 to 29, having a detection limit of at
15 least 10^4 CFU/mL of bacterial cells.