Claims

1. A nanoparticle which is characterised by a photoluminescent core having a surface,
wherein the core is an amorphous core formed from threonine and polyethylenimine (PEI); and
wherein the surface is functionalised with at least a carbohydrate, wherein the photoluminescence from the core is emittable within the range of about 400 nm to about 650 nm.

2. The nanoparticle according to claim 1, wherein the emittable photoluminescence is at least 1.5 times a comparator nanoparticle which does not comprise both threonine and PEI, 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;
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
vii) a nanoparticle having a core formed from serine and poly(L-lysine) (PLL).

3. The nanoparticle according to claim 1 or 2, wherein the PEI is a branched PEI, and/or wherein the core has a molecular weight of less than 3 kD.

4. The nanoparticle according to any one of claims 1 to 3, wherein the carbohydrate is mannose.

5. The nanoparticle according to any one of claims 1 to 4, having a mean diameter of about 1 nm to about 8 nm.

6. The nanoparticle according to any one of claims 1 to 5, having a photoluminescence stability of at least 95% after 30 min irradiation, wherein the photoluminescence is fluorescence.

7. The nanoparticle according to any one of claims 1 to 6, having a zeta potential of more than +5 mV, and/or having a minimum inhibitory concentration (MIC) value against bacteria of more than 150 µg/mL.

8. 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 to form a surface functionalised nanoparticle with at least a carbohydrate.

9. The method according to claim 8, wherein step (b) is performed at about 60 °C for about 48 h.

10. The method according to claim 8 or 9, further including a step of filtrating the core from the unreacted threonine and PEI after step (a).

11. The method according to any one of claims 8 to 10, further including a step of purifying the nanoparticle after step (b).

12. A photoluminescence assay for quantifying a sample comprising bacterial cells, including the steps of:

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;

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 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.

13. The assay according to claim 12, wherein step (a) is performed for at least 10 min.

14. The assay according to claim 12 or 13, wherein the silica coated magnetic particle has a mean particle size of about 15 nm to about 40 nm.

15. The assay according to any one of claims 12 to 14, wherein the silica coated magnetic particle has a silica shell thickness of at least about 5 nm, wherein the silica coated magnetic particle has a magnetic particle core mean particle size of about 10 nm.

16. The assay according to any one of claims 12 to 15, wherein the silica coated magnetic particle has a saturation magnetization of more than 40 emu/g, and/or wherein the silica coated magnetic particle has negligible remanence, and/or wherein the silica coated magnetic particle has a zeta potential of about -5 mV to about +5 mV.

17. The assay according to any one of claims 12 to 16, wherein the silica coated magnetic particle is at least partially functionalised with an amino moiety, and/or wherein the silica coated magnetic particle is conjugated to an antibody for targeting bacterial cells.

18. The assay according to any one of claims 12 to 17, further including a step of resuspending the second magnetic pellet in a solvent after step (e).

19. The assay according to any one of claims 12 to 18, 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).

20. The assay according to any one of claims 12 to 19, having a detection limit of at least 10^4 CFU/mL of bacterial cells.