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~~.~~

~~2. The nanoparticle according to claim 1~~, wherein the photoluminescence from the core is emittable within the range of about 400 nm to about 650 nm.

~~3~~2. The nanoparticle according to claim ~~2~~1, wherein the emittable photoluminescence is at least 1.5 times a comparator nanoparticle which does not comprise both threonine and PEI~~.~~

~~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;
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).

~~5~~3. The nanoparticle according to ~~any one of~~ claim~~s~~ 1 or 2~~to 4~~, wherein the PEI is a branched PEI~~.~~

~~6. The nanoparticle according to any one of claims 1 to 5~~, and/or wherein the core has a molecular weight of less than 3 kD.

~~7~~4. The nanoparticle according to any one of claims 1 to ~~6~~3, wherein the carbohydrate is mannose.

~~8~~5. The nanoparticle according to any one of claims 1 to ~~7~~4, having a mean diameter of about 1 nm to about 8 nm.

~~9~~6. The nanoparticle according to any one of claims ~~2~~1 to ~~8~~5, having a 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.

~~11~~7. The nanoparticle according to any one of claims 1 to ~~10~~6, having a zeta potential of more than ~~about~~ +5 mV~~.~~

~~12. The nanoparticle according to any one of claims 1 to 11~~, and/or having a minimum inhibitory concentration (MIC) value against bacteria of more than 150 µg/mL.

~~13~~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.

~~14. The method according to claim 13, wherein step (a) is performed at high temperature and pressure.~~

~~15~~9. The method according to claim~~s~~ ~~13~~8 ~~or 14~~, wherein step (b) is performed at about 60 °C for about 48 h.

~~16~~10. The method according to ~~any one of~~ claim~~s~~ ~~13~~8 or ~~9 to 15~~, further including a step of filtrating the core from the unreacted threonine and PEI after step (a).

~~17~~11. The method according to any one of claims ~~13~~8 to ~~16~~10, further including a step of purifying the nanoparticle after step (b).

~~18~~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.

~~19~~13. The assay according to claim ~~18~~12, wherein step (a) is performed for at least 10 min.

~~20~~14. The assay according to claim~~s~~ ~~18~~12 or ~~19~~13, wherein the silica coated magnetic particle has a mean particle size of about 15 nm to about 40 nm.

~~21~~15. The assay according to any one of claims ~~18~~12 to ~~20~~14, wherein the silica coated magnetic particle has a silica shell thickness of at least about 5 nm~~.~~

~~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~~16. The assay according to any one of claims ~~18~~12 to ~~22~~15, wherein the silica coated magnetic particle has a saturation magnetization of more than ~~about~~ 40 emu/g~~.~~

~~24. The assay according to any one of claims 18 to 23~~, and/or wherein the silica coated magnetic particle has negligible remanence~~.~~

~~25. The assay according to any one of claims 18 to 24~~, and/or wherein the silica coated magnetic particle has a zeta potential of about -5 mV to about +5 mV.

~~26~~17. The assay according to any one of claims ~~18~~12 to ~~25~~16, 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~~, and/or wherein the silica coated magnetic particle is conjugated to an antibody for targeting bacterial cells.

~~28~~18. The assay according to any one of claim~~s~~ ~~18~~12 to ~~27~~17, further including a step of resuspending the second magnetic pellet in a solvent after step (e).

~~29~~19. The assay according to any one of claims ~~18~~12 to ~~28~~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).

~~30~~20. The assay according to any one of claims ~~18~~12 to ~~29~~19, having a detection limit of at least 10^4 CFU/mL of bacterial cells.