CLAIMS:

1. A microcapsule comprising:

- a silica shell having a thickness of from ~~about~~ 50 nm to ~~about~~ 500 µm, and a plurality of pores, said shell forming a capsule having a diameter from ~~about~~ 0.2 µm to ~~about~~ 1500 µm, and having a density of ~~about~~ 0.001 g/cm^3 to ~~about~~ 1.0 g/cm^3,

wherein said shell comprises :

- from ~~about~~ 0% to ~~about~~ 70% Q3 configuration, and from ~~about~~ 30% to ~~about~~ 100% Q4 configuration, or

~~wherein said shell comprises •~~ from ~~about~~ 0% to ~~about~~ 60% T2 configuration and from ~~about~~ 40% to ~~about~~ 100% T3 configuration, or

~~wherein said shell comprises •~~ a combination of T and Q configurations thereof, and

wherein an exterior surface of said capsule is covered by a functional group, said microcapsule further comprises a surface layer, and wherein said surface layer is functionalized with an organosilane.

2. The microcapsule of claim 1, wherein said shell comprises from ~~about~~ 40% Q3 configuration and ~~about~~ 60% Q4 configuration.

3. The microcapsule of claim 1, wherein said shell comprises from ~~about~~ 100% Q4 configuration.

4. The microcapsule of claim 1, wherein said pores have pore diameters from ~~about~~ 0.5 nm to ~~about~~ 100 nm.

~~5. The microcapsule of any one of claims 1 to 4, further comprising a surface layer.~~

~~6~~5. The microcapsule of claim ~~5~~1, wherein said surface layer comprises a thickness from ~~about~~ 1 nm to ~~about~~ 10 nm.

~~7. The microcapsule of any one of claims 6 to 6, wherein said surface layer is functionalized with an organosilane.~~

~~8~~6. The microcapsule of claim ~~7~~1, wherein said organosilane is chosen from a functional trimethoxysilane, a functional triethoxysilane, a functional tripropoxysilane.

~~9~~7. The microcapsule of claim ~~8~~6, wherein said organosilane is chosen 3-aminopropyltriethoxysilane, vinyltriacetoxy silane, vinyltrimethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane, 3-chloropropyltriethoxysilane, bis-(triethoxysilylpropyl)tetrasulfane, methyltriethoxysilane, n-octyltriethoxysilane, and phenyltrimethoxysilane and combinations thereof.

~~10~~8. The microcapsule of any one of claims ~~6~~ 5 to ~~8~~6, wherein said surface layer is further functionalized with a hydroxyl group, an amino group, a benzylamino group, a chloropropyl group, a disulfide group, an epoxy group, a mercapto group, a methacrylate group, a vinyl group, and combinations thereof.

~~11~~9. The microcapsule of any one of claims 1 to ~~10~~8, having a melting point from ~~about~~ 1600ºC to ~~about~~ 1725ºC.

~~12~~10. The microcapsule of any one of claims 1 to ~~11~~9, further comprising a conductive layer surrounding said exterior surface of said capsule.

~~13~~11. The microcapsule of claim ~~12~~10, wherein said conductive layer is a metallic layer, or a conductive polymer layer.

~~14~~12. The microcapsule of claim ~~13~~11, wherein said metallic layer is a layer of silver (Ag), gold (Au), copper (Cu), aluminum (Al), or combinations thereof.

~~15~~13. The microcapsule of claim ~~13~~11, wherein said conductive polymer layer is a layer of polypyrrole, polythiophene, polyanilines or combinations thereof.

~~16~~14. The microcapsule of any one of claims ~~6~~ 5 to ~~10~~8, further comprising an ~~active~~ agent.

~~17~~15. The microcapsule of claim ~~16~~14, wherein said ~~active~~ agent is chosen from a catalyst for monomers polymerization, a polymer stabilizer chemical, a fire retardant chemical, a colorant, a pharmaceutically active drug, an enzyme, a cosmetic oil, a fragrance, a perfume, a food additives, an humidifier, an explosive, a phase change material (PCM), an insecticide, an herbicide, a fungicide and combinations thereof.

~~18~~16. The microcapsule of claim ~~17~~15, wherein said polymer stabilizer chemical is chosen from butylated hydroxytoluene (BHT), α-tocopherol, tocopheryl acetate, an organophosphate, Tris(2,4-di-tert-butylphenyl) phosphite, trisnonylphenyl phosphite, dilauryl thiodipropionate, distearyl thiodipropionate, Bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, benzotriazoles, benzophenones and combinations thereof.

~~19~~17. The microcapsule of claim ~~17~~15, wherein said fire retardant chemical is chosen from tetrabromobisphenol-A, decabromodiphenylethane, dibromoneopentylglycol, or combinations thereof.

~~20~~18. The microcapsule of claim ~~17~~15, wherein said colorant is chosen from carbon black, molybdate orange, chrome oxide green, anthanthrone, anthraquinone, benzimidazole, and quinacridone.

~~21~~19. The microcapsule of any one of claims ~~16~~ 14 to ~~17~~15, wherein said ~~active~~ agent is crosslinked to said surface layer, to said exterior surface, or both.

~~22~~20. The microcapsule of any one of claims ~~16~~ 14 to ~~17~~15, wherein said ~~active~~ agent is encapsulated in said microcapsule.

~~23. The microcapsule of claim 1, having the NMR spectrum as shown in Fig. 1.~~

~~24~~21. A process for the preparation of a microcapsule comprising step a):

a) contacting with an acidic or alkali catalyst an emulsion formed between a water phase comprising water, an alcohol and one or more surfactants, and an oil phase comprising a silica precursor and a hydrophobic solvent or an oil, for a time sufficient and at a temperature sufficient obtain a formed microcapsule in a liquid phase;

wherein said surfactant is chosen from a PEO/PPO copolymer ~~(pluronic P123)~~, sorbitan monooleate ~~(Span 80)~~, sorbitan trioleate ~~(Span 85)~~, sorbitan tristearate ~~(Span 65)~~ or sorbitan sesquioleate, sorbitan monolaurate ~~(Span 20)~~, a PEO/PPO copolymer, glycerol monooleate, Tween 20 ~~(polysorbate 20)~~, Tween 80 ~~(polysorbate 80)~~, polysorbate 61 ~~(Tween 61)~~, cetyl trimethylamonium bromide ~~(CTAB)~~, sodium dodecyl sulfate ~~(SDS)~~, a polyoxyethylene fatty ether ~~(Brij30)~~, a nonylphenoxypolyethoxyethanol, an octylphenoxypolyethoxyethanol and combinations thereof.

~~25~~22. The process of claim ~~24~~21, further comprising step b) after step a):

b) washing said formed microcapsule to remove said acidic or alkali catalyst, said surfactant and said oil, to obtain washed microcapsules.

~~26~~23. The process of claim ~~25~~22, further comprising step c) after step b):

c) separating said formed microcapsule from said liquid phase.

~~27~~24. The process of claim ~~26~~ 23 further comprising step d) after step c):

d) drying said washed microcapsules to obtain dried microcapsules.

~~28~~25. The process of claim ~~27~~24, wherein drying is by calcining said formed microcapsule to obtain dried microcapsule at ~~about~~ 200°C to ~~about~~ 800°C.

~~29~~26. The process of claim ~~27~~24, wherein drying is by forced convection including spray drying, flash drying, fluidized bed drying; or freeze drying said formed microcapsule to obtain dried microcapsule.

~~30~~27. The process of claim ~~27~~24, further comprising step e) after step d):

e) thermal annealing said dried microcapsule at 700°C to less than ~~about~~ 1100°C.

~~31~~28. The process of any one of claims ~~24~~ 21 and ~~25~~22, further comprising reacting said formed microcapsule with a functionalizing reagent to functionalize a surface of said formed microcapsule.

~~32~~29. The process of claim ~~24~~21, wherein said oil phase comprises said silica precursor and said hydrophobic solvent or said oil in a weight ratio of ~~about~~ 4:1 to ~~about~~ 1:10 (silica precursor : oil or solvent ratio).

~~33~~30. The process of any one of claims ~~24~~ 21 to ~~32~~29, wherein said hydrophobic solvent is chosen from hexane, heptanes, cyclohexane, pentane, cyclopentane, toluene, decalin, benzene, carbon tetrachloride, cyclohexane,1,4 dioxane and chloroform and combinations thereof.

~~34~~31. The process of any one of claims ~~24~~ 21 to ~~33~~30, wherein said oil is a vegetable oil.

~~35~~32. The process of claim ~~34~~31, wherein said vegetal oil is chosen from palm oil, soybean oil, rapeseed oil, sunflower seed oil, peanut oil, cottonseed oil, palm

kernel oil, coconut oil, corn oil, grape seed oil, hazelnut oil, linseed oil, rice bran oil, safflower oil, sesame oil, olive oil and combinations thereof.

~~36~~33. The process of any one of claims ~~24~~ 21 to ~~35~~32, wherein said silica precursor is chosen from one or more silanes having 1, 2, 3 or 4 hydrolysable groups per molecule.

~~37~~34. The process of claim ~~36~~33, wherein said silane is chosen from a methoxysilane, an ethoxysilane, a propoxysilane, an isopropoxysilane, an aryloxysilane, tetramethoxysilane (TMOS), tetraethoxysilane (TEOS), tetrapropoxysilane (TPOS) or a functional trimethoxy, triethoxysilane, tripropoxysilane including aminopropylsilane, aminoethylaminopropylsilane, vinyltrimethoxysilane, 3-chloropropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, methacryloyloxypropyltrimethoxysilane, phenyltriethoxysilane, phenyltrimethoxysilane, glycidoxypropoxyltrimethoxysilane, glycidoxypropyltriethoxysilane, mercaptopropyltriethoxysilane, mercaptopropyltrimethoxysilane, aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-(2-aminoethylamino)propyltrimethoxysilane, 3-[2-(2-aminoethylamino)ethylamino]propyltrimethoxysilane, [2(cyclohexenyl)ethyl]triethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane or a mixture of any two or more of the above.

~~38~~35. The process of claim ~~37~~34, wherein said ~~organo-reactive~~ silane ~~for post-functionalization~~ is chosen from a functional trimethoxysilane, a functional triethoxysilane, and a functional tripropoxysilane.

~~39~~36. The process of any one of claims ~~24~~ 21 to ~~38~~35, wherein said water phase comprising water, said alcohol and said surfactant comprises water and said alcohol in a weight ratio from ~~about~~ 1:100 to 1:4 (alcohol: water ratio).

~~40~~37. The process of any one of claims ~~24~~ 21 to ~~39~~36, wherein said alcohol is chosen from methanol, ethanol, propanol, glycerol, glycol or combinations thereof.

~~41~~38. The process of any one of claims ~~24~~ 21 to ~~40~~37, wherein said surfactant is in a concentration from ~~about~~ 0.05 mM to ~~about~~ 15 mM.

~~42~~39. The process of any one of claims ~~25~~ 21 to ~~41~~38, wherein said acid catalyst is chosen from HCl, acetic acid, and sulfuric acid.

~~43~~40. The process of any one of claims ~~25~~ 22 to ~~42~~39, wherein said alkali catalyst is chosen from sodium hydroxide, potassium hydroxide or ammonia.

~~44~~41. The process of any one of claims ~~25~~ 22 to ~~43~~40, wherein said time sufficient is chosen from ~~about~~ 30 minutes to ~~about~~ 18 hours.

~~45~~42. The process of any one of claims ~~25~~ 22 to ~~44~~41, wherein said temperature sufficient is chosen from room temperature (24ºC) to ~~about~~ 50ºC.

~~46~~43. A microcapsule prepared according to the process of any one of claims ~~25~~ 22 to ~~45~~42.

~~47~~44. A process for the post-functionalization in solution of a microcapsule , for the preparation of a microcapsule according to claims 1 to ~~6~~5, and ~~46~~ 43 comprising step a):

a) dispersion, under inert atmosphere, of the dried silica microcapsules comprising

- a silica shell having a thickness of from 50 nm to 500 µm, and a plurality of pores said shell forming a capsule having a diameter from 0.2 µm to 1500 µm, and having a density of 0.001 g/cm^3 to 1.0 g/cm^3,

wherein said shell comprises:

- from 0% to 70% Q3 configuration, and from 30% to 100% Q4 configuration, or
- from 0% to 60% T2 configuration and from 40% to 100% T3 configuration, or
- a combination of T and Q configurations thereof,

wherein an exterior surface of said silica microcapsule is covered by a functional group,

in a dried organic solvent in the presence of one or more organo-reactive silanes and an organic acid or an organic base for a time sufficient and at a temperature sufficient obtain a functionalized microcapsule in a liquid dispersion.

~~48~~45. The process of claim ~~47~~44, wherein said dried organic solvent comprises dichloromethane, tetrahydrofuran, ethyl acetate, or combinations thereof.

~~49~~46. The process of claim ~~47~~44, wherein said organic acid is a carboxylic acid.

~~50~~47. The process of claim ~~47~~44, wherein said organic base is an amine base.

~~51~~48. The process of claim ~~47~~44, further comprising step b) after step a):

b) separating said functionalized microcapsule from said liquid dispersion.

~~52~~49. The process of claim ~~51~~48, further comprising step c) after step b):

c) drying said functionalized microcapsule to obtain a dried functionalized microcapsule.

~~53~~50. The process of any one of claims ~~47~~ 44 to ~~49~~46, wherein said time sufficient is from ~~about~~ 12 to 24 hours.

~~54~~51. The process of any one of claims ~~47~~ 44 to ~~53~~50, wherein said temperature sufficient is from ~~about~~ 20°C to ~~about~~ 50°C.

~~55~~52. The process of claim 50, wherein said drying is at ~~about~~ 30°C to ~~about~~ 120°C, under vacuum or at a normal pressure or using a spray drying system.

~~56~~53. A process for the post-functionalization in solid state of a microcapsule according to any one of claims 1 to ~~65~~, and ~~48~~ 43 wherein said functionalization is by treating the dried microcapsules with an organosilane vapor.

~~57. The microcapsule of claim 1, having an NMR spectrum as shown in Fig. 1.~~

~~58~~54. A process for the preparation of a microcapsule encapsulating an active agent comprising step a) :

a) contacting with an acidic or alkali catalyst an emulsion formed between a water phase comprising water, an alcohol and one or more surfactants, and an oil phase comprising a silica precursor and a hydrophobic solvent or an oil, for a time sufficient and at a temperature sufficient obtain a formed microcapsule in a liquid phase,

wherein said surfactant is chosen from a PEO/PPO copolymer, sorbitan monooleate, sorbitan trioleate, sorbitan tristearate or sorbitan sesquioleate, sorbitan monolaurate, a PEO/PPO copolymer, glycerol monooleate, Tween 20, Tween 80, polysorbate 61, cetyl trimethylamonium bromide, sodium dodecyl sulfate, a polyoxyethylene fatty ether, a nonylphenoxypolyethoxyethanol, an octylphenoxypolyethoxyethanol and combinations thereof.

~~59~~55. The process of claim ~~58~~54, further comprising step b) after step a):

b) washing said formed microcapsule to remove said acidic or alkali catalyst, said surfactant and said oil, to obtain washed microcapsules.

~~60~~56. The process of claim ~~59~~55, further comprising step c) after step b):

c) separating said formed microcapsule from said liquid phase.

~~61~~57. The process of claim ~~60~~ 56 further comprising step d) after step c):

d) drying said washed microcapsules at a temperature sufficient to dry said washed microcapsule without destroying the active agent encapsulated therein, to obtain dried microcapsules.

~~62~~58. The process of claim ~~61~~57, wherein drying is by heating with pressure, heating without pressure, freeze drying, or combinations thereof.