

Patent Claims

1. A Mmetal nanoparticle sol having a metal particle content ≥ 1 g/l, containing
 - silver nanoparticles
 - at least one polymeric dispersant and
 - at least one liquid dispersion medium

characterized in that wherein the metal nanoparticle sol contains from 0.1 to 10 wt% of at least one metal selected from the group consisting of: ruthenium, rhodium, palladium, osmium, iridium and platinum, expressed in terms of the silver content of the metal nanoparticle sol, in the form of the metal or at least one metal compound.
2. The Mmetal nanoparticle sol according to Claim 1, ~~characterized in that wherein~~ the metal selected from the group consisting of: ruthenium, rhodium, palladium, osmium, iridium and platinum is ruthenium.
3. The Mmetal nanoparticle sol according to Claim 1 or 2, ~~characterized in that wherein~~ at least 90 wt% ~~preferably at least 95 wt%, particularly preferably at least 99 wt%~~, of the ruthenium is present in the form of ruthenium dioxide.
4. The metal nanoparticle sol according to at least one of Claims 1 to 3, wherein at least 95 wt% of the ruthenium is present in the form of ruthenium dioxide.
5. The metal nanoparticle sol according to at least one of Claims 1 to 4, wherein at least 99 wt% of the ruthenium is present in the form of ruthenium dioxide.
46. The Mmetal nanoparticle sol according to at least one of Claims 1 to 35, ~~characterized in that wherein~~ the liquid dispersion medium is water or a mixture containing at least 50 wt%; ~~preferably at least 60 wt%~~ of water.
7. The metal nanoparticle sol according to at least one of Claims 1 to 6, wherein the liquid dispersion medium is water or a mixture containing at least 60% of water.
5. Metal nanoparticle sol according to at least one of Claims 1 to 4, characterized in that the dispersant is a polymeric dispersant, preferably one with a weight average M_w , from 100 g/mol to 1 000 000 g/mol, particularly preferably from 1000 g/mol to 100 000 g/mol.

8. The metal nanoparticle sol according to at least one of Claims 1 to 7, wherein the polymeric dispersant has a weight average M_w , from 100 g/mol to 1 000 000 g/mol.

9. The metal nanoparticle sol according to at least one of Claims 1 or 7, wherein the polymeric dispersant has a weight average M_w , from 1000 g/mol to 100 000 g/mol.

5 10. The metal nanoparticle sol according to at least one of Claims 1 to 59, characterized in that wherein the dispersant is at least one dispersant selected from the group consisting of alkoxyates, alkylolamides, esters, amine oxides, alkyl polyglucosides, alkylphenols, arylalkylphenols, water-soluble homopolymers, statistical copolymers, block copolymers, graft polymers, polyethylene oxides, polyvinyl alcohols, copolymers of polyvinyl alcohols
10 and polyvinyl acetates, polyvinylpyrrolidones, cellulose, starch,

gelatin, gelatin derivatives, amino acid polymers, polylysine, polyasparagic acid, polyacrylates, polyethylene sulphonates, polystyrene sulphonates, polymethacrylates, condensation products of aromatic sulphonic acids with formaldehyde, naphthalene sulphonates, lignosulphonates, copolymers of acrylic monomers, polyethyleneimines, polyvinylamines, polyallylamine, poly(2-vinylpyridines) and/or polydiallyldimethylammonium chloride.

~~711. The M~~metal nanoparticle sol according to at least one of Claims 1 to ~~610~~, ~~characterized in that wherein~~ the metal nanoparticle sol contains from 0.1 to 5 wt%, preferably from 0.4 to 2 wt% of at least one metal selected from the group: ruthenium, rhodium, palladium, osmium, iridium and platinum, expressed in terms of the silver content, in the form of the metal or at least one metal compound.

~~12. The metal nanoparticle sol according to at least one of Claims 1 to 11, wherein the metal nanoparticle sol contains from 0.4 to 2 wt% of at least one metal selected from the group: ruthenium, rhodium, palladium, osmium, iridium and platinum, expressed in terms of the silver content, in the form of the metal or at least one metal compound.~~

~~813. A M~~method for producing a metal nanoparticle sol according to at least one of Claims 1 to ~~712~~, ~~characterized in that wherein~~

a) a silver salt solution, a solution containing at least one metal salt of a metal selected from the group: ruthenium, rhodium, palladium, osmium, iridium and platinum, and a solution containing hydroxide ions are combined,

b) the solution obtained from step a) is subsequently reacted with a reducing agent,

at least one of the solutions in step a) containing at least one dispersant, characterized in that the three solutions are combined simultaneously in step a).

~~914. The M~~method according to Claim ~~813~~, ~~characterized in that wherein~~ the silver salt solution is one containing silver cations and anions selected from the group: nitrate, perchlorate, fulminates, citrate, acetate, acetylacetonate, tetrafluoroborate or tetraphenylborate.

~~1015. The M~~method according to Claim ~~138~~ or ~~149~~, ~~characterized in that wherein~~ the solution containing hydroxide ions can be obtained by the reaction of bases selected from the group consisting of LiOH, NaOH, KOH, Mg(OH)₂, Ca(OH)₂, NH₄OH, aliphatic amines, aromatic amines, alkali metal amides, and/or alkoxides.

~~1116. The M~~method according to at least one of Claims ~~138~~ to ~~1510~~, ~~characterized in that wherein~~ the reducing agent is selected from the group consisting of polyalcohols, aminophenols, amino alcohols, aldehydes, sugars, tartaric acid, citric acid, ascorbic acid and salts thereof, triethanolamine, hydroquinone, sodium dithionite, hydroxymethanesulphinic acid,

sodium disulphite, formamidinesulphinic acid, sulphurous acid, hydrazine, hydroxylamine, ethylenediamine, tetramethylethylenediamine, hydroxylamine sulphate, sodium borohydride, formaldehyde, alcohols, ethanol, n-propanol, isopropanol, n-butanol, isobutanol, sec-butanol, ethylene glycol, ethylene glycol diacetate, glycerol and/or dimethylaminoethanol.

5 | ~~1217. The Method~~ according to at least one of Claims ~~138~~ to ~~1611~~, characterized in that
 | wherein the metal salt of a metal selected from the group: ruthenium, rhodium, palladium,
 | osmium, iridium and platinum is at least one ruthenium salt selected from ruthenium chloride,
 | ruthenium acetate, ruthenium nitrate, ruthenium ethoxide, ruthenium acetylacetonate.

10 | ~~1318. Use of a metal nanoparticle sol according to at least one of Claims 1 to 7-12 for the~~
 | production of conductive printing inks.

| ~~1419. Use of a metal nanoparticle sol according to at least one of Claims 1 to 7-12 for the~~
 | production of conductive coatings or conductive structures.