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[Fortsetzung auf der nächsten Seite]

(54) **Title:** CERAMIC WALL CLADDING COMPOSITES THAT REFLECT IR RADIATION

(54) **Bezeichnung:** KERAMISCHE WANDVERKLEIDUNGSVERBÄNDE MIT IR-STRAHLUNG REFLEKTIERENDEN EIGENSCHAFTEN

(57) **Abstract:** The invention relates to a method for coating substrates, comprising the following steps: a) provision of a substrate; b) application of a composition to at least one side of the substrate, said composition having an inorganic compound that contains at least one metal and/or semi-metal selected from the group composed of Sc, Y, Ti, Zr, Nb, V, Cr, Mo, W, Mn, Fe, Co, B, Al, In, Tl, Si, Ge, Sn, Zn, Pb, Sb, Bi or mixtures thereof, at least one element selected from the group composed of Te, Se, S, O, Sb, As, P, N, C, Ga or mixtures thereof; c) drying of the composition that has been applied in step (b); d) application of at least one coating to the side or sides of the substrate that has or have been coated with the composition in step (b), the coating being a silane of general formula $(Z')Si(OR)_3$, in which Z' represents R, OR or Gly (Gly=3-glycidyloxypropyl) and R represents an alkyl group with between 1 and 18 carbon atoms and in which all the indices R can be identical or different, and containing oxide particles, selected from the oxides of Ti, Si, Zr, Al, Y, Sn, Zn and Ce or mixtures thereof and an initiator. The coating preferably contains 3-aminopropyltrimethoxysilane and/or 3-aminopropyltriethoxysilane and/or N-2-aminoethyl-3-aminopropyltrimethoxysilane; and e) drying of the coating applied in step (d), the composition from step (b) and/or the coating from step (d) containing at least one pigment that reflects IR radiation and said pigment having an electrically conductive core that is coated with a layer containing tin oxide and/or titanium oxide. The invention also relates to the coated substrate.

WO 2007/087910 A1

(57) **Zusammenfassung:** Die vorliegende Erfindung betrifft ein Verfahren zur Beschichtung von Substraten, umfassend die Schritte: a) Bereitstellung eines Substrates, b) Aufbringung einer Zusammensetzung auf mindestens einer Seite des Substrates, die Zusammensetzung enthält eine anorganische Verbindung, wobei die anorganische Verbindung mindestens ein Metall und/oder Halbmetall ausgewählt aus der Gruppe Sc, Y, Ti, Zr, Nb, V, Cr, Mo, W, Mn, Fe, Co, B, Al, In, Tl, Si, Ge, Sn, Zn, Pb, Sb, Bi oder Mischungen derselben und mindestens ein Element ausgewählt aus der Gruppe Te, Se, S, O, Sb, As, P, N, C, Ga oder Mischungen derselben enthält, c) Trocknen der in Schritt (b) aufgetragenen Zusammensetzung, d) Aufbringung mindestens einer Beschichtung auf der mindestens einen Seite des Substrates, auf der in Schritt (b) die Zusammensetzung aufgebracht wurde, wobei die Beschichtung ein Silan der allgemeinen Formel $(Z')Si(OR)_3$, wobei Z' R, OR oder Gly (Gly=3-Glycidyloxypropyl) ist und R ein Alkylrest mit 1 bis 18 Kohlenstoffatomen ist und alle R gleich oder unterschiedlich sein können, Oxidpartikel, ausgewählt aus den Oxiden von Ti, Si, Zr, Al, Y, Sn, Zn, Ce oder Mischungen derselben, und einen Initiator enthält, wobei in der Beschichtung vorzugsweise 3-Aminopropyltrimethoxysilan und/oder 3-Aminopropyltriethoxysilan und/oder N-2-Aminoethyl-3-aminopropyltrimethoxysilan enthalten ist, und e) Trocknen der in Schritt (d) aufgetragenen Beschichtung, wobei die Zusammensetzung des Schrittes (b) und/oder die Beschichtung des Schrittes (d) mindestens ein IR-Strahlung reflektierendes Pigment enthält und das IR-Strahlung reflektierende Pigment einen Kern aufweist, wobei auf dem Kern eine den elektrische Strom leitende Schicht enthaltend Zinnoxide und/oder Titanoxide aufgebracht ist, sowie das beschichtete Substrat.



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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

CERAMIC WALL CLADDING COMPOSITES THAT REFLECT IR RADIATION

The subject-matter of the present invention relates to a method for producing coated substrates with IR radiation reflecting properties, and to substrates which can be
5 obtained by the aforementioned method.

Since the origin of human settlement, attempts have been made either to keep heat inside houses or to prevent it from entering. In the past, for example, some stabilization of the internal temperature of a house has been achieved using two walls
10 separated by an air gap.

It is known that mirrors reflect both visible light and IR radiation. However, it is not practicable to line a room with mirrors.

15 Metal foils, which are fitted behind plaster in a room, constitute a means known for many years for reducing heat loss, particularly behind heaters. A disadvantage, however, is the poor adhesion of the metal foils to the plaster or a wall.

Coatings with IR radiation reflecting substances are likewise known. A disadvantage,
20 however, is that such coatings always lead to one-colored surfaces, which are often glossy. Decoration is not freely selectable.

The introduction of metal powder into building materials very often leads to corrosion problems. These are often manifested by loss of the building substance's mechanical
25 properties and/or discolorations.

It is a technical object of the present invention to overcome the disadvantages of the prior art, and in particular to provide a coated substrate having IR radiation reflecting properties and a method for its production, with which shielding against IR radiation is
30 reliably ensured, the substrate can be produced more cost-effectively and with which the lining of rooms is simplified. A further intention is to reduce the quantitative proportion of substance which effects the IR radiation shielding.

The technical object of the present invention is achieved by a method for coating substrates, comprising the steps of:

- a) preparing a substrate,
- b) applying a composition onto at least one side of the substrate, the composition containing an inorganic compound, the inorganic compound containing at least one metal and/or semimetal selected from the group Sc, Y, Ti, Zr, Nb, V, Cr, Mo, W, Mn, Fe, Co, B, Al, In, Tl, Si, Ge, Sn, Zn, Pb, Sb, Bi or mixtures thereof and at least one element selected from the group Te, Se, S, O, Sb, As, P, N, C, Ga or mixtures thereof,
- 5 c) drying the composition applied in step b),
- d) applying at least one coating onto the at least one side of the substrate onto which the composition was applied in step b), the coating containing a silane of the general formula $(Z^1)Si(OR)_3$, where Z^1 is R, OR or Gly (Gly=3-glycidyoxypropyl) and R is an alkyl radical having from 1 to 18 carbon atoms and all R may be identical or different, oxide particles selected from the oxides of Ti, Si, Zr, Al, Y, Sn, Zn, Ce or mixtures thereof, and an initiator, the coating preferably containing 3-aminopropyltrimethoxysilane and/or 3-aminopropyltriethoxysilane and/or N-2-aminoethyl-3-aminopropyltrimethoxysilane, and
- 15 e) drying the coating applied in step d),
- the composition of step b) and/or the coating of step d) containing at least one IR radiation reflecting pigment and the IR radiation reflecting pigment comprising a core, an electrical current conducting layer containing tin oxides and/or titanium oxides being applied on the core.

25

The method of the present invention is not limited to any specific substrates. The substrates may be either open-pored or closed-pored. The substrate in step a) may preferably be a flexible and/or rigid substrate. In a preferred embodiment, the substrate in step a) is a cloth, a fabric, a mesh, a foil, a textile and/or sheet metal. It is also preferable for the substrate to be a paper substrate.

30

Preferably, the substrate in step a) is essentially thermally stable at a temperature of more than 100°C. In a further preferred embodiment, the substrate in step a) is

essentially thermally stable under the drying conditions of step c) and/or e). In this context, the term "thermally stable" is intended to mean that the structure of the substrate is essentially unchanged by drying the applied coatings.

- 5 In a preferred embodiment, the inorganic compound of step b) is selected from TiO_2 , Al_2O_3 , SiO_2 , ZrO_2 , Y_2O_3 , BC, SiC, Fe_2O_3 , SiN, SiP, aluminosilicates, aluminum phosphates, zeolites, partially exchanged zeolites or mixtures thereof. Preferred zeolites are e.g. ZSM-5, Na-ZSM-5 or Fe-ZSM-5, or amorphous microporous mixed oxides which may contain up to 20 per cent of non-hydrolyzable organic compounds, e.g. vanadium oxide-silicon oxide glass or aluminum oxide-silicon oxide-methylsilicon sesquioxide glasses.

The inorganic compound of step b) preferably has a particle size of from 1 nm to 10,000 nm, more preferably from 5 nm to 5000 nm, preferably from 10 nm to 2000 nm, 15 in a further preferred embodiment from 10 nm to 1000 nm, preferably from 15 nm to 700 nm and most preferably from 20 nm to 500 nm. It may be preferable for the composite material according to the invention to comprise at least two particle size fractions of the at least one inorganic compound. It may likewise be preferable for the substrate according to the invention to comprise at least two particle size fractions of 20 at least two inorganic compounds. The particle size ratio may be from 1:1 to 1:10,000, preferably from 1:1 to 1:100. The quantity ratio of the particle size fractions in the composition of step b) may preferably be from 0.01:1 to 1:0.01. The composition of step b) is preferably a suspension, which is preferably an aqueous suspension. The suspension may preferably contain a liquid selected from water, alcohol, acid or a 25 mixture thereof.

The inorganic compound of step b) is preferably obtained by hydrolyzing a precursor of the inorganic compound containing the metal and/or semimetal. The hydrolysis may be carried out e.g. using water and/or alcohol. An initiator which is preferably an acid or base, and which is preferably an aqueous acid or base, may be present during the 30 hydrolysis.

The precursor of the inorganic compound is preferably selected from metal nitrate, metal halide, metal carbonate, metal alcoholate, metal halide, semimetal alcoholate or mixtures thereof. Preferred precursors are e.g. titanium alcoholates, e.g. titanium isopropylate, silicon alcoholates, e.g. tetraethoxysilane, zirconium alcoholates.

- 5 Preferred metal nitrates are e.g. zirconium nitrate. In a preferred embodiment, the composition contains at least half the molar ratio of water, water vapor or ice in relation to the hydrolyzable precursor, expressed in terms of the hydrolyzable group of the precursor.

- 10 In a preferred embodiment, the composition of step b) is a sol. In a preferred embodiment it is possible to use commercially available sols, e.g. titanium nitrate sol zirconium nitrate sol or silica sol.

- In a further preferred embodiment, the electrical current conducting layer of the IR radiation reflecting pigment contains tin oxide and/or titanium oxide doped with at least one halogen, the halogen preferably being selected from fluorine, chlorine, bromine, iodine or mixtures thereof.
- 15

- Preferably, the core of the IR radiation reflecting pigment is encapsulated essentially fully or preferably fully by the electrically conductive layer.
- 20

- In a preferred embodiment, the at least one IR radiation reflecting pigment is contained in the composition of step b). Further preferably, the at least one IR radiation reflecting pigment is contained in the coating of step d). Preferably, the at least one IR radiation reflecting pigment is contained in the composition of step b) and in the coating of step d).
- 25

- The core of the IR radiation reflecting pigment may contain metal oxides and/or silicon oxides. The core may or may not be in the form of platelets. Cores in the form of platelets, which are preferred, preferably have an extent of less than 500 μm in the principal dimension and in particular less than 250 μm , and the thickness is preferably less than 10 μm , in particular not more than 5 μm and more particularly from 0.1 μm to 3 μm . The ratio (aspect ratio) of the extent in the principal dimension to the thickness
- 30

is preferably more than 3 and more preferably more than 5 for substrates in platelet form.

The core may contain e.g. SiO_2 and/or metal oxides e.g. Fe_2O_3 , TiO_2 , MTiO_3 , where
 5 M = Mg, Ca, Ba, Sr, and/or Al_2O_3 , and/or BaSO_4 and/or CaSO_4 . The core is preferably based on substrates which are in platelet form and/or transparent or semitransparent, e.g. mica, talc, kaolin, glass or other silicate materials. Metal platelets, e.g. aluminum platelets or metal oxides in platelet form, e.g. iron oxide or bismuth oxychloride in platelet form, may furthermore constitute the core.

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At least one insulating layer is preferably arranged between the core of the IR radiation reflecting pigment and the electrical current conducting layer. The insulating layer may preferably contain a hydrated silicon dioxide layer or another insoluble silicate. This insulating layer is preferably applied according to the method specified in
 15 EP 0,375,575. The core may nevertheless preferably be coated first with one or more layers of e.g. chromium oxide, iron oxide, zirconium oxide, aluminum oxide, tin oxide and/or further colorless or colored metal oxides.

The insulating layer preferably contains about 3-6 wt.% SiO_2 , and more preferably
 20 about 5 wt.% SiO_2 , expressed in terms of the total mass of the IR radiation reflecting pigment.

In a preferred embodiment, the material of which the insulating layer is made has a conductivity of less than 10^{-6} S/cm, more preferably less than 5×10^{-7} S/cm and most
 25 preferably less than 10^{-7} S/cm. The conductivity may be determined according to the teaching of DE 42 13 747 A1, the resistivity being converted into the conductivity.

The electrical current conducting layer may contain either tin oxide or titanium oxide doped with halogen or a mixture of the aforementioned oxides. It is possible to use
 30 arbitrarily composed mixed oxides of $\text{SnO}_{2-x} \text{X}_x$ and/or $\text{TiO}_{2-x} \text{X}_x$, X being selected from fluorine, chlorine, bromine, iodine or mixtures thereof and x being less than 2 and more than 0.

The electrical current conducting layer may preferably also contain further metal oxides e.g. chromium oxide, iron oxide, zirconium oxide, aluminum oxide, tin oxide, e.g. in order to increase the mechanical stability.

- 5 The electrical current conducting layer preferably has a resistivity of from 5 to $2 \times 10^5 \Omega \text{ cm}$. The resistivity may be determined according to the teaching of DE 42 13 747 A1.

- 10 The IR radiation reflecting pigment preferably has a reflectivity of more than 75% on average, more preferably more than 80% on average, in particular more than 85% on average and preferably more than 90% on average in the wavelength range of from 4000 nm to 20 000 nm. The expression on average means that there is a reflection in said range as a mean value over the specified wavelength range.

- 15 The IR radiation reflecting pigment preferably has a mass-average particle size of less than $500 \mu\text{m}$, more preferably from $100 \mu\text{m}$ to $500 \mu\text{m}$ and most preferably from $200 \mu\text{m}$ to $500 \mu\text{m}$.

- 20 The IR radiation reflecting pigment may be prepared according to the teaching of DE 42 13 747 A1.

The composition of step b) preferably contains an initiator. The initiator may preferably be an acid or base, which is preferably an aqueous acid or base.

- 25 The composition of step b) is preferably produced by firstly preparing a dispersion/suspension of the inorganic compound. The IR radiation reflecting pigment is then subsequently dispersed in it.

- 30 The drying of the composition in step c) is preferably carried out by heating to a temperature of between 50°C and 1000°C . In a preferred embodiment, it is dried for from 1 minute to 2 hours at a temperature of from 50°C to 100°C .

In another preferred embodiment, the drying is carried out for from 1 second to 10 minutes at a temperature of from 100°C to 800°C in step d).

The drying of step c) may be carried out by means of warmed air, hot air, infrared radiation, microwave radiation or electrically generated heat.

In a preferred embodiment, R in the general formula $(Z^1)Si(OR)_3$ is an alkyl radical having 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and/or 18 carbon atoms.

- 10 In a preferred embodiment, the coating of step d) contains a second silane of the general formula $(Z^2)_zSi(OR)_{4-z}$, where R is an alkyl radical having from 1 to 6 carbon atoms and Z^2 is $H_aF_bC_n$, a and b being whole numbers, all R may be identical or different, $a+b=1+2n$, $z = 1$ or 2 and n is from 1 to 16, or for the case that Z^1 Gly, Z^2 is Am (Am=3-aminopropyl) with $z = 1$. Preferably, n is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16. In a preferred embodiment, R in the general formula $(Z^2)Si(OR)_3$ is an alkyl radical having 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 and/or 16 carbon atoms.

- In a further preferred embodiment, the coating of step d) contains 3-glycidyloxypropyltriethoxysilane and/or 3-glycidyloxypropyltrimethoxysilane as the silane and/or 3-aminopropyltrimethoxysilane and/or 3-aminopropyltriethoxysilane and/or N-2-aminoethyl-3-aminopropyltrimethoxysilane (DAMO) as the second silane. The coating of step d) preferably contains tetraethoxysilane as the silane and a silane of the formula $(H_aF_bC_n)_zSi(OR)_{4-z}$ as the second silane, where a and b are whole numbers, $a+b = 1+2n$, z is 1 or 2, n is from 1 to 16 and all R may be identical or different, all R preferably being identical and containing from 1 to 6 carbon atoms.

- The coating of step d) more preferably contains tetraethoxysilane, methyltriethoxysilane, octyltriethoxysilane and/or hexadecyltrimethoxysilane as the silane and/or 3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyltriethoxysilane as the second silane.

In a preferred embodiment, the coating of step d) contains an acid or base as initiator, which is preferably an aqueous acid or base.

5 The surface of the oxide particles contained in the coating of step d) is preferably hydrophobic. There are preferably organic radicals $X_{1+2n}C_n$ bound to silicon atoms on the surface of the oxide particles of the coating of step d), when n is from 1 to 20 and X is hydrogen and/or fluorine. The organic radicals may be identical or different. Preferably, n is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 and/or 20. The groups bound to silicon atoms are preferably methyl, ethyl, propyl, butyl and/or
10 pentyl groups. In a particularly preferred embodiment, trimethylsilyl groups are bound to the surface of the oxide particles. The organic residues may preferably be cleaved, and more preferably hydrolyzed.

The oxide particles of the coating of step d) may be selected from the oxides of Ti, Si, Zr, Al, Y, Sn, Zn, Ce or contain mixtures thereof. Preferably, the oxide particles of the
15 coating of step d) are partially hydrolyzed on the surface of the oxide particles under the reaction conditions of step d). Reactive centers are preferably formed thereby, which react with the organic silicon compounds of the coating of step d). These organic silicon compounds may be bound covalently to the oxide particles by e.g. -O-
20 bonds during the drying of step e). The oxide particles are thereby crosslinked with the cured coating. Therefore, the layer thickness of the cured coating can surprisingly be increased further.

The oxide particles may have an average particle size of from 10 to 1000 nm, preferably from 20 to 500 nm, more preferably from 30 to 250 nm. If the coating is to
25 be transparent and/or colorless, then it is preferable to use only oxide particles which have an average particle size of from 10 to 250 nm. The average particle size refers to the particle size of the primary particles or, if the oxides are present as aggregates, to the size of the aggregates. The particle size is determined by light scattering methods,
30 for example using a device of the type HORIBA LB 550® (from Retsch Technology).

The coating of step d) preferably contains a polymer. In the coating of step d), the polymer preferably has a mean mass-average molecular weight of at least 3000

g/mol. The mean mass-average molecular weight is preferably at least 5000 g/mol, more preferably at least 6000 g/mol and most preferably at least 10,000 g/mol.

5 The polymer of the coating of step d) preferably has an average degree of polymerization of at least 50. In a further preferred embodiment, the average degree of polymerization is at least 80, more preferably at least 95 and most preferably at least 150. The polymer of the coating of step d) is preferably selected from polyamide, polyester, epoxy resins, melamine-formaldehyde condensate, urethane-polyol resin or mixtures thereof.

10

Enough coating is preferably applied onto the substrate in step d) for there to be a layer of the dried coating with a layer thickness of from 0.05 to 10 μm after drying in step e). There is preferably a coating of step d) with a layer thickness of from 0.1 μm to 9 μm , more preferably from 0.2 μm to 8 μm and most preferably from 0.3 μm to 7 μm on the dried substrate.

15

The drying of the coating in step e) may be carried out by any method which is known to the person skilled in the art. In particular, the drying may be carried out in an oven. The drying is more preferably carried out with a hot air oven, circulating air oven, 20 microwave oven or by infrared irradiation. In particular, the drying may preferably be carried out with the method and the drying times of step c). In a preferred embodiment, the coating of step e) is dried by heating to a temperature of between 50°C and 1000°C.

25 In a further preferred embodiment, at least one further coating may be applied before the application of the coating in step b) and/or d). This further coating may e.g. be an impression. Such an impression may be applied by any printing method which is familiar to the person skilled in the art, in particular the offset printing method, flexo printing method, tampon printing or inkjet printing method.

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In a further embodiment, at least one further coating may be applied after the application of the coating in step d). This further coating is not limited and may be any coating which is known to the person skilled in the art. In particular, this coating may

also be an impression. In this case as well, the impression may be applied by any method which is familiar to the person skilled in the art, in particular the offset printing method, flexo printing method, tampon printing or inkjet printing method.

- 5 Coated substrates of the present invention surprisingly exhibit a very high flexibility. If the substrate is flexible, then the substrate can be bent without destroying or tearing the applied coatings. In particular, coatings may thereby be applied onto flexible nonwovens which fit to the surface contour of a background, without detrimentally affecting the coating. As mentioned above, a very wide variety of protective layers can
- 10 be applied as a coating, in particular layers protecting against aggressive chemicals or dirt-repellent coatings. A decoration may, as a further advantage, be freely selected.

- It is surprising that the coated substrates of the present invention exhibit sufficient reflection shielding against IR radiation. The coated substrates can be used as a
- 15 substitute for the means known in the prior art for reflection/shielding rooms against IR radiation. The coated substrates of the present invention can furthermore be produced more efficiently than those of the prior art.

The coated substrate is preferably wallpaper for lining rooms.

Patent Claims

1. A method for coating substrates, comprising the steps of:

a) preparing a substrate,

b) applying a composition onto at least one side of the substrate, the composition containing an inorganic compound, the inorganic compound containing at least one metal and/or semimetal selected from the group Sc, Y, Ti, Zr, Nb, V, Cr, Mo, W, Mn, Fe, Co, B, Al, In, Tl, Si, Ge, Sn, Zn, Pb, Sb, Bi or mixtures thereof and at least one element selected from the group Te, Se, S, O, Sb, As, P, N, C, Ga or mixtures thereof,

c) drying the composition applied in step b),

d) applying at least one coating onto the at least one side of the substrate onto which the composition was applied in step b), the coating containing a silane of the general formula $(Z^1)\text{Si}(\text{OR})_3$, where Z^1 is R, OR or Gly (Gly=3-glycidyloxypropyl) and R is an alkyl radical having from 1 to 18 carbon atoms and all R may be identical or different, oxide particles selected from the oxides of Ti, Si, Zr, Al, Y, Sn, Zn, Ce or mixtures thereof, and an initiator, the coating preferably containing 3-aminopropyltrimethoxysilane and/or 3-aminopropyltriethoxysilane and/or N-2-aminoethyl-3-aminopropyltrimethoxysilane, and

e) drying the coating applied in step d),

the composition of step b) and/or the coating of step d) containing at least one IR radiation reflecting pigment and the IR radiation reflecting pigment comprising a core, an electrical current conducting layer containing tin oxides and/or titanium oxides being applied on the core.

2. A method according to claim 1,

characterized in that

the substrate in step a) is a flexible and/or rigid substrate.

3. A method according to at least one of claims 1 and 2,

characterized in that

the substrate in step a) is a cloth, a fabric, a mesh, a foil and/or a textile.

4. A method according to at least one of claims 1 to 3,
characterized in that
the substrate in step a) is essentially thermally stable at a temperature of more
than 100°C.

5

5. A method according to at least one of claims 1 to 4,
characterized in that
the substrate in step a) is essentially thermally stable under the drying conditions
of step c) and/or e).

10

6. A method according to at least one of claims 1 to 5,
characterized in that
the inorganic compound of step b) is selected from TiO_2 , Al_2O_3 , SiO_2 , ZrO_2 , Y_2O_3 ,
BC, SiC, Fe_2O_3 , SiN, SiP, aluminosilicates, aluminum phosphates, zeolites,
partially exchanged zeolites or mixtures thereof.

15

7. A method according to at least one of claims 1 to 6,
characterized in that
the inorganic compound of step b) has a particle size of from 1 nm to 10,000 nm.

20

8. A method according to at least one of claims 1 to 7,
characterized in that
the composition of step b) is a suspension, which is preferably an aqueous
suspension.

25

9. A method according to at least one of claims 1 to 8,
characterized in that
the inorganic compound of step b) is obtained by hydrolyzing a precursor of the
inorganic compound containing the metal and/or semimetal.

30

10. A method according to claim 9,
characterized in that

the precursor of the inorganic compound is selected from metal nitrate, metal halide, metal carbonate, metal alcoholate, semimetal halide, semimetal alcoholate or mixtures thereof.

- 5 11. A method according to at least one of claims 1 to 10,
characterized in that
the electrical current conducting layer of the IR radiation reflecting pigment
contains tin oxide and/or titanium oxide doped with at least one halogen, the
halogen preferably being selected from fluorine, chlorine, bromine, iodine or
10 mixtures thereof.
12. A method according to at least one of claims 1 to 11,
characterized in that
at least one insulating layer is arranged between the core of the IR radiation
15 reflecting pigment and the electrical current conducting layer.
13. A method according to at least one of claims 1 to 12,
characterized in that
the IR radiation reflecting pigment has a mass-average particle size of less than
20 500 μm , more preferably from 100 μm to 500 μm and most preferably from 200
 μm to 500 μm .
14. A method according to at least one of claims 12 and 13,
characterized in that
25 the material of which the insulating layer is made has a conductivity of less than
 10^{-6} S/cm.
15. A method according to at least one of claims 1 to 14,
characterized in that
30 the composition of step b) contains an initiator.
16. A method according to claim 15,
characterized in that

the initiator is an acid or base, which is preferably an aqueous acid or base.

17. A method according to at least one of claims 1 to 16,
characterized in that

5 the composition of step b) is a sol.

18. A method according to at least one of claims 1 to 17,
characterized in that

10 the drying of the composition in step c) is carried out by heating to a temperature of between 50°C and 1000°C.

19. A method according to at least one of claims 1 to 18,
characterized in that

15 the coating of step d) contains a second silane of the general formula $(Z^2)_z\text{Si}(\text{OR})_{4-z}$, where R is an alkyl radical having from 1 to 8 carbon atoms and Z^2 is $\text{H}_a\text{F}_b\text{C}_n$, a and b being whole numbers, all R may be identical or different, $a+b=1+2n$, $z = 1$ or 2 and n is from 1 to 16, or for the case that Z^1 is Gly, Z^2 is Am (Am=3-aminopropyl) with $z = 1$.

20. A method according to at least one of claims 1 to 19,
characterized in that

25 the coating of step d) contains 3-glycidyloxypropyltriethoxysilane and/or 3-glycidyloxypropyltrimethoxysilane as the silane and/or 3-aminopropyltrimethoxysilane and/or 3-aminopropyltriethoxysilane and/or N-2-aminoethyl-3-aminopropyltrimethoxysilane as the second silane.

21. A method according to at least one of claims 1 to 20,
characterized in that

30 the coating of step d) contains tetraethoxysilane as the silane and a silane of the formula $(\text{H}_a\text{F}_b\text{C}_n)_z\text{Si}(\text{OR})_{4-z}$ as the second silane, where a and b are whole numbers, $a+b = 1+2n$, z is 1 or 2, n is from 1 to 16 and all R may be identical or different, all R preferably being identical and containing from 1 to 6 carbon atoms.

22. A method according to at least one of claims 1 to 21,
characterized in that
the coating of step d) contains tetraethoxysilane, methyltriethoxysilane,
5 octyltriethoxysilane and/or hexadecyltrimethoxysilane as the silane and/or
3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyltriethoxysilane as the second silane.

23. A method according to at least one of claims 1 to 22,
characterized in that
10 the coating of step d) contains an acid or base as initiator, which is preferably an
aqueous acid or base.

24. A method according to at least one of claims 1 to 23,
characterized in that
15 the surface of the oxide particles contained in the coating of step d) is
hydrophobic.

25. A method according to at least one of claims 1 to 24,
characterized in that
20 there are organic radicals $X_{1+2n}C_n$ bound to silicon atoms on the surface of the
oxide particles of the coating of step d), when n is from 1 to 20 and X is hydrogen
and/or fluorine.

26. A method according to at least one of claims 1 to 25,
characterized in that
25 the coating of step d) contains a polymer which preferably has a mean mass-
average molecular weight of at least 3000 g/mol.

27. A method according to at least one of claims 1 to 26,
characterized in that
30 the polymer of the coating of step d) has an average degree of polymerization of
at least 50.

28. A method according to at least one of claims 1 to 27,
characterized in that
the polymer of the coating of step d) is selected from polyamide, polyester,
epoxy resins, melamine-formaldehyde condensate, urethane-polyol resin or
mixtures thereof.
29. A method according to at least one of claims 1 to 28,
characterized in that
enough coating is applied onto the substrate in step d) for there to be a layer of
the dried coating with a layer thickness of from 0.05 to 10 μm after drying in step
e).
30. A method according to at least one of claims 1 to 29,
characterized in that
at least one further coating is applied before the application of the coating in step
b) and/or d).
31. A method according to at least one of claims 1 to 30,
characterized in that
at least one further coating is applied after the application of the coating in step
d).
32. A method according to at least one of claims 1 to 31,
characterized in that
the drying of the coating in step e) is carried out by heating to a temperature of
between 50°C and 1000°C
33. A coated substrate which can be obtained according to at least one of claims 1
to 32.
34. A substrate according to claim 33,
characterized in that
it is wallpaper.

35. Use of the coated substrate according to claim 33 as wallpaper.