

Description

This invention relates to a composition for forming a film of precious metal on firing the composition, and to a method of forming a film of precious metal on a substrate using the composition.

- 5 Compositions which form a film of precious metal (by which is meant in this specification one or more of platinum, palladium, gold and silver) on firing are useful particularly for decorating ceramic or glass substrates.

Commercially available liquids for this purpose are based on organic solvents and are complex mixtures containing (a) a precious metal compound which decomposes on firing to form the precious metal, (b) metal compounds, such as those of rhodium, bismuth or chromium, to improve the colour, adhesion or brightness of the fired film and (c) resin and organic solvent to dissolve or carry (a) and (b).

10 It would be desirable to reduce or eliminate such organic solvent so as to reduce or eliminate any environmental hazards it presents, for instance in the preparation, transportation or use of compositions containing it, for example from the fumes released on applying the compositions or firing them. Such a task is not straightforward, however, because the compositions still of course need to be stable, apply readily and produce good films on firing. A composition which is based on water rather than on organic solvent would have the added advantage that materials, such as brushes or screen printing screens or stencils, with which the composition came into contact could be cleaned with water-based cleaning agents. In spite of these advantages, there is no water-based bright gold composition commercially available as far as we know. A water-based composition has now been invented.

UK patent specification 2097811A discloses a paint medium for applying overglaze decoration to pottery, characterised in that it comprises:

15 15-40% by weight of polyvinyl pyrrolidone or a mixture of polyvinyl pyrrolidone and aqueous polyethylene oxide, 45-85% by weight of ethylene glycol and/or propylene glycol, and optionally water.

- 25 The specification mentions colouring matter which may be oxides and gold and organic gold compounds.

UK specification 2216536A discloses a burnish gold composition containing 10-40% by weight of gold in the form of gold powder and/or a sparingly soluble gold compound, 2-20% by weight of polyvinyl pyrrolidone, 3-30% by weight of an aqueous acrylate resin dispersion with 30-60% by weight of solids content, and 5-50% by weight of water.

30 The present invention provides a homogeneous composition for forming on firing a film of precious metal, which is one or more of platinum, palladium, gold and silver, on a substrate, which composition comprises polymeric resin and a solution, in water and a co-solvent, of thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a homogeneous composition of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a homogeneous composition of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.

The invention provides also a method of forming a film of precious metal on a substrate, which method comprises applying the composition to a substrate and drying and firing the applied composition.

- 40 The invention also provides a transfer bearing the composition which has been dried thereon.

Some of the present thiolates are novel compounds, and the invention provides novel compounds as such, in particular a thiolate which is a gold compound of formula AuSR'' or a salt thereof, in which R'' is such that HSR'' represents:

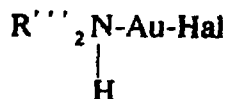
4,6-dihydroxy-2-mercaptopyrimidine; or

- 45 N-(mercaptoalkanoyl)glycine whose alkan group contains 1 or 2 carbon atoms.

The invention provides also a process for preparing a novel thiolate, which process comprises reacting in a solvent a compound of formula $\text{AuCl}(\text{SR}'_2)$ with a thiol of formula HSR'' to form the gold compound, and in solution, the sulphide of formula SR'_2 .

50 The invention provides also a process for preparing a novel thiolate, which process comprises reacting a tetrahaloaurate with a thiol of formula HSR'' to form the gold compound.

The invention also provides a process for preparing a novel thiolate, which process comprises reacting a thiol of formula HSR'' with a gold(I) amine complex of formula



wherein Hal represents a halogen atom and each R''' is the same or different and represents an aliphatic, aromatic or heterocyclic group or the two R''' symbols together with the N atom represent a cyclic amine to form the gold compound.

Though the present composition still contains co-solvent, the composition is water-based. It can be diluted with water (ie, it is water-thinable) and need not contain as much organic solvent as conventional liquid precious metal formulations. It can be applied readily, and produces good films on firing.

It is surprising that a water-soluble (not colloidal) precious metal compound can be employed. The invention is based on the discovery that this can be done if the compound is a dissolved thiolate and, as the composition is progressively heated on firing, the precious metal compound remains in homogeneous composition, preferably in solution, until the precious metal compound decomposes to the precious metal while its carrier matrix volatilises.

For clarity, the invention is described in terms of heating to leave a homogeneous composition, preferably a solution, of the precious metal thiolate in the co-solvent and then a homogeneous composition, preferably a solution, of the thiolate in the resin. It will be recognised, however, that the thiolate may change in structure during the heating; what is important, however, is that whatever the form of the subsequent precious metal compound, it remains in homogeneous composition, preferably in solution. Similarly, the resin may decompose during its volatilisation.

As the present composition is heated, a homogeneous composition is maintained, so that the thiolate does not precipitate until it decomposes to the precious metal while the resin volatilises. The thiolate is in solution in the initial composition, and it is preferred that it remain in solution during the heating until it decomposes to the precious metal while the resin volatilises. Accordingly, it is preferred that the composition comprises a solution, in water and a co-solvent, of polymeric resin and thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a solution of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a solution of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.

The present composition usually contains 5-85% of water. Percentages herein are by weight. The composition can be diluted with water for application. The composition contains preferably 15-70%, especially 40-55%, of water. It is especially advantageous that the composition contain a greater weight of water than the total of all organic solvent.

The precious metal usually comprises gold or platinum, especially gold. Specific instances are:

- (a) gold;
- (b) platinum;
- (c) gold and platinum;
- (d) gold and palladium;
- (e) gold and platinum and palladium; and
- (f) any one of (a)-(e) and silver.

Preferably, the precious metal is (a), (b), (d) or any one of these and silver.

A thiol is an organic compound which is an analogue of an alcohol, the oxygen atom of the hydroxyl group of the alcohol having been replaced formally by a sulphur atom. A metal thiolate is a derivative of a thiol in which the hydrogen atom of its SH group is replaced formally by a metal atom. The present precious metal thiolate must form a solution in the water/co-solvent mixture, and also be such as to fulfil the other functions demanded. Usually the thiolate employed has a solubility in water at 20 °C of at least 100, preferably 200-300, grams per litre. Preferably, the thiolate, usually in the form of a salt, is soluble in the water alone. Advantageously, the precious metal, especially gold, thiolate starts to decompose to precious metal above 200 °C; such thiolates tend to give bright rather than dull films after firing. Suitable thiolates are known compounds.

The thiolate can be an aliphatic, aromatic or heterocyclic thiolate, preferably containing at least one group selected from nitro groups and groups of formula -COOH, -SO₂OH, -OH, -CO.NH₂, -NH₂ or -O-P(O)(OH)₂, any of whose H atoms optionally being substituted, or a salt thereof. Such thiolates are discussed below with reference to the precious metal being gold. Thus, a preferred group of thiolates are gold compounds of formula:

Au-S-R-H or Au-S-R-X

or a salt of either, in which:

X represents a nitro group or a group of formula -COOH, -SO₂OH, -OH, -CO.NH₂, -NH₂ or -O-P(O)(OH)-

2, any of whose hydrogen atoms optionally being substituted; and

R represents a divalent organic group.

Although the gold compounds are described, in the conventional way, as being of a mononuclear formula such as Au-S-R-X, it will be understood that in fact they may be of polynuclear formula to satisfy the 2-co-ordinate nature of gold(I) complexes.

Any substituent in X is usually an aliphatic, aromatic or heterocyclic group or an optionally substituted amino group, for instance an amino group mono- or di-substituted by alkyl of 1-6 carbon atoms. The aliphatic group is usually alkyl of 1-6 carbon atoms, for instance ethyl, isopropyl or n-butyl. The aromatic group is usually optionally substituted phenyl, any substituent usually being X as here defined, alkyl of 1-6 carbon atoms or mercapto whose hydrogen atom is optionally substituted by a gold atom. The heterocyclic group is usually optionally substituted purine, pyridine or pyrimidine, any substituent usually being X as here defined, alkyl of 1-6 carbon atoms, or an aromatic group as described above. The -CO.NH₂ or -NH₂ group may be mono- or di-substituted, for instance by alkyl of 1-6 carbon atoms optionally substituted by X as here defined.

When R represents a divalent aliphatic group (ie the group attached to S is aliphatic rather than aromatic or heterocyclic), it is usually a divalent hydrocarbon of 1-7 carbon atoms (eg alkane of 1-6 carbon atoms or toluene) optionally substituted by X as defined above, usually by one X, or by an oxo group on a non-terminal carbon atom. When R represents a divalent aromatic group (ie the group attached to S is aromatic rather than aliphatic or heterocyclic), it is usually divalent benzene optionally substituted by X as defined above, usually by one X. When R represents a divalent heterocyclic group (ie the group attached to S is heterocyclic rather than aliphatic or aromatic), it is usually divalent pyrimidine, purine or pyridine optionally substituted by X as defined above (usually by one X) and/or by phenyl (usually by no more than one phenyl) and/or by alkyl of 1-6 carbon atoms (usually by no more than one such alkyl group).

X preferably represents -COOH.

In a particular embodiment, -R-X represents -CH₂CH₂X, -CH(CH₃)CO.NH.CH₂X, -CH₂CH₂CO.NH.CH₂X, -CH₂C₆H₄-p-X, -CH₂COCH₂CH₂X, -CH(X)CH₂X, -CH₂CH(NH₂)X, -CH₂CO.NH.CHX.CH₂.C₃H₃N₂, -CN₂-CO.NH.CH₂CH₂CO.NH.CHX.CH₂.C₃H₃N₂, -CH₂CONH.CH₂CH₂CO.NH.CH₂CO.NH.CH₂X, -CH₂CH(CO.NH.CH₂X)NH.CO.CH₂CH₂CH(NH₂)X or -CS.N(CH₃)CH₂CH₂X, in which X represents -COOH, C₆H₄ represents divalent benzene and C₃H₃N₂ represents imidazol-4-yl.

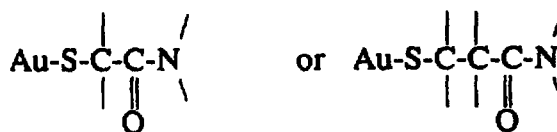
In another particular embodiment, -R-X represents -CH₂CH₂X or -CH₂-C₆H₄-p-X, in which X represents a nitro group or a group of formula -SO₂OH, -OH or -NH₂ and C₆H₄ represents divalent benzene.

In a further particular embodiment, -R-X represents -C₆H₄-p-X, in which X represents a nitro group or a group of formula -SO₂OH, OH or NH₂ and C₆H₄ represents divalent benzene.

In a yet further particular embodiment of the gold compounds of formula Au-S-R-H or Au-S-R-X, H-S-R-H or H-S-R-X represents:

4,5-diamino-6-mercapto-2-phenylpyrimidine,
2-amino-6-mercapto-8-methylpurine,
2-mercapto-4-amino-pyridopyrimidine,
2-mercaptopyridine,
2-mercaptobenzoxazole,
2-mercaptobenzimidazole,
5-mercapto-1-methyltetrazole,
4-mercaptopyridine,
2-mercapto-5-nitrobenzimidazole, or
4-amino-6-hydroxy-2-mercaptopyrimidine.

The sulphur atom which links to the gold atom in a preferred class of gold compounds is linked to the same carbon atom, or is separated by one carbon atom from the carbon atom, which bears a substituted amido group, so that these compounds contain the group

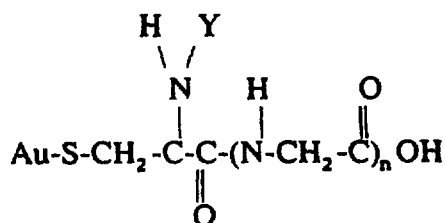


Specific examples of this class are gold compounds of formula Au-S-R-H or Au-S-R-X which are such that H-S-R-H or H-S-R-X represents:

N-(2-mercaptopropionyl)glycine,

N-(3-mercaptopropionyl)glycine,
 N-(2-mercaptoacetyl)glycine,
 2-mercaptoacetyl-L-histidine or
 2-mercaptopropionyl-L-histidine.

Another preferred class of gold compounds is of formula:

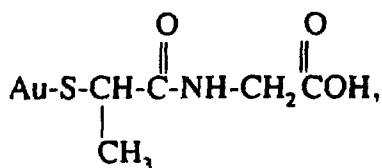


in which n represents 0 or an integer of at least 1 and Y represents a hydrogen atom or an alkanoyl group of 2-6 carbon atoms which may optionally bear a single amino(carboxy)methyl group. The amino(carboxy)-methyl group, when present, is usually on the terminal carbon atom of the alkanoyl group. Usually n represents 0 or an integer of 1-4.

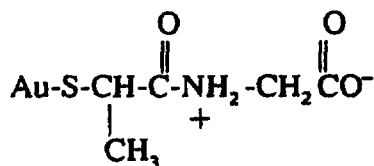
Specific examples of this class are gold compounds of formula Au-S-R-H or Au-S-R-X which are such that H-S-R-H or H-S-R-X represents:

acetylcysteine,
 glutathione or
 L-cysteine.

A specific preferred gold thiolate is N-(2-mercaptopropionyl)glycine gold (I), of formula:



which may alternatively be written in the Zwitterion form:



though the thiolate is believed to be polynuclear in accordance with the discussion above.

With regard to this gold thiolate, we refer to UK patent specification 2047672A. The reference is not concerned with film formation, but with preparing a $^{195\text{m}}\text{Au}$ -containing liquid by adsorbing $^{195\text{m}}\text{Hg}$ onto a certain adsorption agent and then eluting the daughter radioisotope $^{195\text{m}}\text{Au}$. Table 1 on page 5 lists combinations of adsorption agents and eluants, and among these eluants is an aqueous solution of mercaptopropionyl glycine. There is no specific disclosure of the use of this eluent, and no specific data on the present gold thiolate. Example 11 describes a series of experiments in which certain liquids containing ^{198}Au are passed through certain adsorption agents. The Example explains that the isotope ^{198}Au was employed instead of the daughter radioisotope $^{195\text{m}}\text{Au}$ because *inter alia* of the short half-life of $^{195\text{m}}\text{Au}$. The Example states that the liquids were prepared by dissolving 1-3 μg of gold containing ^{198}Au in 1ml of an aqueous solution having a pH of about 5-6 and containing 0.001-0.1 molar of one of a Table of what it calls gold ion complexing agents. One of the agents is mercaptopropionyl glycine, and the Table records that employing it with the adsorption agent SiO_2/Ag left 88% of the ^{198}Au not adsorbed. We believe that

employing mercaptopropionyl glycine as the agent would not give the present gold thiolate, but gold having moieties strongly adsorbed on the surface of the metal, and hence not having one gold atom per N-(2mercapto-propionyl)glycine ligand as the present gold thiolate does. In any event, the gold materials suggested or disclosed in this reference are radioactive. They would decay to become progressively less radioactive, but some radioactivity would remain. The gold in the present gold thiolates is preferably naturally occurring gold, which is non-radioactive. Thus, it is preferred that the gold in the present N-(2-mercapto-propionyl)glycine gold(I) or salt thereof be non-radioactive (and hence is not a mixture of the non-radioactive form with the radioactive form). It is preferred that all the present thiolates, not only N-(2-mercapto-propionyl)glycine gold(I) or a salt thereof, be non-radioactive.

The optionally substituted sulpho group (-SO₂OH) which X can represent in the present gold thiolates introduces more sulphur, which generally forms sulphur oxides on firing the composition to form a film, and hence it is less preferred that X has this value. Nitro and optionally substituted hydroxyl groups tend to make the thiolate less water-soluble and less stable to reduction than is ideal, and hence it is less preferred that X has either of these values. Generally, it is most preferred that X represents optionally substituted carboxy.

The thiolate can be in the form of a salt. Salts can be formed with bases by reason for instance of the carboxy or sulpho group which X can represent. A thiolate which forms a salt with a base can be employed in basic solution which forms the salt therein. Any salt is preferably with ammonia or an organic base particularly an optionally substituted amine, any substituent being for instance alkyl of 1-6 carbon atoms optionally substituted by X as defined above. Particular optionally substituted amines of interest are triethylamine, ethanolamine, diethanolamine, triethanolamine, pyridine, morpholine or diisopropylamine, especially the first four of these.

Where the present thiolates are novel, they can be made in ways known in themselves. Where the thiolate is a salt, it can be made for instance by reaction with a base.

When the present thiolate is a gold compound of formula AuSR'' or a salt thereof in which R'' is such that HSR'' represents N-(mercaptoalkanoyl)glycine whose alkan group contains 1 or 2 carbon atoms, it can be seen that the N-(mercaptoalkanoyl)glycine is:

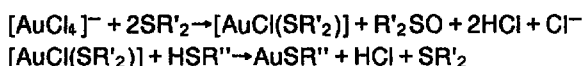
N-(2-mercaptoacetyl)glycine,

N-(3-mercapto-propionyl)glycine, or

N-(2-mercapto-propionyl)glycine.

The last mentioned is particularly outstanding.

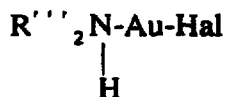
The present thiolates can be prepared by the general procedure of A K Al-Sa'ady et al, Inorganic Synthesis, volume 23, 191(1985), represented in the case of gold by the general equations:



Au(III) in the form of tetrachloroaurate anion is reduced to Au(I) by a water-soluble sulphide of formula SR'₂. Each R' radical is the same or different and preferably represents methyl, ethyl or 2-hydroxyethyl. Preferably the water-soluble sulphide is ethyl 2-hydroxyethyl sulphide. Addition of the appropriate thiol ligand via the thiol HSR'', usually at ambient temperatures, yields a gold thiolate, generally as a white precipitate though in the case of mercaptosuccinic acid as a yellow solution. The reaction solvent is usually water, ethanol or isopropanol, preferably water so that soluble inorganic salts (for example NaCl) can be extracted by water-washing. Yields of the gold thiolates can be as high as 80% or more (based on gold), with the remainder soluble in water. The gold thiolates produced can be dissolved in water by the addition of a base, usually an organic base, for instance an optionally substituted amine, to form the corresponding salt, in this instance a substituted ammonium salt.

The present gold thiolates can also be prepared by reacting a tetrahaloaurate (particularly a tetrachloroaurate or tetrabromoaurate) with the thiol of formula HSR'' to form the gold compound.

The present gold thiolates can also be prepared by reacting the thiol of formula HSR'' with a gold(I) amine complex of formula



wherein Hal represents a halogen atom

(preferably a chlorine or bromine atom) and each R''' is the same or different and represents an aliphatic, aromatic or heterocyclic group, or preferably the two R''' symbols together with the N atom represent a cyclic amine (such as benzotriazole or pyridine) to form the gold compound. The aliphatic, aromatic or heterocyclic groups which R''' may represent can be such groups as are discussed above as substituents in X.

The present thiolate can be formed in situ in the present composition, for instance by forming a salt therein, for example as described above.

The present composition contains 3-22% of precious metal, as the thiolate. The composition preferably contains 8-12% of the precious metal, especially gold, as the thiolate. The composition usually contains 10-40%, preferably 14-26%, of the thiolate, especially gold thiolate.

The polymeric resin must form a homogeneous composition with the other ingredients, and also be such as to fulfil the other functions demanded. The resin preferably forms a solution in the water/co-solvent mixture, though it may form a dispersion or emulsion therein. Preferably, the resin is soluble or forms a clear dispersion, in the water alone. Suitable resins are known materials. Polyacrylic, polymethacrylic, polyvinyl pyrrolidone, polycellulose ether, polyamide, polyethylene glycol, polyester, polyacrylamide, polyvinyl acetate, polyvinyl alcohol, alkyd, polyamine or polyurethane, resins or mixtures thereof can be employed. The resin can be in the form of a co-polymer or graft polymer. The resin can contain solubilising groups, particularly carboxylate and/or hydroxy and/or amino groups, especially carboxylate groups, to enhance the water solubility of the resin. Preferably, the resin comprises one or more, usually one, of polyvinyl pyrrolidone resins, polymethacrylic resins and polycellulose ether resins, for instance one or more, usually one, of polymethacrylic resins and polycellulose ether resins. Resins tend to volatilise steadily over a range of temperatures rather than all the substance volatilising at the same temperature. Preferably, the present resin is chosen such that the majority at least of it volatilises in the range 200-550 °C. Preferably, the resin comprises polyvinyl pyrrolidone, polymethacrylic or polycellulose ether resin the majority of which volatilises in this range.

The resin must satisfy the present requirements that on firing, the thiolate forms a homogeneous composition, preferably a solution, in it, and then the thiolate decomposes to the precious metal while the resin volatilises. For instance, if gold mercaptosuccinic acid, which decomposes to gold around 150 °C, is employed in a composition analogous to the present compositions but whose resin starts to evaporate around 200-300 °C, then on firing, a homogeneous composition (for instance a solution) of the thiolate in the resin is not formed. Instead, a premature dispersion of gold in the resin forms. A dull film results. However, the same resin can be employed successfully to produce bright gold films with a thiolate with which it does satisfy these requirements; and the same thiolate can be employed successfully to produce bright gold films with a resin with which it does satisfy these requirements. For example, N-(2-mercaptoacetyl)-glycine gold(I) starts to decompose around 200 °C and decomposes to gold around 280-300 °C; it can be employed successfully to produce bright gold films with resins which volatilise around 280-300 °C and which would be unsuccessful with gold mercaptosuccinic acid.

The present composition can contain less than 5% of the resin but usually contains 5-45%, especially 7-13%, of the resin. The weight ratio of resin solid to precious metal, especially gold, in the thiolate can be for instance at least 1:1, eg at least 1.2:1, for instance at least 1.5:1, as these tend to produce better, "scum-free", and brighter films on firing. Satisfactory bright films have been obtained, however, using ratios from 0.1:1 to 1.5:1. A typical composition has a ratio of 1:1.

The co-solvent must, with the water, dissolve the precious metal thiolate and form a homogeneous composition, preferably a solution, with the resin, and be such as to fulfil the other functions demanded. The co-solvent is preferably of boiling point between 100 and 280 °C. for instance between 100 and 220 °C. A preferred group of co-solvents are the water-miscible alcohols, ethers or esters, especially the water-miscible alcohols. Preferably, the co-solvent comprises 1,2-propanediol, 1,3-propanediol, n-butanol, tetrahydrofuran acetate, glycerol, glycerol diacetate or ethyl lactate, especially 1,2-propanediol, 1,3-propanediol or ethyl lactate. The particular co-solvent can affect the brightness of the films on firing.

The composition usually contains 5-45%, preferably 15-30%, for instance 25-30%, of the co-solvent.

It will be appreciated that particular ingredients and their amounts depend on each other and that any candidate material can readily be tested. For instance, it has been found that when the resin is a cellulosic resin the content of the co-solvent in the composition is preferably 25-30%, while when the resin is an acrylic or methacrylic resin the content of the co-solvent in the composition is preferably 15-30%.

The composition can contain minor metal compound additives, such as compounds of palladium (for example palladium sulphate), rhodium, bismuth or chromium, generally used in combination, to improve the colour, adhesion or brightness of the fired film, particularly on pottery. Minor metal compound additives for

the film particularly on glass can be for instance compounds of silver, vanadium or silicon. For bright films, the additives are usually in solution in the composition. They may be present, for instance, in a total content of 0.01-5%, usually 0.1-0.4%, of the composition. Such additives and their amounts and function are known in themselves for use in conventional liquid precious metal compositions based on organic solvents.

5 Known minor metal additive compounds which are soluble in the present mixture of water and co-solvent can be employed, for example chromium trioxide or $[\text{Cr}_2(\text{SO}_4)_3]$; ammonium bismuth citrate or bismuth lactate; $[\text{RhCl}(\text{ox})(\text{NH}_3)]$, $[\text{Rh}(\text{gly})_3]$, $[\text{Rh}_2(\text{acetate})_4]$, $\text{Na}_3[\text{Rh}(\text{NO}_3)_6]$ or $[\text{Rh}(\text{acac})\text{CO}]$; Me_3SiOMe ; or $[\text{VO}(\text{acac})_2]$; wherein acac represents acetylacetonate, ox oxalate and gly glycinate. In a particular embodiment, the rhodium, bismuth or silver is employed as the same thiolate as is the precious metal, for instance Ag N-(2-mercapto-propionyl)glycine. Thus, where the thiolate of the precious metal is a gold compound of formula Au-S-R-X or a salt thereof, the rhodium minor metal additive can be of formula $[\text{Rh}(\text{SRX})_3]$.

15 The composition must be homogeneous, for ease of application etc. To improve the rheology of the composition for application and to control the drying of the applied film, the composition can contain additional solvent, such as a water-miscible alcohol for instance isopropanol or n-hexanol, a water-miscible ketone for instance butanone, or a water-miscible solid for instance 1,6-hexandiol. The content of additional solvent is preferably 5-10% of the composition. The composition can contain surfactant, for instance in a content of 0.05-0.5%, for example to improve the brushing properties of the composition.

A particular composition according to the invention consists essentially of:

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Polyvinyl pyrrolidone	7-13%
Gold thiolate	14-26%
1,2-propanediol	15-30%
Water	40-55%
Isopropanol	5-10%
Minor metal additives	0.1-0.4%

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A preferred composition according to the invention consists essentially of:

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Polyvinyl pyrrolidone	7-13%
Gold thiolate	14-26%
1,2-propanediol	15-30%
Ethyl lactate	15-30%
Water	30-55%
Isopropanol	5-10%
Minor metal additives	0.1-0.4%

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40 The present composition may be UV-curable by reason of the polymeric resin being UV-curable, or may be cured thermally by reason of the polymeric resin being thermosetting.

The present composition can be applied to substrates and fired, each in ways known in themselves and this is advantageous as conventional equipment and techniques can be employed. The substrate on which firing occurs is preferably ceramic, such as porcelain or china, or glass. The composition can be applied directly to the substrate. Alternatively, the composition can be applied in the desired pattern (for instance, a decorative pattern) to a transfer substrate and dried thereon to form a transfer; the transfer can then be used in the usual way to transfer the pattern to the substrate, such as a ceramic substrate, on which it is fired. The composition can be applied for instance by brushing, by using a steel wheel or neoprene wheel or by printing, for example ink jet printing (otherwise known as inject or injection printing) but preferably screen printing. Particular components in the composition suit particular application procedures and the particular composition employed depends on the particular application procedure, bearing in mind for instance the desired rheology. The applied composition is usually dried, for instance at ambient temperature, before firing. It can, however, be dried as part of the heating sequence for firing. The present compositions are usually fired at 200-900 °C, for instance 460-650 °C on a glass substrate, 650-900 °C on a ceramic substrate, and 200-350 °C on a plastic substrate.

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The present composition produces good films. Precious metal films fall into three classes, burnished, self-burnished and bright. Compositions for forming burnished films, which - as the name implies - need to be burnished to produce the desired film, contain precious metal powder, or in some cases, insoluble

precious metal compound. The fired films usually contain a greater weight of precious metal than do those of bright films but are dull in appearance, exhibiting no significant reflectivity. After firing, they are burnished by mechanical abrasion, for instance with sand and water, to give a matt appearance. More recently, self-burnished films have been introduced. These contain insoluble matting agent which gives the fired film the appearance and durability of a burnished film without the necessity of burnishing. Compositions for forming bright films contain soluble precious metal compound. The fired films are very reflective, often having "mirror-like" properties. The present composition can be of any of these types. Preferably, it produces a bright film on firing. The composition can contain in addition, however, precious metal powder or insoluble precious metal compound to produce a burnished film on firing and then burnishing. Alternatively, the present composition can contain in addition an insoluble matting agent to produce a self-burnished film on firing.

The present composition is preferably used to decorate the substrate, for instance to produce decorative table ware. The composition can be used, however, for electronic applications, for instance to lay down electrically conductive pathways on insulating materials.

The invention is illustrated by the following Examples, in which the rhodium complex unless otherwise stated is of formula $\text{Rh}(\text{acac})\text{CO}$ wherein acac represents the acetylacetonate group, the polycellulose ether resin is "Natrastol" resin supplied by Aqualon Limited, United Kingdom, the polymethacrylic resin is "Versicol K11" supplied by Allied Colloids, Bradford, United Kingdom, the polyvinyl pyrrolidone is supplied by Aldrich Chemicals, United Kingdom and the compositions used for film formation unless otherwise indicated are all solutions. Unless otherwise stated, these compositions were brushed onto glazed china and then heated to a maximum of 780°C during a one hour firing cycle, with a ten minute soak at maximum temperature.

EXAMPLE 1

N-(2-mercaptopropionyl)glycine gold(I) was prepared in a two-necked 1000ml round-bottomed flask as follows:

A solution of sodium tetrachloroaurate (35g) in distilled water (200ml) was slowly added to a solution of ethyl 2-hydroxyethyl sulphide (20.5g) in distilled water (200ml). Solid addition of mercaptopropionylglycine (5.21g) followed by vigorous stirring yielded gold mercaptopropionylglycine as a white solid (yield, based on gold, 85%).

Analysis:	Theory:	C, 16.8	N, 3.9
	Found:	C, 16.15	N, 3.65%
Melting Point = 230°C (with decomposition).			

COMPARATIVE EXAMPLES 1-3

In an analogous way to Example 1, there were prepared:

- gold L-cysteine;
- gold 2-mercaptoethanesulphonic acid; and
- gold 2-mercaptopyridine;

each in a yield, based on gold, in excess of 80%.

COMPARATIVE EXAMPLE 4

Gold mercaptosuccinic acid was produced in an analogous way to Example 1 except that isopropanol was used instead of water and that the gold complex was soluble in the isopropanol and hence was isolated by evaporation of the solvent under reduced pressure (0.1 Torr) and then trituration of the resulting oil with diethyl ether to produce a white precipitate (yield, based on gold, in excess of 80%).

COMPARATIVE EXAMPLE 5

In an analogous way to Example 1, there was prepared:

- gold 4-hydroxythiophenol

(Analysis for C:	Theory 22.3% Found 21.8%)
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6 in a yield, based on gold, in excess of 80%.

EXAMPLE 2

10 In an analogous way to Example 1, there was prepared:
gold 4,6-dihydroxy-2-mercaptopyrimidine;

(Analysis for C:	Theory 13.9% Found 13.2%)
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15 in a yield, based on gold, in excess of 80%.

COMPARATIVE EXAMPLE 6

20 The following composition was obtained by mixing the ingredients:

	Parts
Polycellulose ether resin	10
Bis(ethylenediamine)gold trichloride	22 (10.1 parts gold)
1,3-Propanediol	15
Water	38
Isopropanol	15
Rhodium complex	0.05
Chromium trioxide	0.05

In these Examples, parts are by weight and the resin contents are based on their dry weights.

The composition was brushed onto china and heated to a maximum of 780 °C for 10 minutes during a one hour firing cycle. A dull and pitted film resulted. The film was not adherent; gentle rubbing removed it.

It can be seen that the gold compound is not the present gold thiolate.

COMPARATIVE EXAMPLE 7

40 The following composition was prepared and used in an analogous way to Comparative Example 6:

	Parts
Polymethacrylic resin	11
Gold mercaptosuccinic acid	18 (11 parts gold)
1,3-Propanediol	15
Water	40
Isopropanol	15
Rhodium complex	0.05
Chromium trioxide	0.05

A dull, adherent, film resulted. The dull nature of the film was due to premature decomposition of the thiolate during firing to give an insoluble gold product.

COMPARATIVE EXAMPLES 8-10

55 Compositions were prepared and used in an analogous way to Comparative Example 7 by substituting for its gold thiolate the following gold thiolate, in an amount corresponding to 10 parts of gold:

Gold cysteine (Comparative Example 8)

Gold mercaptobenzoic acid (Comparative Example 9)

Gold 2-mercaptopyridine (Comparative Example 10)

In each case, a dull film resulted. The dull nature of the film was due to premature decomposition of the thiolate during firing to give an insoluble gold product. The film was not adherent; gentle rubbing removed it.

COMPARATIVE EXAMPLE 11

The following composition was prepared and used in an analogous way to Comparative Example 6:

	Parts
Polycellulose ether resin	17
Gold thiobarbituric acid	17 (10 parts gold)
1,3-Propanediol	15
Ethyl lactate	15
Water	20
Isopropanol	15
Triethylamine	1
Rhodium complex	0.05
Chromium trioxide	0.05

A dull and pitted film resulted. The dull nature of the film was due to premature decomposition of the thiolate during firing to give an insoluble gold product. The film was not adherent; gentle rubbing removed it.

EXAMPLE 3

The following composition was prepared and used in an analogous way to Comparative Example 6:

	Parts
Polymethacrylic resin	10
N-(2-mercaptopropionyl)glycine gold(I)	18.5 (10 parts gold)
1,3-Propanediol	15
Water	40
Isopropanol	15
Triethylamine	1
Rhodium complex	0.05
Chromium trioxide	0.05

A bright, adherent, film resulted.

It can be seen that the composition contains 10% gold as the thiolate.

The composition was also applied by steel wheel and by neoprene wheel. In both cases, it gave the same result as the brushing.

EXAMPLES 4-6

Example 3 was followed except that for its 1,3-propanediol there were substituted 15 parts of tetrahydrofuran acetate (Example 4), glycerol diacetate (Example 5) or ethyl lactate (Example 6). In each case, the resulting gold film was adherent and essentially bright.

The composition was applied also by steel wheel, and also neoprene wheel. In each case, a bright, continuous film was obtained on firing.

EXAMPLES 7-9

The following compositions were prepared and used in an analogous way to Comparative Example 6:

EXAMPLE 7

	Parts
Polycellulose ether resin	10
N-(2-mercaptopropionyl)glycine gold(I)	18.5 (10 parts gold)
1,2-Propanediol	15
Ethyl lactate	15
Water	40
Triethylamine	1
Rhodium complex	0.05
Chromium trioxide	0.05

EXAMPLE 8

	Parts
Polyvinyl pyrrolidone resin (molecular weight 30,000)	12
N-(2-mercaptopropionyl)glycine gold(I)	16.5 (9 parts gold)
1,2-Propanediol	15
Ethyl lactate	25
Water	30
Triethylamine	1
Rhodium complex	0.05
Chromium trioxide	0.05
Ammonium bismuth citrate	0.05

EXAMPLE 9

	Parts
Polyethylene glycol resin (molecular weight 20,000)	10
N-(2-mercaptopropionyl)glycine gold(I)	18.5 (10 parts gold)
1,2-Propanediol	15
Glycerol	5
Ethyl lactate	10
Water	40
Rhodium complex	0.05
Chromium trioxide	0.05

In each case, a bright, adherent film resulted.

COMPARATIVE EXAMPLE 12

The following composition was obtained and used in an analogous way to that of Comparative Example 6:

	Parts
Polyvinyl pyrrolidone	91
Gold-2-mercaptobenzimidazole	182
Water	273
1,2-Propanediol	91
Ethyl lactate	227.5
Ammonia solution (specific gravity 0.88)	45.5
[Rh ₂ (acetate) ₄]	1
	<u>811</u>

A dull non-adherent film resulted from the firing of the composition. This was a result of the low solubility of the gold compound during application (brushing) of the composition, resulting in a heterogeneous composition on heating. It was estimated that only about 5% of the gold-mercaptide was dissolved in the initial medium.

COMPARATIVE EXAMPLES 13-19

Compositions were prepared and used as in Comparative Example 12 by substituting for its gold compound the following:

13. Gold-5-mercapto-1-methyltetrazole
14. Gold-2-mercapto-5-nitrobenzimidazole
15. Gold-4-aminothiophenol
16. Gold-4-hydroxythiophenol
17. Gold-mercaptoacetic acid
18. Gold-2-mercaptopropionic acid
19. Gold-mercapto-2,3-hydroxypropane.

The resultant films were all unsatisfactory. The compositions of Comparative Examples 13-15 were unsatisfactory for the same reason as that of Comparative Example 12, resulting in dull and particulate films, often with severe pitting. The compositions of Comparative Examples 16-19 prematurely decomposed to gold powder during the production or use of the liquid gold compositions, resulting in heterogeneous compositions. The gold compounds of Comparative Examples 16-19 and their general classes are inherently unstable in the presence of organic base and therefore are not useful for producing bright gold films from water based media.

EXAMPLE 10

A water-based liquid gold composition that has a resin solid to gold ratio of 1:10 was prepared by mixing:

	Parts
Polycellulose resin ("Natrasol 250GR" sold by Aqualon, UK)	9.1
N-(2-mercaptopropionyl)glycine gold(I)	182
Water	273
1,2-propanediol	91
Ethyl lactate	182
Triethylamine	45.5
[Rh ₂ (acetate) ₄]	1
	<u>783.6</u>

It can be seen that the composition contains 1.2% of the resin by weight.

The resulting film was bright and continuous, after gently washing off with water the low amount of inorganic deposit left on the film and then drying with tissue paper.

EXAMPLE 11

A composition was prepared and used as in Example 10 by substituting for its gold compound gold-acetylcysteine. It gave the same result.

EXAMPLE 12

A water-based liquid gold composition containing gold-(γ -L-glutamyl-L-cysteinyl-glycine), otherwise called gold-glutathione, was prepared by mixing:

	Parts
Polyvinyl pyrrolidone	72
Gold-glutathione	172
Water	290
1,2-propanediol	72
Ethyl lactate	91
Triethylamine	68
[Rh ₂ (acetate) ₄]	1
	<u>766</u>

The resulting film was bright and continuous.

EXAMPLE 13

A water-based liquid gold composition containing gold and palladium to produce a metallic (grey) fired appearance was prepared by mixing:

	Parts
Polyvinyl pyrrolidone	50
N-(2-mercaptopropionyl)glycine gold(I)	100
Palladium sulphate	15
Water	150
1,2-propanediol	50
Ethyl lactate	100
Triethylamine	25
Polysulphide solution	12.5
[RhCl(ox)(NH ₃) ₄]	1
	<u>503.5</u>

ox = oxalato; polysulphide solution = a 15% ammonium polysulphide solution in water (obtained from BDH, United Kingdom). The resulting film was bright and continuous in appearance.

EXAMPLE 14

A water-based liquid gold composition suitable for fast and slow firing cycles was prepared by mixing:

	Parts
Polyvinyl pyrrolidone	30
N-(2-mercaptoacetyl)glycine gold(I)	100
Water	240
1,2-propanediol	30
Ethyl lactate	125
n-Butanol	5
Triethylamine	25
Polysulphide solution	12.5
[RhCl(ox)(NH ₃) ₄]	1
Cr ₂ (SO ₄) ₄	1.9
[Bi-citrate]	2.5
	<u>572.9</u>

ox = oxalate: Bi-citrate was purchased from BDH, United Kingdom, as ammonium bismuth citrate. The polysulphide solution was as in Example 13. Reflective and continuous films were obtained from the following firing profiles:

Fast firing: 40 minute cycle; maximum temperature = 805 °C; 2 minutes soak.

Slow firing: 200 °C per hour; maximum temperature = 750 °C; 10 minutes soak.

The same composition was brushed onto porcelain ware to produce a bright and continuous film using the same firing cycle as Comparative Example 6. The same composition brushed onto porcelain ware was fired to a maximum temperature of 900 °C; 40 minute cycle; 2 minutes soak, to produce a bright and continuous film.

EXAMPLE 15

A water-based liquid gold composition suitable for application to glassware was prepared by mixing:

	Parts
Polymethacrylic resin ("Versicol K11" from Allied Colloids, UK)	100
N-(2-mercaptoacetyl)glycine gold(I)	200
Water	380
1,3-propanediol	20
2-propanol	100
[Rh(CO)(acac)] ₂	2
CrO ₃	1
Me ₃ SiOMe	1
Silver-N-(2-mercaptoacetyl)glycine	30
	<u>734</u>

The composition was brushed onto glassware, and fired for one hour in total to a maximum temperature of 620 °C, 10 minutes soak. A bright and continuous film resulted.

EXAMPLE 16

A water-based liquid gold composition suitable for ink-jet printing and having a high water concentration was prepared by mixing:

	Parts
Polyvinyl pyrrolidone	74
N-(2-mercaptopropionyl)glycine gold(I)	59
Water	314.4
Butanone	46
n-Butanol	39
Triethylamine	8
Polysulphide solution	10
[Rh(NH ₃) ₆]Cl ₃	1
[Bi-lactate]	1.4
	<u>614.4</u>

The composition of Example 16 contains 61% water. The polyvinyl pyrrolidone resin has a molecular weight = 10,000 daltons. The polysulphide solution is as in Example 13. The composition was sprayed by an ink-jet sprayer onto flat tiles and fired to produce a bright and continuous gold film.

EXAMPLE 17

A water-based liquid gold composition that is suitable for screen-printing was prepared by mixing:

	Parts
Polycellulose resin	45
N-(2-mercaptopropionyl)glycine gold(I)	181
Water	454
1,2-propanediol	181
Glycerol	91
Ethyl lactate	45
[Rh ₂ (acetate) ₄]	1
[Cr ₂ (SO ₄) ₂]	1.8
	<u>999.8</u>

The composition contains 4.5% resin as solid. The composition was printed through a screen of mesh size 305 μ onto glazed tile. The fired film was bright and continuous. A low amount of inorganic deposit left on the film after firing was gently washed with water and then dried with tissue paper, to give a bright and continuous film.

EXAMPLE 18

A water-based liquid gold composition which contains gold powder to produce a burnished effect, and which is suitable for screen-printing was prepared by mixing:

	Parts
Polycellulose resin	62
Gold powder	400
N-(2-mercaptopropionyl)glycine gold(I)	250
Water	1000
1,2-propanediol	250
Ethyl lactate	62
Glycerol	125
Triethylamine	62
[Rh ₂ (acetate) ₄]	1
	<u>2212</u>

The composition was applied in an analogous way to that of Example 17. The resulting film was abraided to produce an off-bright gold effect.

EXAMPLE 19

In the same way as described for the composition of Example 19, a brushing burnish gold was prepared by simply reducing the polycellulose resin concentration to 25 parts.

EXAMPLE 20

In an analogous way to Example 1, there was prepared gold-N-(3-mercaptopropionyl)glycine in a yield, based on gold, in excess of 80%.

Analysis:	Theory:	C, 16.8	N, 3.9
	Found:	C, 16.35	N, 3.55%

Claims

1. A homogeneous composition for forming on firing a film of precious metal, which is one or more of platinum, palladium, gold and silver, on a substrate, which composition comprises polymeric resin and a solution, in water and a co-solvent, of thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a homogeneous composition of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a homogeneous composition of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.
2. A composition for forming on firing a film of precious metal, which is one or more of platinum, palladium, gold and silver, on a substrate, which composition comprises a solution, in water and a co-solvent, of polymeric resin and thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a solution of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a solution of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.
3. A composition according to claim 1 or 2 which contains 5-85% by weight of water.
4. A composition according to claim 3 which contains 40-55% by weight of water.
5. A composition according to any one of the preceding claims wherein the precious metal comprises gold.
6. A composition according to claim 5 wherein the thiolate is a gold compound of formula Au-S-R-H or Au-S-R-X or a salt of either, in which:
X represents a nitro group or a group of formula -COOH, -SO₂OH, -OH, -CO.NH₂, -NH₂ or -O-P(O)-(OH)₂, any of whose hydrogen atoms optionally being substituted; and
R represents a divalent organic group.
7. A composition according to claim 6 wherein the gold compound of formula Au-S-R-H or Au-S-R-X is such that H-R-S-H or H-S-R-X represents:
N-(2-mercaptopropionyl)glycine;
N-(3-mercaptopropionyl)glycine;
N-(2-mercaptoacetyl)glycine;
2-mercaptoacetyl-L-histidine;
3-mercaptopropionyl-L-histidine;



The composition was applied in an analogous way to that of Example 17. The resulting film was abraided to produce an off-bright gold effect.

EXAMPLE 19

In the same way as described for the composition of Example 19, a brushing burnish gold was prepared by simply reducing the polycellulose resin concentration to 25 parts.

EXAMPLE 20

In an analogous way to Example 1, there was prepared gold-N-(3-mercaptopropionyl)glycine in a yield, based on gold, in excess of 80%.

Analysis:	Theory:	C, 16.8	N, 3.9
	Found:	C, 16.35	N, 3.55%

Claims

1. A homogeneous composition for forming on firing a film of precious metal, which is one or more of platinum, palladium, gold and silver, on a substrate, which composition comprises polymeric resin and a solution, in water and a co-solvent, of thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a homogeneous composition of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a homogeneous composition of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.
2. A composition for forming on firing a film of precious metal, which is one or more of platinum, palladium, gold and silver, on a substrate, which composition comprises a solution, in water and a co-solvent, of polymeric resin and thiolate of the precious metal, the composition containing 3-22% by weight of the precious metal as the thiolate, and the co-solvent, resin and thiolate being such that as the composition on a substrate dries and is progressively heated in firing, the water evaporates off to leave a solution of the resin and thiolate in the co-solvent, then the co-solvent evaporates off to leave a solution of the thiolate in the resin, and then the thiolate decomposes to the precious metal while the resin volatilises.
3. A composition according to claim 1 or 2 which contains 5-85% by weight of water.
4. A composition according to claim 3 which contains 40-55% by weight of water.
5. A composition according to any one of the preceding claims wherein the precious metal comprises gold.
6. A composition according to claim 5 wherein the thiolate is a gold compound of formula Au-S-R-H or Au-S-R-X or a salt of either, in which:
X represents a nitro group or a group of formula -COOH, -SO₂OH, -OH, -CO.NH₂, -NH₂ or -O-P(O)-(OH)₂, any of whose hydrogen atoms optionally being substituted; and
R represents a divalent organic group.
7. A composition according to claim 6 wherein the gold compound of formula Au-S-R-H or Au-S-R-X is such that H-R-S-H or H-S-R-X represents:
N-(2-mercaptopropionyl)glycine;
N-(3-mercaptopropionyl)glycine;
N-(2-mercaptoacetyl)glycine;
2-mercaptoacetyl-L-histidine;
3-mercaptopropionyl-L-histidine;



L-cysteine;
acetylcysteine; or
glutathione.

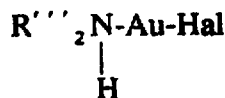
- 5 8. A composition according to any one of the preceding claims which contains 8-12% by weight of the precious metal as the thiolate.
9. A composition according to any one of the preceding claims wherein the resin comprises polyvinyl pyrrolidone, polymethacrylic or polycellulose ether resin the majority of which volatilises in the range
10 200-550 ° C.
10. A composition according to any one of the preceding claims which contains 5-45% by weight of the resin.
- 15 11. A composition according to any one of the preceding claims wherein the co-solvent is of boiling point between 100 and 220 ° C.
12. A composition according to any one of the preceding claims wherein the co-solvent comprises water-miscible alcohol, ester or ether.
- 20 13. A composition according to claim 12 wherein the alcohol comprises 1,2-propanediol or 1,3-propanediol.
14. A composition according to any one of the preceding claims which contains 5-45% by weight of the co-solvent.
- 25 15. A composition according to any one of the preceding claims which produces a bright film on firing.
16. A composition according to any one of claims 1-14 which contains in addition precious metal powder or insoluble precious metal compound to produce a burnished film on firing and then burnishing.
- 30 17. A composition according to any one of claims 1-14 which contains in addition an insoluble matting agent to produce a self-burnished film on firing.
18. A transfer bearing a composition claimed in any one of the preceding claims which has been dried
35 thereon.
19. A method of forming a film of precious metal on a substrate, which method comprises applying a composition claimed in any one of claims 1-17 to a substrate and drying and firing the applied composition.
- 40 20. A method according to claim 19 wherein the substrate on which firing occurs is ceramic or glass.
21. A method according to claim 19 or 20 wherein the firing is at 460-900 ° C.
- 45 22. A thiolate which is a gold compound of formula $AuSR''$ or a salt thereof, in which R'' is such that HSR'' represents:
4,6-dihydroxy-2-mercaptopyrimidine; or
N-(mercaptoalkanoyl)glycine whose alkan group contains 1 or 2 carbon atoms.
- 50 23. A thiolate according to claim 22 which is the gold compound of formula $AuSR''$ or a salt thereof with an amine or substituted amine.
24. A thiolate which is N-(2-mercaptopropionyl)glycine gold(I) or a salt thereof.
- 55 25. A thiolate according to claim 24 which is non-radioactive.
26. A process for preparing a thiolate claimed in any one of claims 22-25, which process comprises reacting in a solvent a compound of formula $AuCl(SR'_2)$ with a thiol of formula HSR'' to form the gold



compound and, in solution, the sulphide of formula SR'_2 .

27. A process for preparing a thiolate claimed in any one of claims 22-25, which process comprises reacting a tetrahaloaurate with a thiol of formula HSR'' to form the gold compound.

28. A process for preparing a thiolate claimed in any one of claims 22-25, which process comprises reacting a thiol of formula HSR'' with a gold(I) amine complex of formula



wherein Hal represents a halogen atom and each R''' is the same or different and represents an aliphatic, aromatic or heterocyclic group or the two R''' symbols together with the N atom represent a cyclic amine to form the gold compound.

Patentansprüche

1. Homogene Zusammensetzung, um beim Brennen einen Film aus einem Edelmetall, ausgewählt aus Platin, Palladium, Gold und/oder Silber, auf einem Substrat zu bilden, wobei die Zusammensetzung ein Polymerharz und eine Lösung eines Thiolats des Edelmetalls in Wasser und ein Co-Lösungsmittel umfaßt, die Zusammensetzung 3 bis 22 Gew.-% des Edelmetalls als Thiolat enthält, und das Co-Lösungsmittel, das Harz und das Thiolat so sind, daß dann, wenn die Zusammensetzung auf einem Substrat trocknet und nach und nach beim Brennen erhitzt wird, das Wasser verdampft, wobei eine homogene Zusammensetzung des Harzes und des Thiolats in dem Co-Lösungsmittel zurückbleibt, dann das Co-Lösungsmittel verdampft, wobei eine homogene Zusammensetzung des Thiolats in dem Harz zurückbleibt, und dann das Thiolat sich zu dem Edelmetall zersetzt, während sich das Harz verflüchtigt.

2. Zusammensetzung, um beim Brennen einen Film aus Edelmetall, ausgewählt aus Platin, Palladium, Gold und/oder Silber, auf einem Substrat zu bilden, wobei die Zusammensetzung eine Lösung eines Polymerharzes und eines Thiolats des Edelmetalls in Wasser und einem Co-Lösungsmittel umfaßt, die Zusammensetzung 3 bis 22 Gew.-% des Edelmetalls als Thiolat enthält, und das Co-Lösungsmittel, das Harz und das Thiolat so sind, daß dann, wenn die Zusammensetzung auf einem Substrat trocknet und nach und nach beim Brennen erhitzt wird, das Wasser verdampft, wobei eine Lösung des Harzes und des Thiolats in dem Co-Lösungsmittel zurückbleibt, dann das Co-Lösungsmittel verdampft, wobei eine Lösung des Thiolats in dem Harz zurückbleibt, und dann sich das Thiolat zu dem Edelmetall zersetzt, während sich das Harz verflüchtigt.

3. Zusammensetzung nach Anspruch 1 oder 2, die 5 bis 85 Gew.-% Wasser enthält.

4. Zusammensetzung nach Anspruch 3, die 40 bis 55 Gew.-% Wasser enthält.

5. Zusammensetzung nach einem der vorhergehenden Ansprüche, worin das Edelmetall Gold umfaßt.

6. Zusammensetzung nach Anspruch 5, worin das Thiolat eine Goldverbindung der Formel $Au-S-R-H$ oder $Au-S-R-X$ oder ein Salz von einem der beiden ist, worin

X eine Nitrogruppe oder eine Gruppe der Formel $-COOH$, $-SO_2OH$, $-OH$, $-CO.NH_2$, $-NH_2$ oder $-O-P(O)(OH)_2$ bedeutet, wobei jeweils die Wasserstoffatome gegebenenfalls substituiert sein können und

R eine divalente organische Gruppe bedeutet.

7. Zusammensetzung nach Anspruch 6, worin die Goldverbindung der Formel $Au-S-R-H$ oder $Au-S-R-X$ so ist, daß $H-R-S-H$ oder $H-S-R-X$ bedeutet:

N-(2-Mercaptopropionyl)glycin,

N-(3-Mercaptopropionyl)glycin,



- N-(2-Mercaptoacetyl)glycin,
 2-Mercaptoacetyl-L-histidin
 3-Mercaptopropionyl-L-histidin
 L-Cystein,
 Acetylcystein oder
 Glutathion.
8. Zusammensetzung nach einem der vorhergehenden Ansprüche, die 8 bis 12 Gew.-% des Edelmetalls als Thiolat enthält.
 9. Zusammensetzung nach einem der vorhergehenden Ansprüche, worin das Harz Polyvinylpyrrolidon-, Polymethacryl- oder Polycelluloseetherharz umfaßt, dessen Hauptanteil sich im Bereich von 200 bis 550 °C verflüchtigt.
 10. Zusammensetzung nach einem der vorhergehenden Ansprüche, die 5 bis 45 Gew.-% Harz enthält.
 11. Zusammensetzung nach einem der vorhergehenden Ansprüche, worin das Co-Lösungsmittel einen Siedepunkt zwischen 100 und 220 °C hat.
 12. Zusammensetzung nach einem der vorhergehenden Ansprüche, worin das Co-Lösungsmittel einen mit Wasser mischbaren Alkohol, Ester oder Ether umfaßt.
 13. Zusammensetzung nach Anspruch 12, worin der Alkohol 1,2-Propandiol oder 1,3-Propandiol umfaßt.
 14. Zusammensetzung nach einem der vorhergehenden Ansprüche, die 5 bis 45 Gew.-% des Co-Lösungsmittels umfaßt.
 15. Zusammensetzung nach einem der vorhergehenden Ansprüche, die einen glänzenden Film beim Brennen erzeugt.
 16. Zusammensetzung nach einem der Ansprüche 1 bis 14, die zusätzlich Edelmetallpulver oder eine unlösliche Edelmetallverbindung enthält, um einen polierten Film beim Brennen und Polieren zu erzeugen.
 17. Zusammensetzung nach einem der Ansprüche 1 bis 14, die zusätzlich ein unlösliches Mattierungsmittel enthält, um einen selbstpolierten Film beim Brennen zu erzeugen.
 18. Abziehbild, das eine Zusammensetzung nach einem der vorhergehenden Ansprüche trägt, die darauf getrocknet ist.
 19. Verfahren zur Bildung eines Films aus Edelmetall auf einem Substrat, wobei das Verfahren umfaßt, daß man eine Zusammensetzung nach einem der Ansprüche 1 bis 17 auf ein Substrat aufträgt und trocknet und die aufgetragene Zusammensetzung brennt.
 20. Verfahren nach Anspruch 19, worin das Substrat, auf dem das Brennen stattfindet, Keramik oder Glas ist.
 21. Verfahren nach Anspruch 19 oder 20, worin das Brennen bei 460 bis 900 °C stattfindet.
 22. Thiolat, das eine Goldverbindung der Formel AuSR" oder ein Salz davon ist, worin R" so ist, daß HSR" bedeutet:
 4,6-Dihydroxy-2-mercaptopyrimidin oder
 N-(Mercaptoalkanoyl)glycin, dessen Alkangruppe 1 oder 2 Kohlenstoffatome enthält.
 23. Thiolat nach Anspruch 22, das die Goldverbindung der Formel AuSR" oder ein Salz davon mit einem Amin oder substituierten Amin ist.
 24. Thiolat, das N-(2-Mercaptopropionyl)glycingold(I) oder ein Salz davon ist.

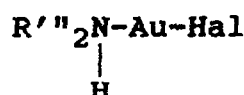


25. Thiolat nach Anspruch 24, das nicht radioaktiv ist.

26. Verfahren zur Herstellung eines Thiolats nach einem der Ansprüche 22 bis 25, wobei das Verfahren
5 umfaßt, daß man in einem Lösungsmittel eine Verbindung der Formel $\text{AuCl}(\text{SR}'_2)$ mit einem Thiol der Formel HSR'' umsetzt, um die Goldverbindung und gelöst das Sulfid der Formel SR'_2 zu bilden.

27. Verfahren zur Herstellung eines Thiolats nach einem der Ansprüche 22 bis 25, wobei das Verfahren
10 umfaßt, daß man ein Tetrahalogenaurat mit einem Thiol der Formel HSR'' umsetzt, um die Goldverbindung zu bilden.

28. Verfahren zur Herstellung eines Thiolats nach einem der Ansprüche 22 bis 25, wobei das Verfahren
15 umfaßt, daß man ein Thiol der Formel HSR'' mit einem Gold(I)aminkomplex der Formel



20 umsetzt, worin Hal ein Halogenatom bedeutet und jeder Rest R''' gleich oder verschieden ist und aliphatische, aromatische oder heterocyclische Gruppen bedeutet oder die zwei Gruppen R''' zusammen mit dem N-Atom ein cyclisches Amin bedeuten, zur Bildung der Goldverbindung.

Revendications

25 1. Composition homogène pour former par chauffage de cuisson une pellicule de métal précieux, qui est constitué par un ou plusieurs des métaux platine, palladium, or et argent, sur un substrat, ladite composition comprenant de la résine polymère et une solution, dans de l'eau et dans un co-solvant, d'un thiolate du métal précieux, la composition contenant 3 à 22 % en poids du métal précieux sous
30 forme du thiolate, et le co-solvant, la résine et le thiolate étant tels que, lorsque la composition sur un substrat sèche et est progressivement chauffée au cours de la cuisson ou de la calcination, l'eau s'en évapore pour laisser une composition homogène de la résine et du thiolate dans le co-solvant, puis le co-solvant part par évaporation pour laisser une solution homogène du thiolate dans la résine, puis le thiolate se décompose en donnant le métal précieux cependant que la résine se volatilise.

35 2. Composition pour former par chauffage de cuisson une pellicule de métal précieux, ce métal étant formé par un ou plusieurs des métaux platine, palladium, or et argent, sur un substrat, cette composition comprenant une solution, dans de l'eau et dans un co-solvant, d'une résine polymère et d'un thiolate du métal précieux, la composition contenant 3 à 22 % en poids du métal précieux sous
40 forme du thiolate et le co-solvant, la résine et le thiolate étant tels que, lorsque la composition sur un substrat sèche et est progressivement chauffée lors de la cuisson ou de la calcination, l'eau s'en évapore pour laisser une solution de la résine et du thiolate dans le co-solvant, puis le co-solvant part par évaporation pour laisser une solution du thiolate dans la résine, puis le thiolate se décompose en donnant le métal précieux cependant que la résine se volatilise.

45 3. Composition selon la revendication 1 ou 2, qui contient 5 à 85 % en poids d'eau.

4. Composition selon la revendication 3, qui contient 40 à 55 % en poids d'eau.

5. Composition selon l'une quelconque des revendications précédentes, dans laquelle le métal précieux
50 est constitué par ou comprend de l'or.

6. Composition selon la revendication 5, dans laquelle le thiolate est un composé de l'or ayant pour
formule Au-S-R-H ou Au-S-R-X ou un sel de l'un ou l'autre composé, dans lesquels :

X représente un groupe nitro ou un groupe de formule $-\text{COOH}$, $-\text{SO}_2\text{OH}$, $-\text{OH}$, $-\text{CO.NH}_2$, $-\text{NH}_2$ ou
55 $-\text{O-P(O)(OH)}_2$, les atomes d'hydrogène de l'un quelconque de ces groupes pouvant éventuellement être remplacés par substitution ; et

R représente un groupe organique divalent.

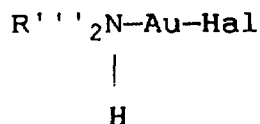


7. Composition selon la revendication 6, dans laquelle le composé de l'or de formule Au-S-R-H ou Au-S-R-X est tel que H-R-S-H ou H-S-R-X représente :
- la N-(2-mercaptopropionyl)glycine ;
 - la N-(3-mercaptopropionyl)glycine ;
 - 5 la N-(2-mercaptoacétyl)glycine ;
 - la 2-mercaptoacétyl-L-histidine ;
 - la 3-mercaptopropionyl-L-histidine ;
 - la L-cystéine ;
 - l'acétylcystéine ; ou
 - 10 le glutathion.
8. Composition selon l'une quelconque des revendications précédentes, qui contient 8 à 12 % en poids du métal précieux sous forme du thiolate.
- 15 9. Composition selon l'une quelconque des revendications précédentes, dans laquelle la résine est constituée par ou comprend de la polyvinylpyrrolidone, de la résine polyméthacrylique ou de poly(éther de cellulose) dont la majeure partie se volatilise dans l'intervalle de la température allant de 200 à 550 °C.
- 20 10. Composition selon l'une quelconque des revendications précédentes, qui contient 5 à 45 % en poids de la résine.
11. Composition selon l'une quelconque des revendications précédentes, dans laquelle le co-solvant a un point d'ébullition compris entre 100 et 220 °C.
- 25 12. Composition selon l'une quelconque des revendications précédentes, dans laquelle le co-solvant est constitué par ou comprend de l'alcool, de l'ester ou de l'éther miscibles à l'eau.
13. Composition selon la revendication 12, dans laquelle l'alcool est constitué par ou comprend le 1,2-propanediol ou le 1,3-propanediol.
- 30 14. Composition selon l'une quelconque des revendications précédentes, qui contient 5 à 45 % en poids du co-solvant.
- 15 15. Composition selon l'une quelconque des revendications précédentes, qui produit par chauffage de cuisson une pellicule brillante.
16. Composition selon l'une quelconque des revendications 1 à 14, qui contient en outre de la poudre de métal précieux ou un composé insoluble du métal précieux, pour produire par chauffage de cuisson
- 40 puis brunissage ou polissage une pellicule brunie ou polie.
17. Composition selon l'une quelconque des revendications 1 à 14, qui contient en outre un agent insoluble de matité pour produire par chauffage de cuisson une pellicule auto-brunie.
- 45 18. Élément pour report ou transfert, portant une composition telle que revendiquée dans l'une quelconque des revendications précédentes, composition qui a été séchée sur cet élément de report.
19. Procédé pour former une pellicule de métal précieux sur un substrat, ce procédé comprenant l'application d'une composition telle que revendiquée dans l'une quelconque des revendications 1 à 17,
- 50 sur un substrat, et le séchage et le chauffage de cuisson de la composition ainsi appliquée.
20. Procédé selon la revendication 19, dans lequel le substrat sur lequel est effectué le chauffage de cuisson est de la matière céramique ou du verre.
- 55 21. Procédé selon la revendication 19 ou 20, dans lequel le chauffage de cuisson s'effectue à 460-900 °C.
22. Thiolate, qui est un composé d'or de formule AuSR'' ou un sel de ce composé, dans lequel R'' est tel que HSR'' représente :



la 4,6-dihydroxy-2-mercaptopyrimidine ; ou
une N-(mercaptoalcanoyl)glycine dont le groupe alcane contient 1 ou 2 atomes de carbone.

23. Thiolate selon la revendication 22, qui est le composé d'or de formule AuSR'' , ou un sel de ce composé avec une amine ou une amine substituée.
24. Thiolate, qui est le N-(2-mercaptopropionyl)glycine or(I) ou un sel de ce composé.
25. Thiolate selon la revendication 24, qui n'est pas radioactif.
26. Procédé pour préparer un thiolate tel que revendiqué dans l'une quelconque des revendications 22 à 25, ce procédé comprenant la réaction, dans un solvant, d'un composé de formule $\text{AuCl}(\text{SR}'_2)$ avec un thiol de formule HSR'' pour former le composé de l'or et, en solution, le sulfure de formule SR'_2 .
27. Procédé pour préparer un thiolate tel que revendiqué dans l'une quelconque des revendications 22 à 25, ce procédé comprenant la réaction d'un tétrahalogénoaurate avec un thiol de formule HSR'' pour former le composé de l'or.
28. Procédé pour préparer un thiolate tel que revendiqué dans l'une quelconque des revendications 22 à 25, ce procédé comprenant la réaction d'un thiol de formule HSR'' avec un complexe d'or(I) amine de formule



(formule dans laquelle Hal représente un atome d'halogène et les R'' , identiques ou différents, représentent chacun un groupe aliphatique, aromatique ou hétérocyclique ou bien deux symboles R'' , pris avec l'atome de N, représentent une amine cyclique) pour former le composé de l'or .