

To meet the requirements regarding reliability, thermal conductivity, and electrical conductivity of the joining site, it has been proposed for some time to connect electronic components and substrates through sintering (see, for example, DE 10 2007 046 901 A1). Sintering technology is a very simple method for connecting components in stable manner. Using said sintering methods, it is usually quite successful to connect electronic components to substrates provided these each comprise a noble metal-containing contact region. However, it is often necessary to connect electronic components and substrates through at least one non-noble contact region. Using the conventional sintering methods, it is often not feasible to produce stable connections through said non-noble contact regions.

Moreover, it has been proposed earlier to use pastes based on nano-particles with a particle size of no more than 100 nm for connecting electronic components and substrates. However, the handling of nano-particles is associated with a health hazard and is therefore often avoided for reasons of occupational safety.

It was therefore one object of the invention to provide a paste that allows at least one electronic component to be connected to at least one substrate through contact regions, whereby at least one of said contact regions contains a non-noble metal. Preferably, said paste shall be used to create a connection between the electronic component and the substrate that ensures high reliability at temperatures to which the electronic component is exposed in operation. Moreover, said paste shall preferably also overcome other disadvantages known from the prior art.

It was also an object of the invention to provide a method for connecting at least one electronic component to at least one substrate through a contact region, whereby at least one of said contact regions contains a non-noble metal.

Said objects are met by the subject matters of the independent claims.

Accordingly, the invention provides a paste containing (a) metal particles, (b) at least one activator that bears at least two carboxylic acid units in the molecule, and (c) a dispersion medium-, wherein the metal particles are selected from the group comprising silver particles, copper particles, nickel particles and aluminium particles.

According to ~~a preferred~~the above mentioned embodiment, the metal is selected from the group consisting of copper, silver, nickel, and aluminium. According to a particularly preferred embodiment, the metal is silver.

5 The metal can be present in the metal particles as pure metal, for example having a purity of at least 99 % by weight, a purity of at least 99.9 % by weight, a purity of at least 99.99 % by weight or a purity of at least 99.999 % by weight. On the other hand, the metal particles can contain multiple metals just as well. It is also feasible for the metal particles to contain alloys or intermetallic phases made of multiple metals.

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According to a preferred embodiment, the metal particles comprise as their main component an element selected from the group consisting of silver, copper, nickel, and aluminium. In the scope of the invention, main component is understood to mean the element of which a larger fraction is present in the metal particle of interest than of any other element that is present in
15 said metal particle.

According to ~~a particularly preferred~~the above mentioned embodiment, the metal particles are silver particles, copper particles, nickel particles or aluminium particles. Said particles can be partly or fully oxidised at their surface, if applicable.

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According to a particularly preferred embodiment, the metal particles are silver particles.

There is no limitation to the shape of said metal particles. Preferably, the metal particles take the shape of flakes, an ellipsoidal shape or a round shape. It is feasible just as well for the metal
25 particles to be a mixture of multiple shapes.

According to a particularly preferred embodiment, the metal particles take the shape of flakes. The fraction of flakes in said embodiment preferably is at least 70 % by weight, more preferably at least 80 % by weight, even more preferably at least 90 % by weight, and particularly preferably at least 99 % by weight, relative to the total weight of the metal particles.

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According to another preferred embodiment, the metal particles have a length ratio of more than 1.0, more preferably a length ratio of more than 1.2, even more preferably a length ratio of more than 1.5, and particularly preferably a length ratio of more than 2.0. Preferably, the metal particles have a length ratio of no more than 20, more preferably a length ratio of no more than
35 15, and even more preferably a length ratio of no more than 10. In this context, the length ratio

Patent claims

1. Paste containing
 - (a) metal particles;
 - 5 (b) at least one activator that bears at least two carboxylic acid units in the molecule; and
 - (c) a dispersion medium;₂

wherein the metal particles are selected from the group comprising silver particles, copper particles, nickel particles and aluminium particles.
- 10 2. Paste according to claim 1, characterised in that the metal particles are silver particles.
3. Paste according to claim 1 or 2, characterised in that the activator has a decomposition point in the range of 100 – 300°C.
- 15 4. Paste according to ~~any one of the claims 1–3~~ 1 or 2, characterised in that the activator is selected from the group consisting of dicarboxylic acids and complexed dicarboxylic acids.
- 20 5. Paste according to ~~any one of the claims 1–4~~ 1 or 2, characterised in that the activator is selected from the group consisting of malonic acid, maleic acid, dimethylmalonic acid, and oxalic acid.
- 25 6. Paste according to ~~any one of the claims 1–5~~ 1 or 2, characterised in that the dispersion medium contains an aliphatic hydrocarbon compound.
7. Method for connecting at least one electronic component to at least one substrate through contact regions, whereby at least one of said contact regions contains a non-noble metal, comprising the steps:
 - 30 (i) providing a substrate having a first contact region and an electronic component having a second contact region, whereby at least one of said contact regions contains a non-noble metal;
 - (ii) providing a paste containing
 - (a) metal particles;

- (b) at least one activator that bears at least two carboxylic acid units in the molecule;
and
- (c) a dispersion medium;