

Cu Paste for Low Temperature Metalization Process

Kosuke Urashima

New Business Development Headquarters,
Tsukuba Research Laboratory

1 Abstract

Printed electronics are expected to be used as environmentally compatible material, because the manufacturing cost is lower and the amount of the metal waste amount is less than the conventional photolithography method. Recently, silver is mainly used as the conductive paste. However, the application of silver paste has been limited to the part of the device, because of the high price and the ion migration in fine wiring. Therefore, the replacement of silver to the cheaper and more reliable copper is expected. We developed a copper paste for low temperature metalization process to be capable of wiring on the resin film.

2 Characteristics of the new product

- Possible to sinter at 150 °C or lower temperature
- Volume resistivity of 17 $\mu\Omega \cdot \text{cm}$
- Possible to form 5 μm thick membranes by screen printing

3 Background of the development

Since 2003, we have been developing the copper oxide that can form a compact copper layer by sintering in a reducing gas atmosphere¹⁾. However, users have been requesting a material that would be much easier to treat and thus some handling issues regarding this copper oxide were pointed out by them. For example, it was the requirement of the atmospheric condition of reducing gas and difficulty to make thicker film. Therefore, we started the development of copper particles in 2013 by focusing on low melting point copper particles which was obtained by reducing mixture of copper carboxylate and amine compound. In 2014, we established the synthesis process of relatively low temperature metalized copper particles by optimizing the mixture composition.

4 Technical details

The appearance of sintered copper membrane samples after screen printing of the developed product on resin film is shown in **Figure 1**. Properties of a metalized layer are shown in **Table 1**. With the application of the copper paste, it is possible to form electric circuits on heat-sensitive materials such as PET film and is expected to be able to apply flexible devices.

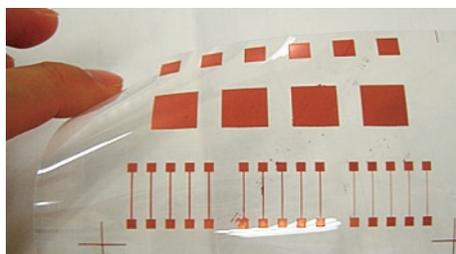


Figure 1 Appearance of Copper Paste after Sintered on Resin Film

Table 1 Cu Paste Properties

Item	Unit	Development product
Thickness of screen printed film after sintering	μm	1~5
Volume resistivity (sintering condition: 140 °C and 1 h, N ₂ gas atmosphere, reduced pressure)	$\mu\Omega \cdot \text{cm}$	17

Our copper particle size is controlled in the sub-micron range (100-200 nm). Generally, the smaller the particle sizes of gold or silver, the lower the melting point. Therefore, nano gold or silver particles can be metalized at lower temperature than the melting point of bulk. In the case of copper particles, however, most of copper particles do not fuse and thus volume resistivity is worse than the sub-micron size as shown in **Figure 2**. We estimate that small copper particles are likely to be oxidized due to increasing surface area and thus less conductive although the melting point might be lower. Since developed copper particles has not only low melting point also oxidation resistance by optimizing particle sizes, it is capable of metalization at low temperature. The conductive membrane made of our copper paste indicates lower volume resistivity after low temperature metalization because the copper particles have appropriate particle size for both features. In the future, we will continue to develop this material and release it on the market of printed electronics.

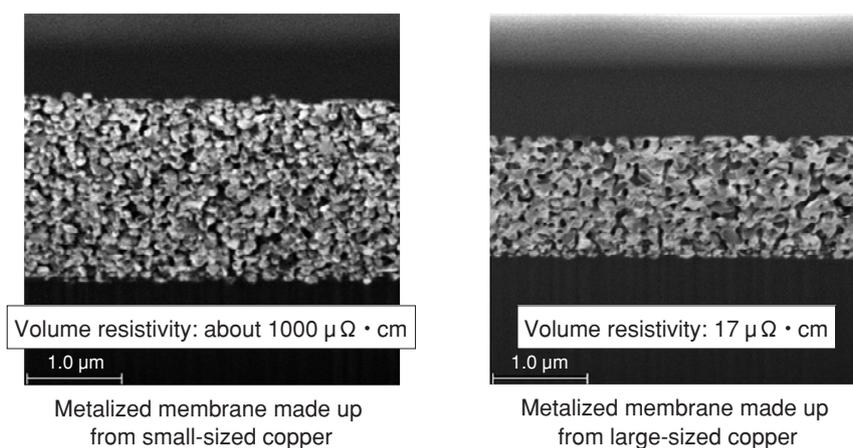


Figure 2 Cross-sectional Images of Cu Paste after Sintered

5 Future Business Development

- Deployment into the market of printed electronics
- Investigation of new applications

[Reference]

- 1) Y. Kumashiro, H. Nakako, K. Kuroda, K. Yamamoto, "Printing Materials for Flexible Electronics Device", Proceedings of International Conference on Electronics Packaging 2010, TB3-1 (2010)