Copprint LF-370 / LF-371

July 2023

Copper Paste for FR4 Photovoltaic cells, and Alumina Substrates

Application Notes

Overview

Copprint LF-370 / LF-371 are solvent-based copper pastes for additive printing of electronic patterns on FR4, Alumina substrates and Photovoltaic cells . Copprint LF-370 / LF-371 contains nano and micro Copper particles, and enables oxidation free, high conductivity copper printing in an air environment, with rapid self-sintering and curing. Copprint copper paste is the highest performance, most sustainable, lowest cost Copper paste suited for manual, semi-automatic or reel-to-reel screen printing applications.

The application notes provide instructions and guidelines for optimal screen printing with Copprint LF-370 / LF-371 including:

1. Storage
2. Screen Printing
3. Drying
4. Sintering
5. Clean Up, Maintenance

Printing guidelines and recommendations

1. Copprint LF-370 / LF-371 Storage

Copprint LF-370 / LF-371 should be stored in a freezer below -10°C. After usage, make sure the jars are well closed including the inner lid and stored back at -10°C or below.

2. Screen Printing

Copprint LF-370 / LF-371 are suited for screen printing on varius substrates.

Before printing take out the jar from the freezer and wait until it naturally warm up to 20°C. Do not heat the jar, as high temperatures will damage the paste. The recommended screen mesh are in the range of 100-200 (metric mesh), NBC-MESH (Japan). Do not mix paste left on the screen after printing with unused paste in the original container. The paste left on the screen should not be used again. Screen printing is based on print-flood procedure.

Close and seal the original container and return to storage at -10°C.

3. Drying

After printing, as the paste is a solvent based paste, a drying step should be carried out. Suitable drying methods could be a conveyor oven, batch oven, IR or NIR radiation etc.
For lab scale testing we recommend the use of a Reflow oven T-961 from Puhui (www.puhuit.com)

The required drying depends on the printing deposition, but should be in the range of 70-120°C for 1 to 3 minutes (a lower temperature requires a longer drying and vice versa).
Attention: Do not over dry the paste, as this will lead to poor conductivity after sintering. See figure below ilustrating what happens in currect drying procedure vs over drying. The paste should be dried to the point that the pattern can be touched with a glove without leaving a stain.

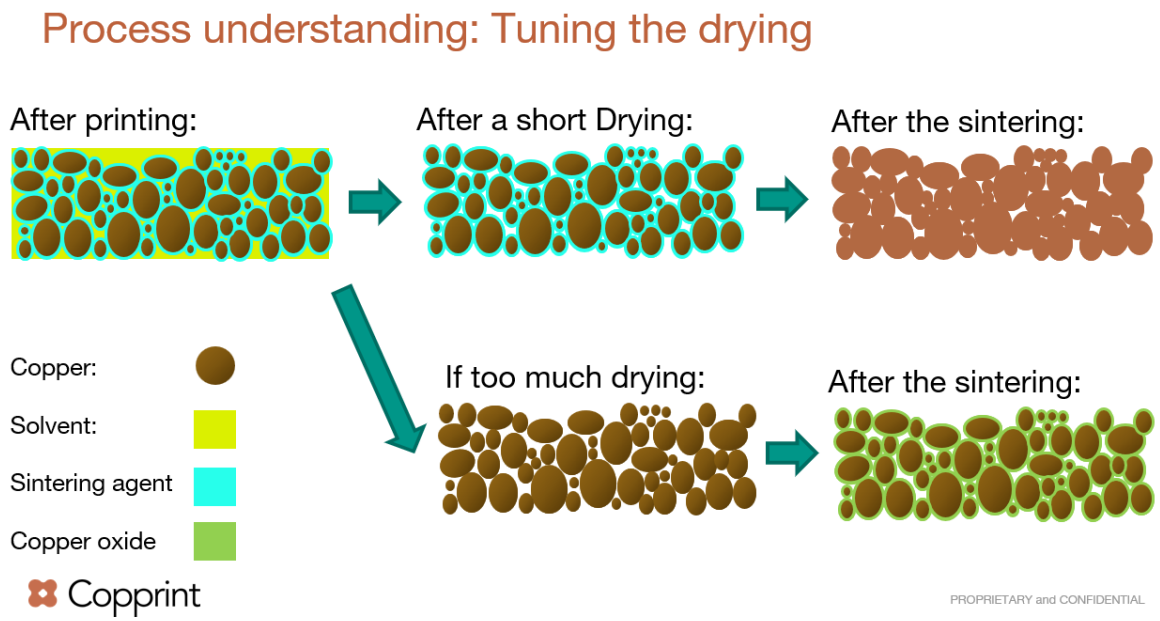


Figure 2
Reflow Oven

The reflow oven is set to enable the following temperature profile (100 C in this module):

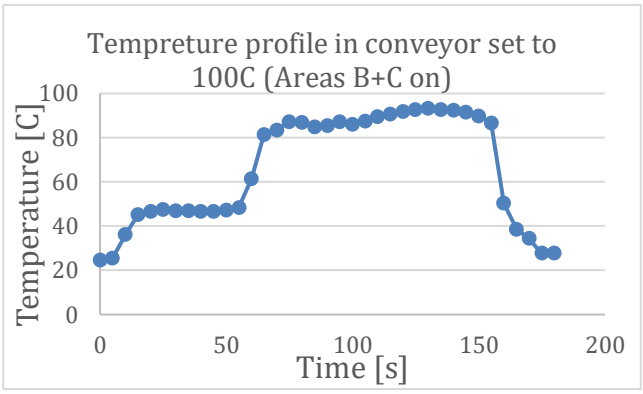


Figure 3. Temperature profile of the single cycle run (reflow oven)

Other manufacturers and drying equipment models may be suitable. Actual settings must be found for each type of equipment, over-drying will harm obtained electrical performance.

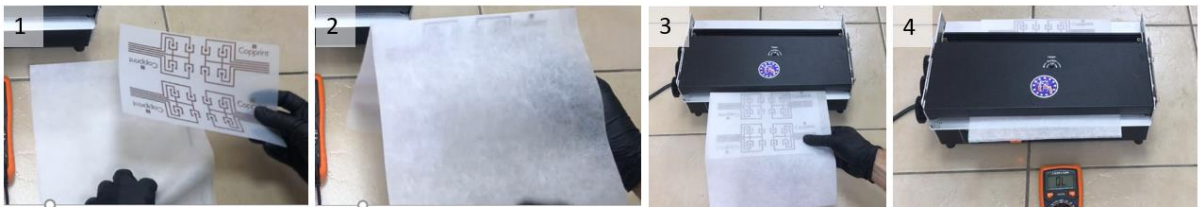
4. Sintering

The dried printed pattern should be sintered within 72 hours after drying, while the best results are obtained within 24 hours after drying. The sintering takes place under ‘snap heating’ (Achieving the desired temperature quickly within a few seconds).In order to obtain that snap heating process we suggest using one of the following techniques:

1. Heat press – For substrates **FR4**, **Alumina**, or **Photovoltaic cells.**
2. Laminator (for high-throughput manufacturing)- For **Photovoltaic cells**

Sintering with lab scale methods should be done when sample is protected from scratches by placing the sample between a folded piece of baking paper / silicon paper (see how-to movies). It is important to use a new sheet of baking paper for each sintering cycle (after the baking paper is heated to high temperature it becomes wrinkled, which if used for another sintering cycle will affect sintering quality of different areas of the sample.

Example Images of sintering in a laminator with protective sheet. 1-2: sample placed in a new folded piece of protective sheet (baking paper / silicon paper) 3-4: sample in holder sintered in the laminator.



4.1 sintering by Heat Press Machine -For substrates **FR4**, **Alumina**, or **Photovoltaic cells**

Recommendation for sintering conditions by a dual heated hot-press (figure 4) differ based on the substrate:

FR4 or **Alumina**: 30 sec @ 270°C (measured temperature).

Photovoltaic cells: 10 sec @ 250°C. (measured temperature).

High pressure is not required, the purpose is to have a close contact of the heating plates and the sintered pattern for fast heating.

We recommend placing the printed pattern in the heat press when it is placed between two sheets of baking paper to prevent scratching and keeping the press clean.

A well sintered sample will have a lighter copperish color, as can be seen in Figure 5.

Figure 4
Heat press machine

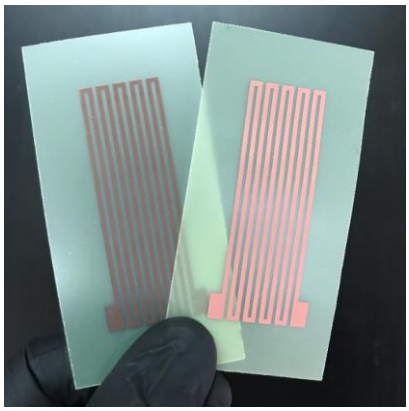


Figure 5
Non sintered (left) and sintered (right) printed pattern

Pneumatic Heat press from China: dual side heating, with large (40X50, 40X60, or 70X50cm) and thick hot-plates, can be purchased directly from one of two manufacturers:

a. http://www.colorking.net/commercial-industrial-grade-oil-extraction-rosin-press-machine-b5-2.html -
contact also via Joseph@color-king.net

b. http://www.auplexheatpress.com/a/products/Press/Dual_Heat_Press/2018/0516/41.html
contact also via sarah@auplexheatpress.com

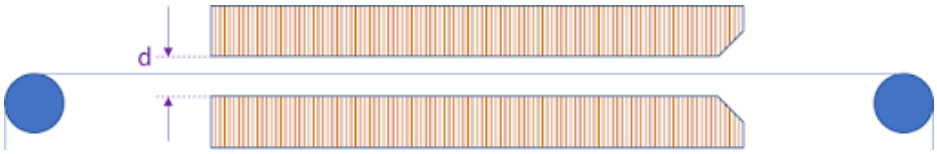
Caution: Always wear oven gloves when handling the heat press

4.2 Sintering for high-throughput manufacturing. For substrate **Photovoltaic cells**

Unlike sintering using a Heat Press machine (which has direct contact with the printed pattern), the sintering processes can be performed via a non-contact approach which can also be applied in reel-to-reel applications.

The non-contact approach is based on two heating plates placed near each other at a distance of d = 0.5-3mm allowing continuous sintering (See Scheme 1).

When designing a non-contact sintering device, the speed and heating plate length will determine the time each printed pattern is exposed to heat. This time should be between 12-15 seconds at temperatures ranging between 250-300 °C degrees centigrade. A longer sintering period will improve electrical performance, the optimal time and temperature depends on the actual machinery set-up.



Scheme 1. Heating plates jig

For lab scale experiments we use an office laminator manufactured by the US compony TLC (contact details below). Even though it is intended for use up to 200C, its temperature can be set to 270-310°C by following our guidelines (a separated detailed file “Modification to TLC laminator”).

For sintering LF371 on Photovoltaic cells we recommend ordering a laminator directly from TLC, with a 5 RPM motor. This laminator enables sintering duration of 12 seconds. (The version sold on Amazon has a faster motor, 14 RPM, resulting in only 5 second sintering time- with this machine a higher sintering temperature is required). The laminator can be ordered with a 220V or 110V electrical connection, they ship worldwide.

Figure 6. TLC-5500 narrow laminator

Figure 7. TLC 6000T wide laminator

Contact details manufacturer TLC:

5 RPM

Mr. P. Luu
Thermal Laminating Corporation (TLC)
USA, IL
Tel: (847)8696010
Fax: (847)8696095
tlcill@aol.com

TLC ships worldwide, please mention that you were referred by Copprint so that they will sell you directly and not refer you to a distributer.

A short movie that demmonstrates all these steps is available online (Handling LF-371 is similar to LF-370): Copprint LF-370 movie.

General notes on sintering (with both methods):

Other commercially available equipment may not work well If the heating process is not uniform. Sintering efficacy can be verified by both resistance measurement and color change of the printed pattern. Dried, printed patterns prior to sintering appear brown; Sintered patterns are orange-pink (Figure 5).

5. Clean Up & Maintenance

After printing screens should be cleaned (within up to 2 hrs.) to avoid copper contamination on the mesh.

Screen cleaning instructions:

1. Wipe off any remaining Copper paste with a paper towel.
2. Wet both sides of the screen with Dowanol DB (CAS 112-34-5) solvent.
3. Gently wipe the screen in a circular motion with a sponge / soft fabric soaked with Dowanol DB. Wipe till remainder of paste is softened (the liquid will turn dark).
4. Wash the screen with tap water. Wet screen areas that have remaining paste with Dowanol DB solvent.
5. Repeat steps 2-4 till the screen is totally clean.
6. Dry the clean screen with paper or dry fabric and leave it to dry.

Disclaimer

Copprint is not responsible for misuse of its products or their use in conjunction with unsafe or improperly maintained equipment or for uses other than intended as specified in this application note.

Product MSDS and Product TDS can be found at Copprint resources.

www.copprint.com