Copprint LF-360

Aug 2023

Nano Copper Paste

For General purpose - Low Temperature Sintering
PET / PC, FR4 and more

Application Notes

Overview

Copprint LF-360 is a solvent-based copper paste for conductive printing of patterns on PET and PC (polycarbonate) substrates. Copprint LF-360 contains nano and micro copper particles, and enables printing oxidation free, highly conductive copper patterns. Processing comprises of three steps: **Printing**, **Drying**, and **Sintering**. Copprint LF-360 can be **printed** by manual, semi-automatic or rotary screen-printing systems. **Drying** is used to evaporate the liquid solvent carrier. **Sintering** forms conductive interactions between the Cu particles and is carried out in a rapid heating step by S2S system (hot press) at 160°C, or R2R system (hot roller) at 170°C without requiring an inert environment.

Recommended substrates:

The table below lists the substrates approved in terms of adhesion and thermal stability under processing conditions. Other types of PET and PC may not be compatible with LF360 and processing conditions.

Substrate	Substrate	Supplier
Polyester (PET)	Elecrom STS H.08 (opaque) Elecrom STS A.00 (transparent)	Polycrome https://www.elecrom.it/
	HSPL 80 HT (opaque)	Coveme https://www.coveme.com/
	Melinex ST505	DuPont Teijin Films http://www.dupontteijinfilms.com/
	AUTOSTAT AHU5/ HT5/CT5	MacDermid Autotype https://industrial.macdermidenthone.com/
	SKC V7610R	SKC, Korea
	Arcophenta TCA 10 2F STE G3, G4, G5, AA STS, Arcophane AA STS	Normandy Coating https://www.normandy-coating.com/en/
Polycarbonate (PC)	CXT LEXAN	Sabic https://sfs.sabic.eu/product/lexan-film/
	Makrofol® DE248 1-1 000000	Covestro

Instructions and guidelines and recommendations for optimal usage of Copprint LF-360:

A complementary short movie that demonstrates the main steps is available online:
https://youtu.be/84CMS0mzRvo

1. Paste storage

Copprint LF-360 should be stored in a freezer at a temperature 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. Paste defrosting before printing

Before printing the paste should be defrosted to room temperature. Remove the paste jar from the freezer and wait until it naturally warms up to 20-25°C. Do not heat the jar, as high temperatures will damage the paste. After defrosting use a paper towel to dry the jar before opening.

3. Screen Printing

Copprint LF-360 is suited for screen printing on PET and PC substrates.

The recommended screen meshes 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.

4. Drying

At this stage we evaporate the liquid solvent from the printed paste. A drying step must 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 around 90°C for 2 minutes.

Attention: There are two temperature sensitive materials in the Cu paste, one of which is an organic solvent that we want to evaporate during the drying step. The second is an additive needed for the sintering step, therefore it is important not to over dry the printed pattern, as this will lead to poor conductivity after sintering. The paste should be dried to the point that the pattern can be touched with a glove without leaving a stain. As a general indication, a drying step at 90°C for 4 minutes, will lead to overdying of the paste, and subsequently to sub optimal performance.

Figure 1
Reflow Oven

5. Sintering

At this stage the printed tracks are transformed to be electrically conductive by thermal heating. In order to obtain conductive tracks with our Cu paste, there are two key elements that must be strictly controlled during sintering:

1. The heating rate must be very fast (we call this “snap heating”, as the desired temperature must quickly be reached within a few seconds). see this illustration of how the heat profile should look, the heating stage is much shorter than the actual sintering time at the desired temperature:

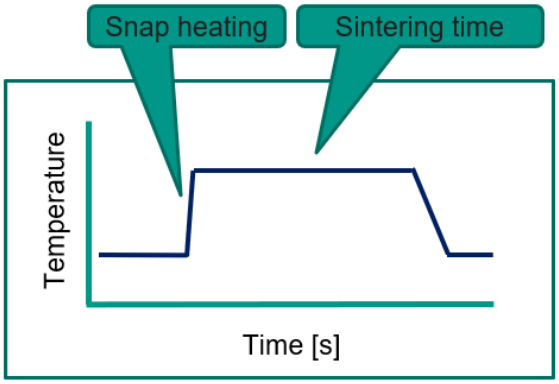


Figure 2: Illustration of snap heating profile.

2. Sintering should be carried out with minimal exposure to oxygen. This is achieved by covering the tracks during the sintering with a cover layer inside a sintering tool like a laminator or a hot press.

In order to perform sintering with the snap heating profile, we recommend using one of two methods:

5.1 Hot press (S2S)

5.2 High-throughput sintering by a hot roller (R2R)

See explanations and vendor info for each of these methods below the notes.

A few general notes relevant to setting with both methods:

Note 1: *this type of very fast heating with minimal exposure to oxygen cannot be achieved with a standard box oven or a hot plate (usually used for sintering / curing of silver inks)*

Note 2: *The dried printed pattern should be sintered within one week after drying, while the best results are obtained within 24 hours after drying.*

Note 3: *Sintering should be done when samples are protected from scratches by placing between a folded piece of baking paper / siliconized paper (see Figure 3 and 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).*

Note 4: *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 3).*

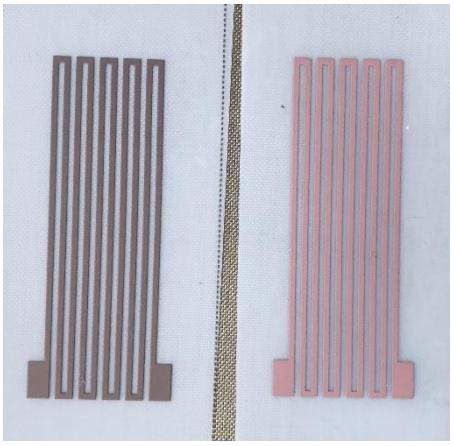


Figure 3
Non sintered (left) and sintered (right) printed pattern on PET

Note 5: *Always wear proper protection gloves when handling the heat press!*

5.1 Sintering with Hot press

There are different heat press machine options that can be used. We recommend using a press with both top and bottom heated surfaces (dual hot plates), operation can be manual (figure 4) or pneumatic (Figure 5).

Figure 4
Manua heat press machine

Figure 5
Pneumatic Heat press machine

Optimal sintering conditions are: 120 sec@ 160°C (actual measured temperature). High pressure is not required, the purpose is to have close contact of the heating plates and the sintered pattern.

Note: *A temperature calibration is needed based on the actual measured temperature. Therefore, please check the temperature between the two hot plates while using a thermocouple, don't rely only on the temperature presented on the device screen.*

5.1.1 Manual hot press

We recommend sintering with this type of hot-press as following:

1. Set the temperature on the hot-press (160C).
2. Check the temperature with a thermocouple in the hot press, after closed for at least one minute.
3. Adjust temperature set-point if needed.
4. Actual sintering: Place the samples (enclosed in baking paper to protect form scratches) inside the hot-press and close for 2min.

We recommend two manual heat press modules:

EU option: Happy Press 4 (must be ordered with the optional heated base plate) German store UK store. https://www.happyfabric.de/contact , kontakt@happyfabric.de

US option: Geo Knight & Co Inc. DC16AP Top part + DCA-1416BHT Bottom part .
Geo Knight & Co Inc. 52 Perkins St. Brockton MA 02302

Toll Free: (800) 525-6766, Local: (508) 588-0186, Fax: (508) 587-5108, Email: info@heatpress.com

5.1.2 Pneumatic hot-press

a. Pneumatic hot press with various dimensions (40X50, 40X60, or 70X50cm) can be ordered from: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

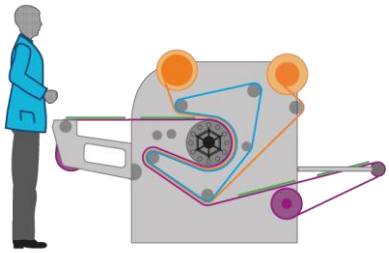
5.2 Sintering by a hot roller

Sintering by hot roller can be carried out in S2S or R2R fashion.

S2S sintering by the Vertex system.

The Vertex system by Klieverik provides an excellent solution for automatic sintering for small and medium scale production. As seen in the schemes below, the printed sheets are driven between the hot drum and the belt. The contact (heating) is 30-40 sec and the drum temperature 170°C.

For more information: Klieverik Vertex for Copper sintering - YouTube



R2R sintering by Klieverik system.

For large scale sintering, we recommend using a hot roller machine. As seen in the schemes below, the printed roll is driven between the hot drum and the belt. The contact (heating) time is 15-20 sec and the drum temperature 170-190°C.

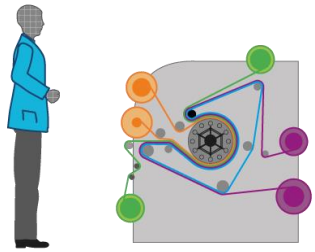


Figure 5: Schemes of Klieverik R2R system

For more information about using the hot roller system for sintering Copprint Paste please contact us.
For more information on the system please contact Klieverik:
Klieverik, Edisonstraat 8, 7575 AT Oldenzaal, Netherland. +31 639216923
johan.Schenke@klieverik.com

6. Relaxation

In order to get the best results in terms of adhesion and flexibility, sintered samples must go through a relaxation stage, by heating to a temperature of 140C for 2-3 minutes (110C for PC substrate). We recommend using the same conveyor oven as used for the drying.

7. 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 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, Product TDS can be found at Copprint resources.

www.copprint.com