

Copprint LF-300

Updated March 2023

Nano Copper Paste for Paper Substrates Application Notes



Overview

Copprint LF-300 is a solvent-based copper paste for additive printing of electronic patterns on paper substrates. Copprint LF-300 contains Nano Copper particles, and enables oxidation free, high conductivity copper printing in an air environment, with rapid self-sintering and curing at 270°C. Copprint LF-300 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-300 including:

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

Printing guidelines and recommendations

1. Copprint LF-300 Storage

Copprint LF-300 should be stored below -10°C. Mix the paste in the original container before printing using a paste mixer (Figure 1) - Eg. ZB500S, solder paste mixer, 15min at 300rpm, or manually until homogeneous in composition throughout.



Figure 1
ZB500S, solder paste mixer

2. Screen Printing

Copprint LF-300 is suited for screen printing on paper substrates.

Pour the requisite volume of paste needed for printing to a new container and verify that it reaches room temperature before printing.

Select your desired screen mesh. The mesh defines the printed pattern layer thickness and pattern resolution. We recommend printing using a screen mesh of 100-150, NBC-MESH (Japan) UX100/040- UX 150/40.

Recommended substrate:

Substrate	Name	Supplier	Notes
Paper	ProPoint™	Pixelle www.pixelle.com	Print on glossy side. Optimal thermal resistance. Good adhesion properties.
	CraftPoint™ Reflections #60		
	FINESSE SILK, "Paper G"	UPM https://www.upm.com/	
	Digi Finesse gloss		
	Supercoat SW80	Mitsubishi https://www.mpm.co.jp/eng/	
	CP 578- 081 1B S03052	Monadnock https://mpm.com/	
	C4528-058 Envi PC 100 EB Label		
	C2218-085 Duraprint 7 Smooth 5 pt.		
	Novapress Silk 80 and 100 gsm	Stora Enso https://www.storaenso.com/	

Other types of paper may be compatible with LF300 and processing conditions, we suggest comparing performance on any new substrate with performance on a recommended substrate.

Do not return any unused paste to the original container. Close and seal the original container and return to storage at -10°C.

3. Drying

After printing, dry the pattern immediately. Drying in a conveyor belt oven with hot air is recommended. For lab scale testing we use a Reflow oven T-961 from Puhui (www.puhuit.com)



Figure 2
Reflow Oven

The reflow oven is set to enable the following temperature profile (90C in this module):

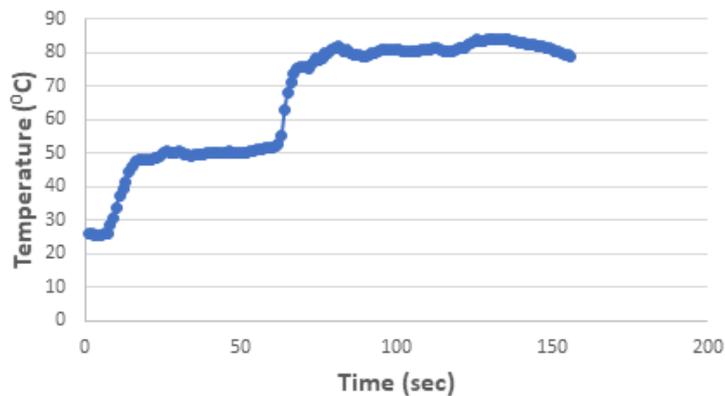


Figure 3. Temperature profile of the single cycle run (reflow oven)

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. The sintering process is based on thermal heating in air environment. No inert atmosphere (like nitrogen) is required.

The sintering takes place under 'snap heating' (Achieving the desired temperature quickly in a few seconds).

In order to obtain that snap heating process, we suggest using one of the following techniques:

1. Heat press
2. Laminator (for high-throughput manufacturing)

Sintering with lab scale methods should be done when sample is protected from scratches by placing 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

Optimal sintering conditions by a dual heated hot-press (figure 4) are: 30 sec@ 270°C (measured temperature). High pressure is not required, the purpose is to have a close contact of the heating plates and the sintered pattern.

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
Hot Press machine

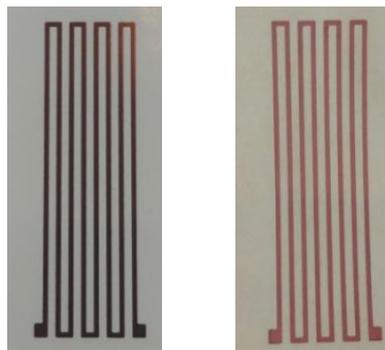


Figure 5
Non sintered (left) and sintered (right) printed pattern

A large hot-press can be purchased directly from one of two manufacturers:

COLOR KING (this is the one shown in the movie)

<http://www.color-king.net/product.php?id=995>

Contact: Joseph@color-king.net

AUPLEX

http://www.auplexheatpress.com/a/products/Press/Dual_Heat_Press/2018/0516/41.html

contact: sarah@auplexheatpress.com

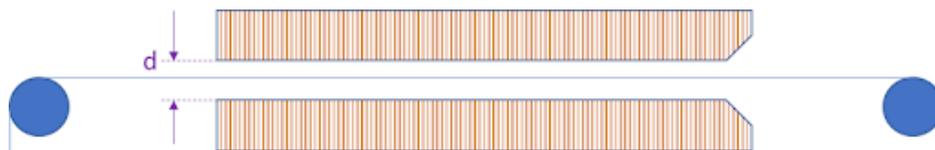
Caution: Always wear oven gloves when handling the heat press

4.2 Sintering for high-throughput manufacturing

Unlike sintering using a Hot 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 $d = 0.5\text{-}3\text{mm}$ 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 3-8 seconds at temperatures ranging between 270-310°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 company 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”). [Watch Copprint Sintering Video using a laminator.](#)

Several versions are available at different sizes. A 220V version can be ordered directly from TLC, they ship world wide.



Figure 6. TLC-5500 narrow laminator

https://www.amazon.com/gp/product/B00851HP18/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1



Figure 7. TLC 6000T wide laminator

https://www.amazon.com/6000T-Thermometer-Thermal-Laminating-Corp/dp/B0019WQ232/ref=sr_1_6?keywords=tlc+pouch+laminator&qid=1580296193&sr=8-6

A 220V version can be ordered directly from the manufacturer TLC:

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 distributor.

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).

Reel-to-Reel Screen Printing

Reel-to-reel screen printing solution can be proposed for large format printing jobs, i.e. Antenna Printing Solution - APS Muhlbauer machine (Figure 8) which is already commercially available system. In particular, the APS Muhlbauer machine provides the whole solution for the customer including screen printing module, drying and sintering module, and paper winder/rewinder. *Watch APS movie for printing NFC antennas and chip assembly.*



Figure 8. APS Muhlbauer machine

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 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