ROTO-PRINTING OF ELECTRICALLY CONDUCTIVE LAYERS ON FLEXIBLE SUBSTRATES

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Abstract

The present work is focused on the development of printed electrically conductive layers on flexible polymeric substrates using large-area printing processes. For this purpose we chose the roto-printer, Testacolor 171 from Norbert Schläfli Maschinen, configured to process Screen, Gravure and Flexography printing. At first, we tested the Gravure printing of silver as a conductive layer on plastic substrates (PET). We have evaluated the printing of fine and thin patterns. Later on, we worked on the Screen printing of silver and copper layers on PET and paper. In this case, we have printed and characterized different types of patterns to evaluate the possibility of using the roto-screen printing for different applications. …

Roto-printer

Technical data
- Printing size: 120 x 130 mm
- Ink amount per print: ~ 1-2mL
- Doctor blade pressure: adjustable
- Doctor blade position: adjustable
- Printing speed: max 35 m/min
- Opto-mechanical alignment < 20 µm

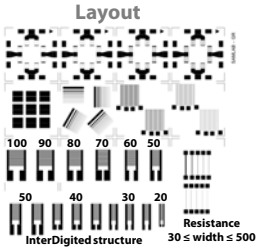
Typical data	FLEXOGRAPHY	GRAVURE	SCREEN
Lateral resolution (µm)	>30	>20	>60
Thickness (µm)	0.5-8	0.1-5	3-25
Ink viscosity (mPa.s)	50-500	10-200	1000-100000
Line edge straightness	Medium	Bad	Medium

For our applications we chose to work with Gravure and Screen techniques and particularly with the Screen printing technique. The Gravure printing is still under development.

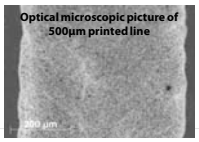
Gravure printing

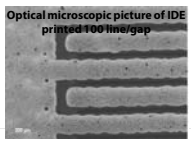
Some tests of Gravure printing were performed to evaluate the printing of small patterns (InterDigitated, resistances) with a line width between 20 and 100 µm.

Layout



Parameters
- **Ink:** Silver / InkTec – TEC-PR-020 40 wt% - η =145 cP
- **Substrate:** PET – 125 µm
- 1 layer
- **Speed:** 30 m/min
- **Curing:** Oven 130°C/15 min





Typical data	
Thickness (nm)	130
Roughness (µm)	0.03
Resistivity (µΩ·cm)	20

Line width (µm)					
Pattern	30	50	100	250	500
Printed	93	110	140	300	550
Difference	63	60	40	50	50

- Thickness less than expected
- Roughness: good
- Good reproduction of the pattern
- Spreading effect

➔➔ Optimization in progress

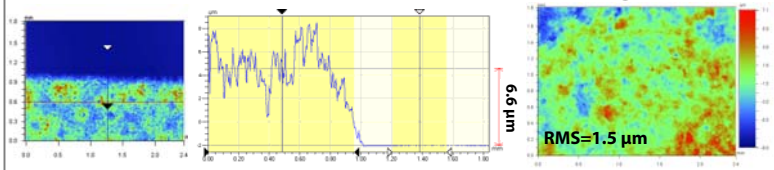
Roto-Screen Printing

With roto-screen printing we are able to print electrically conductive layers in several types of patterns and structures on polymeric substrates. We worked mainly with silver paste but we also developed this technique to print copper layers.

Parameters
- **Ink:** Silver, Dupont 5064H - Microparticles
- **Substrate:** PET – 125 µm
- 1 layer
- **Curing:** Oven 130°C/30 min
- **Stencil:** Polyester – 200 mesh - Gallus

Typical data	
Thickness (µm)	6
Roughness (µm)	1.5
Resistivity (µΩ·cm)	30
Reproducibility	+

Thickness **Roughness**

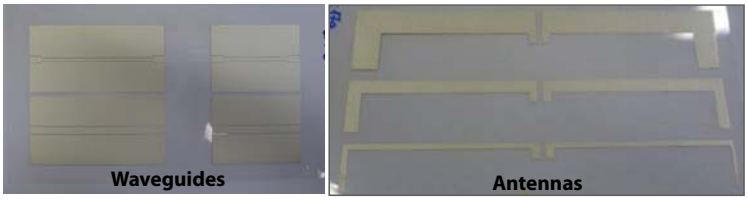


The thickness and roughness are measured by using an inteferometric profilometer (WYKO)

➔ Thickness = 6-7 µm with 1 layer

➔ Roughness = 1.5 µm ➔ Medium roughness due to flake particles

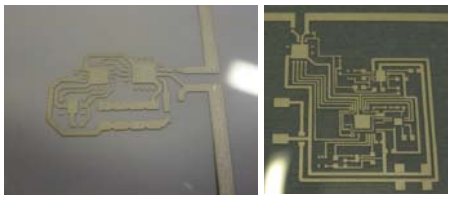
Large structures



➔ Large patterns: homogeneous

➔ 250 µm gaps well defined witouht short circuits

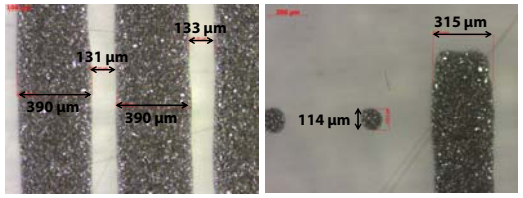
Printed Circuit Board



➔ Simple and complicated design well defined

➔ Respect of the designed dimensions

Design and Resolution



The design and resolution are controlled under microscope (objx5)

➔ Line width resolution ≥ 150 µm

➔ Line edge straightness: Medium

➔ Square pattern resolution ≥ 100 µm

➔ Minimal Gaps ~ 130 µm

Adhesion

The adhesion is evaluated by using a simple scotch test ➔➔ Very good adhesion

Copper screen printing

- **Ink:** CuO - Metalon® ICI-021-NovaCentrix
- **Substrate:** PET - 125 µm or Paper
- **Layer:** 1

PAPER

PET

Typical data	
Thickness (µm)	15
Roughness (µm)	3
Resistivity (µΩ·cm)	100

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