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Advanced Printed Electronics laboratory exercise: Screen-printing.

Purpose of the exercise: Students will learn basics of the screen printing process, needed accessories and how the critical printing parameters affect the print quality. Students will also learn the basic design rules for the process. Students analysing how the printing parameters are affect for the quality of the print.

Exercise execution: Short theory, practical printing exercises, two layers using two different inks. Every team will analysing the results of the printing and return the written report.

1) Ink selection

Ink manufacturer part number?

Material safety datasheet and technical datasheet are in a folder on the table.

Check from the datasheet, what is the drying temperature for the inks?

2) Substrate selection

Kernoprint PET, 135 µm? Walox FR1 PBT 250 µm?

3) Screen selection

Check the PrinLab item code for the screen?

What is the mesh manufacturer part number and TIV?

What are the methods for the screen condition check?

4) Needed accessories for the print process

List accessories, which are needed to the printing process?

5) Select the squeegee type, rubber hardness (shore A) and is the flood squeegee needed?

Squeegee?

Shore value of the squeegee rubber?

What are the benefits of using flood blade?

6) Install the screen into the Ekra E2 device

7) Turn the Ekra system on and set the printing parameters

Open the job file, name is APE group x.

Install the substrate onto the vacuum table and set the snap-off distance

Install the flood blade and set the moving parameters (print from? speed?)

Install the squeegee blade and set the moving parameters (print to? pressure? speed?)

Make the first test drive without ink, do not activate the squeegee down button

8) Prepare the ink

Open the ink jar carefully

Mix the ink using glass stick

What is the grindometer?

9) Substrate preparation and cleaning

Clean up the substrate, use isopropanol and cleanroom wipes

10) Printing

Install the substrate onto the vacuum table

Install the ink onto the top of the screen

Make the first test print (if this is second material, teach an alignment marks for the cameras)

Printing:

- Keep the constant pressure and change the snap-off four times
- Keep the constant snap-off and change the pressure four times

Put the printed sheets into the oven (check time and temperature)

Close the ink jar

11) Clean up the screen, the squeegees and other accessories

Calculate theoretical dry- and wet thickness. Screen parameters you find from the folder on the table. See an appendix 1 and 2.

Most critical things are TIV of the mesh, emulsion relevancy, viscosity relevancy and width of the screen pattern opening.

1. Find the screen BVPxx theoretical ink volume (TIV) from the mesh datasheet.

   TIV = cm^3/m^2 = µm (about)

2. Find the thickness of the emulsion value for the above-mentioned screen.

   thickness of the emulsion = µm

3. Width of the working electrode opening on the screen is about 3 mm. Look from the appendix 1 table, what is the pattern opening relevancy to total wet thickness.

   emulsion relevancy for the total wet thickness = µm

   (emulsion thickness minus table 1 value)

4. Medium viscosity ink release from the mesh about 2/3 (appendix 1, table 2) and the total ink volume (TIV) is known. Determine the relevancy of the viscosity? (2/3 of TIV)!

   Viscosity relevancy= cm^3/m^2

5. What is the theoretical wet thickness? (emulsion relevancy for the total wet thickness + ink viscosity relevancy)

   wet thickness= µm

6. Printing ink consist of particles, solvents, binders etc. From the datasheet you can find the solid content for the ink (%). Calculate theoretical dry thickness after drying?

   dry thickness= µm

Appendix 1. Emulsion and viscosity affects for the total line thickness

Table 1. Emulsion relevancy.

Width of the pattern openings	Relevancy for the total thickness of the print line
< 2 mm	100 %
2–5 mm	67 %
5–10 mm	33 %
> 10 mm	0 %

(Practical quide to screen printing in printed electronics, 2019)

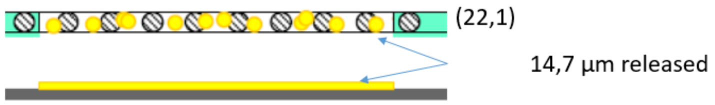
Table 2. Viscosity relevancy.

An estimate is that:

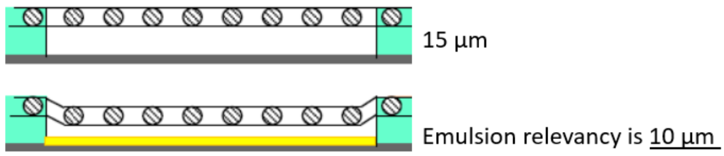
- Very viscous ink, about ½ will release from the mesh
- Medium viscosity ink, 2/3 will release
- Water-like inks, ¾ release

Appendix 2. Theoretical wet and dry thickness determination example

- TIV is 22,1 cm3/m2 (from data)
- Paste is medium viscosity so 2/3 releasing from the mesh



- Emulsion is 15 µm thick and the pattern line width is 4 mm, so emulsion relevancy is 67%. (appendix 1, table 1)



- Total wet thickness is:

- solid content of the ink is 40%, so:
    - Dry thickness is 9,90 µm