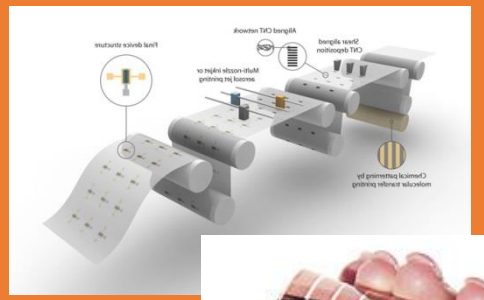
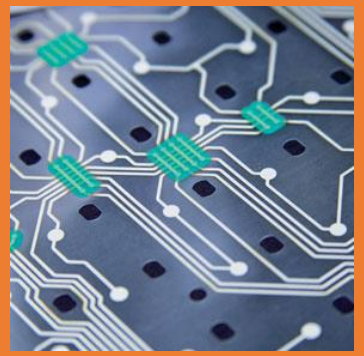
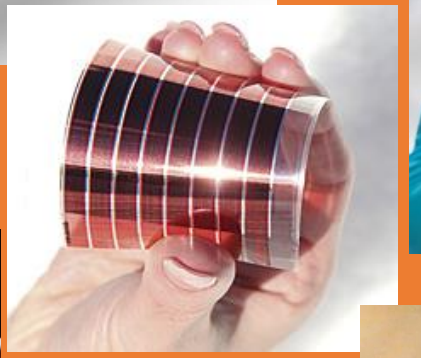
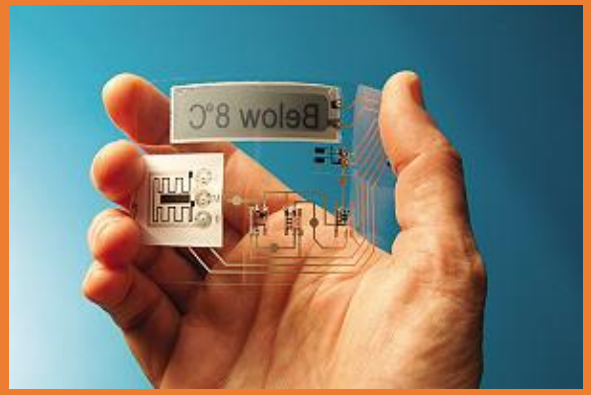
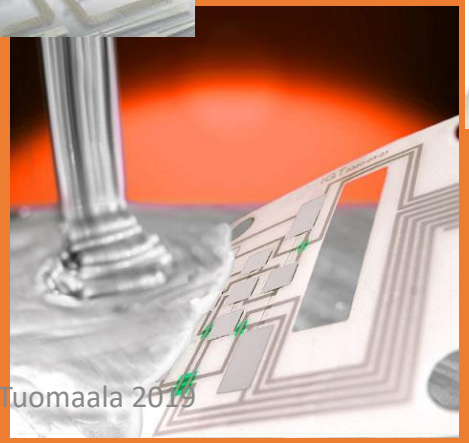

source: J. Van den Brand, Holst Centre/TNO

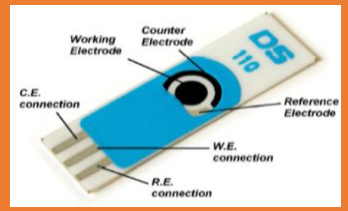


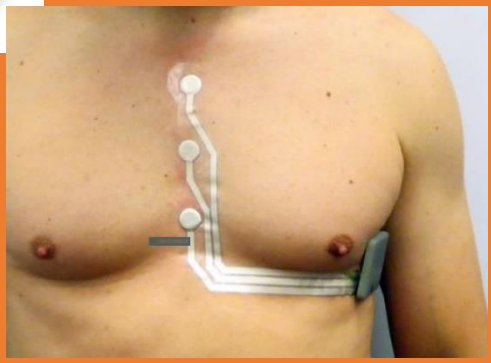









Working Electrode
Counter Electrode
C.E. connection
Reference Electrode
W.E. connection
R.E. connection



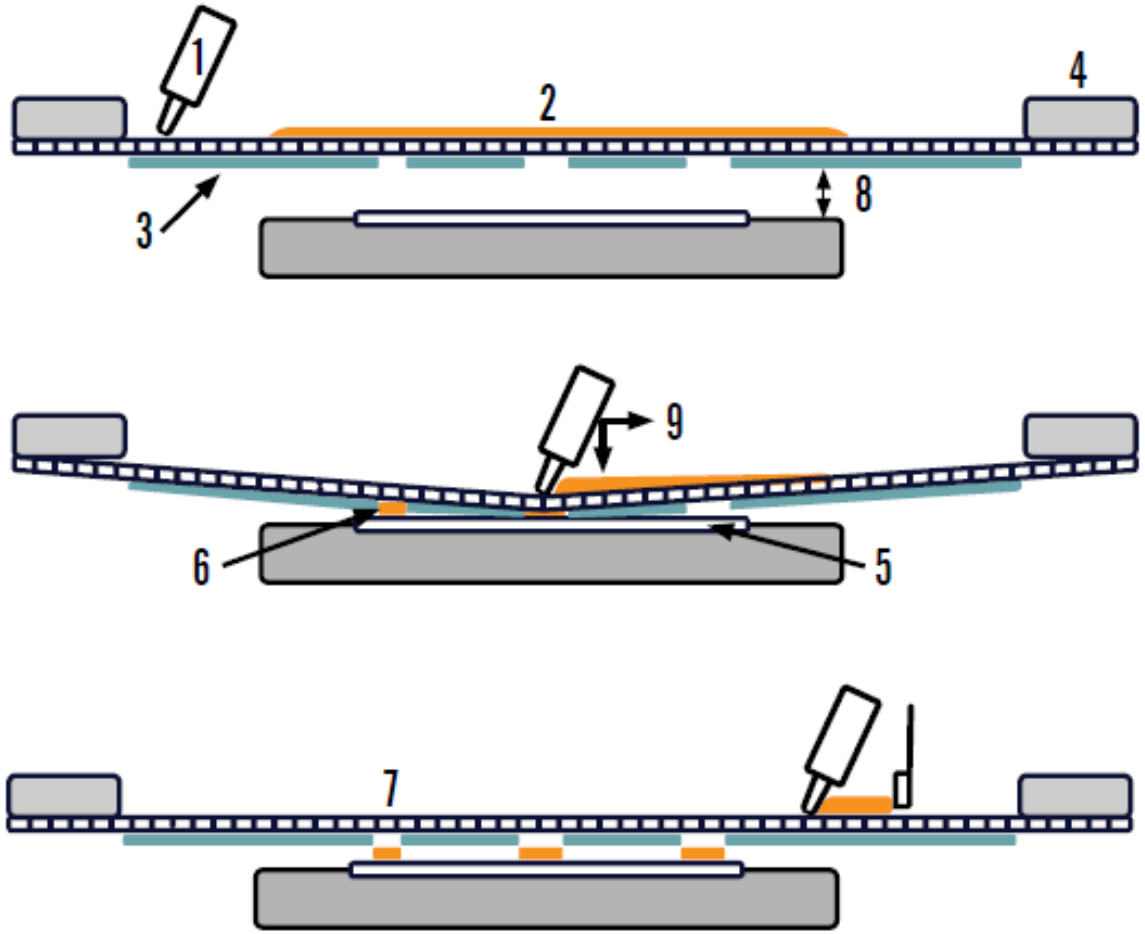
Contents

- Basics of the screen printing process
- Mesh variables and structures
- Process parameters
- Squeegee
- Emulsion
- Basics of the inks
- Design rules of the screen
- Preparation of the printing process

Basics of the screen printing process

Tomi Tuomaala 2019

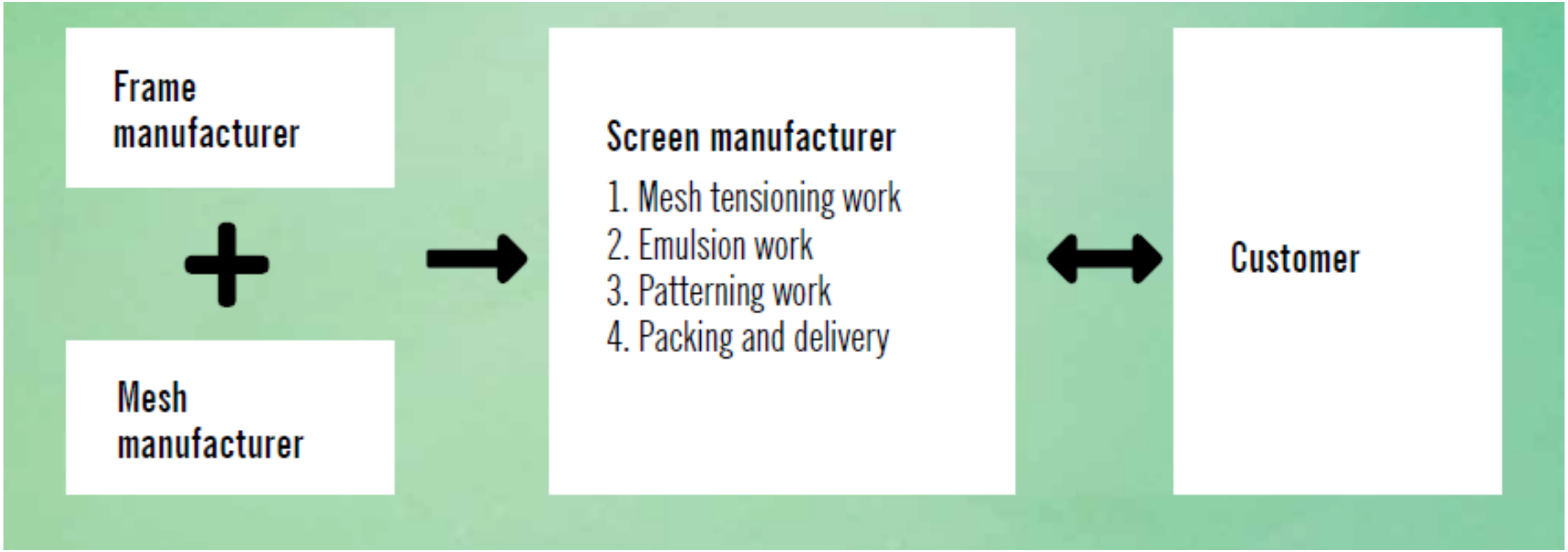
Screen printing process



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

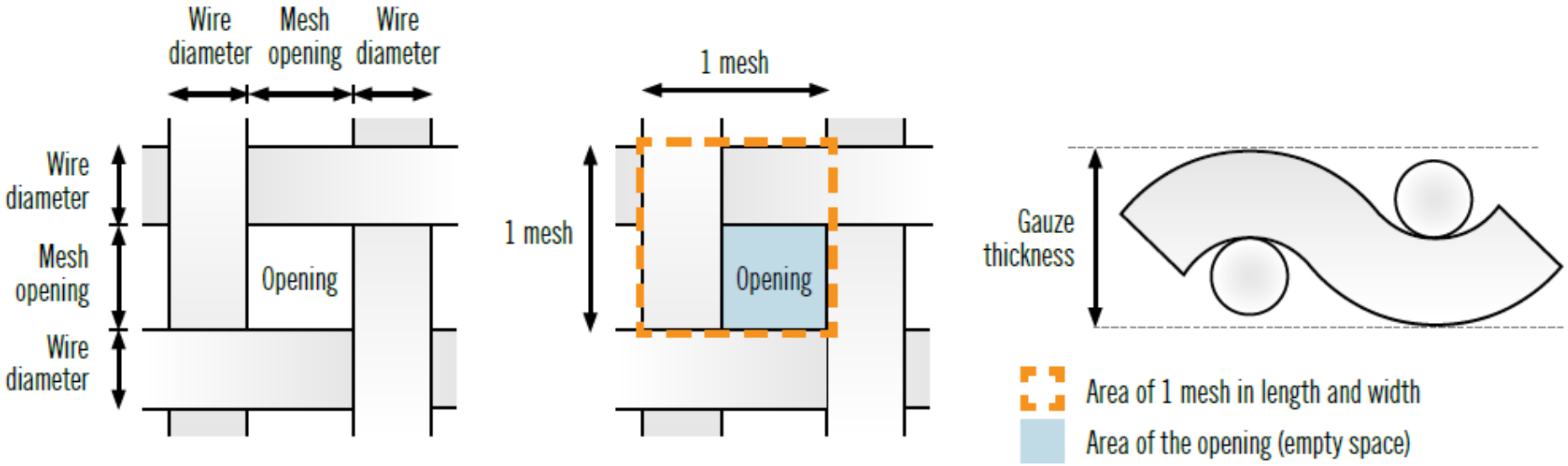
1 Printing squeegee
2 Ink
3 Emulsified screen fabric
4 Screen frame
5 Substrate
6 Through the screen transferred ink
7 Emulsion open area (the specified layout)
8 Distance between the screen and substrate (snap-off)
9 The forces acting on the ink

Steps of the Screen Manufacturing Process

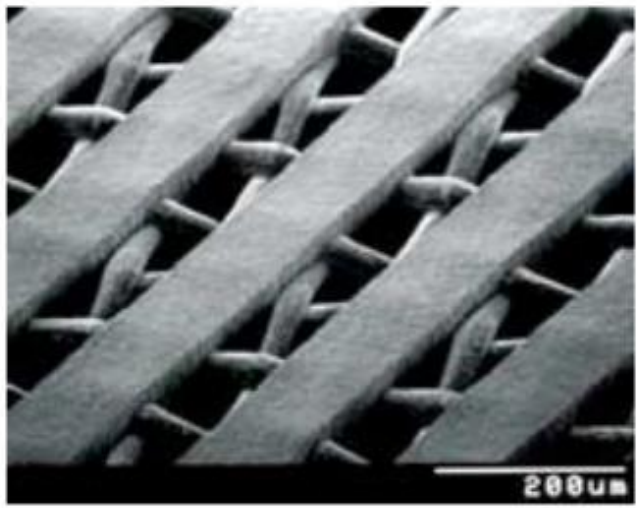


(Practical quide to screen printing in printed electronics, 2019)

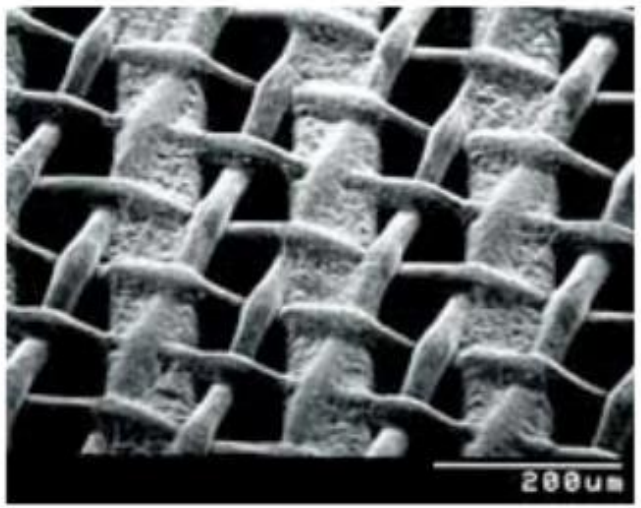
Mesh variables and structures



(Hobby, A. 1997. Screen printing for the industrial user)



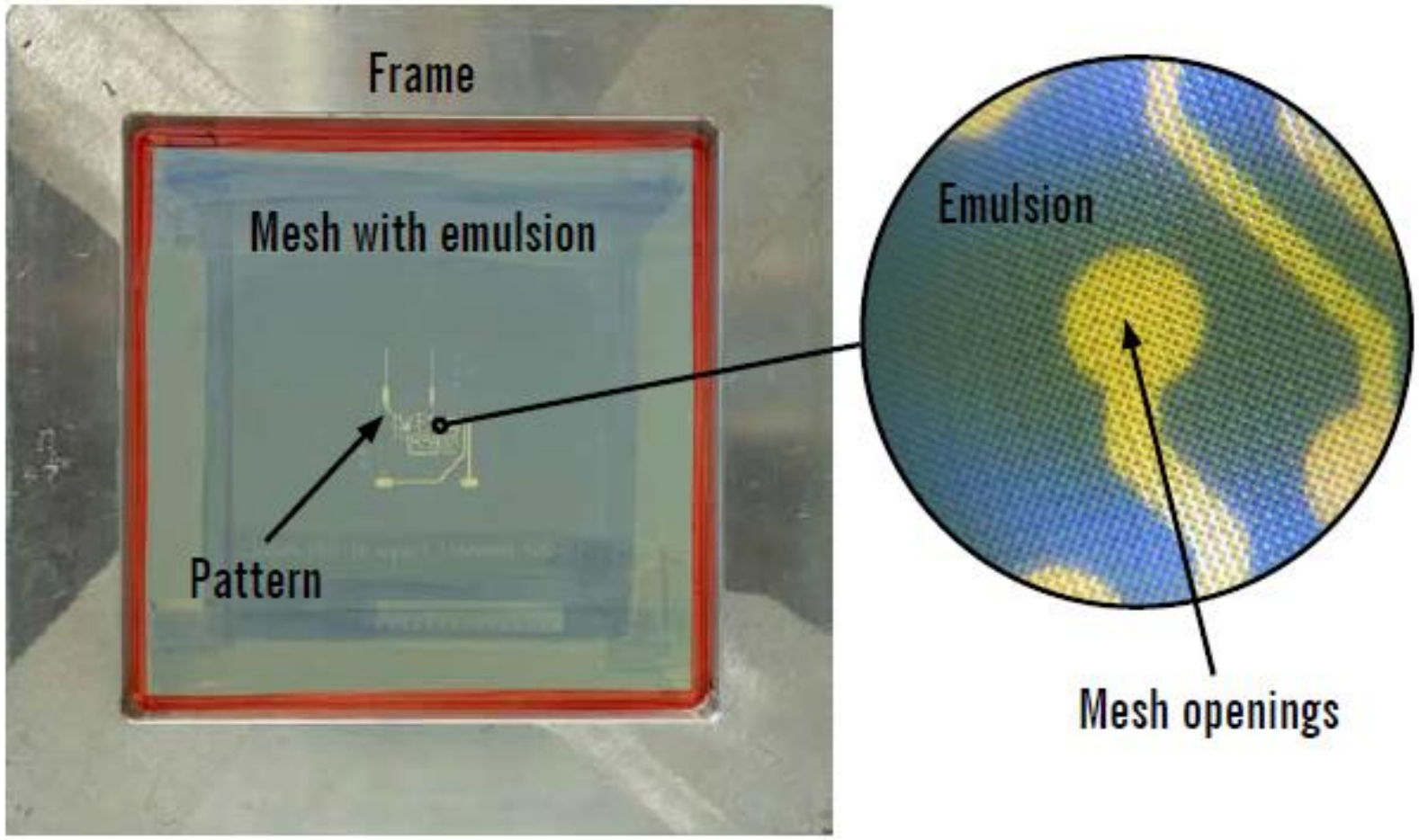
Printing side x150



Squeegee side x150

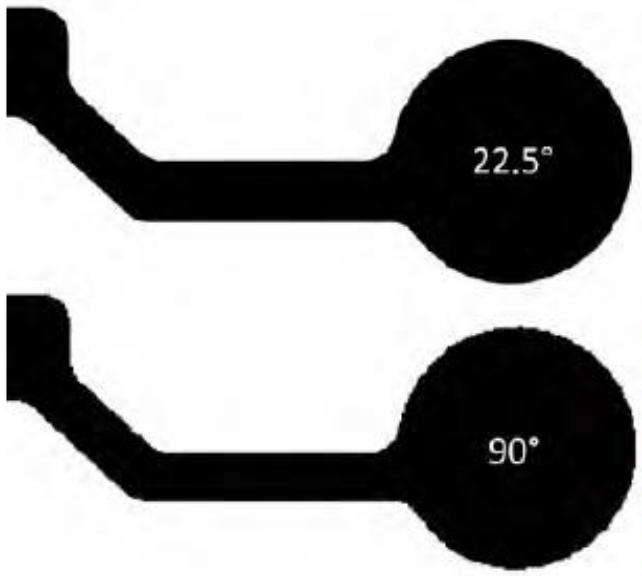
(NBC meshtech.2017)

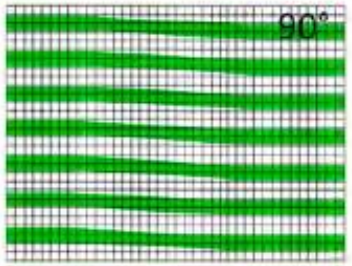
Screen: frame, mesh and emulsion



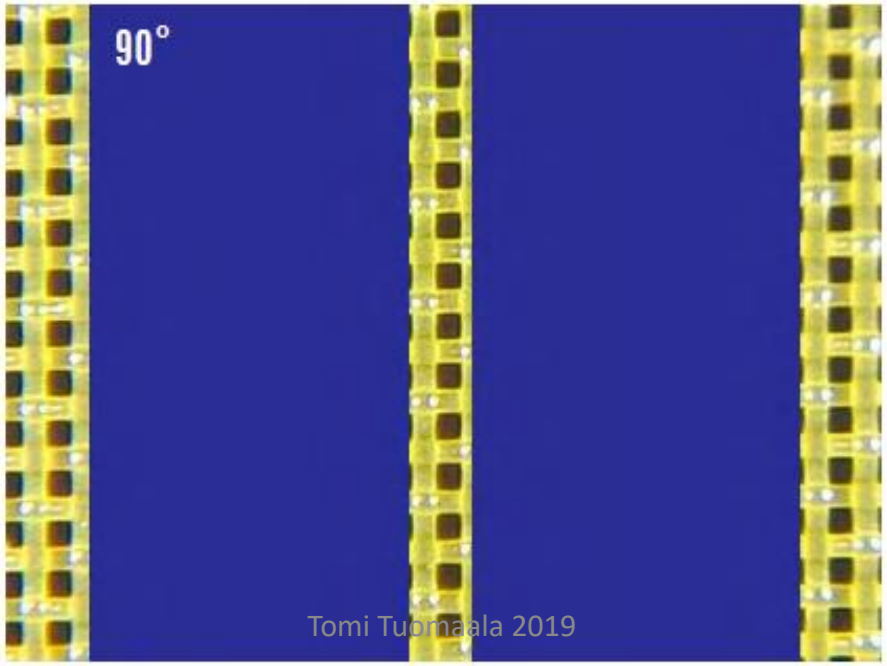
(Practical quide to screen printing in printed electronics, 2019)

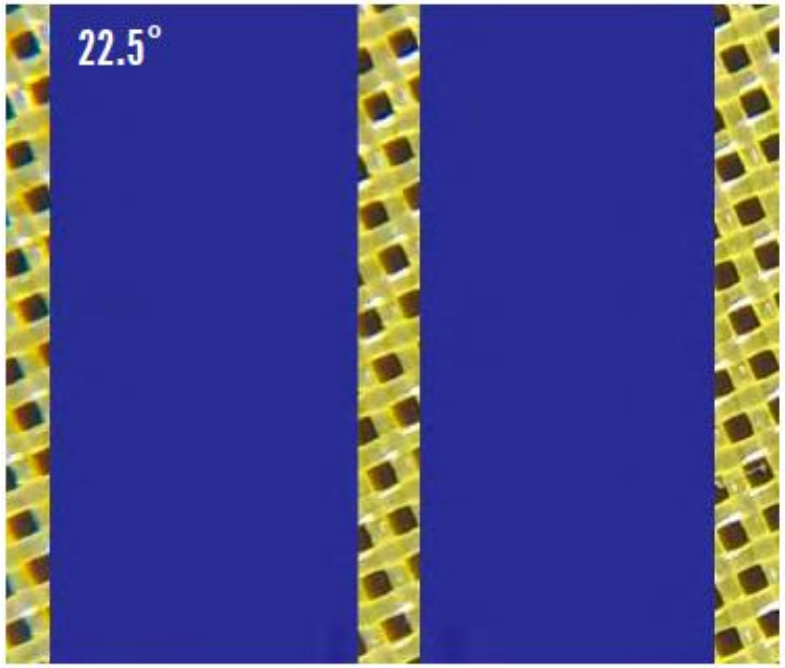
Mesh angle



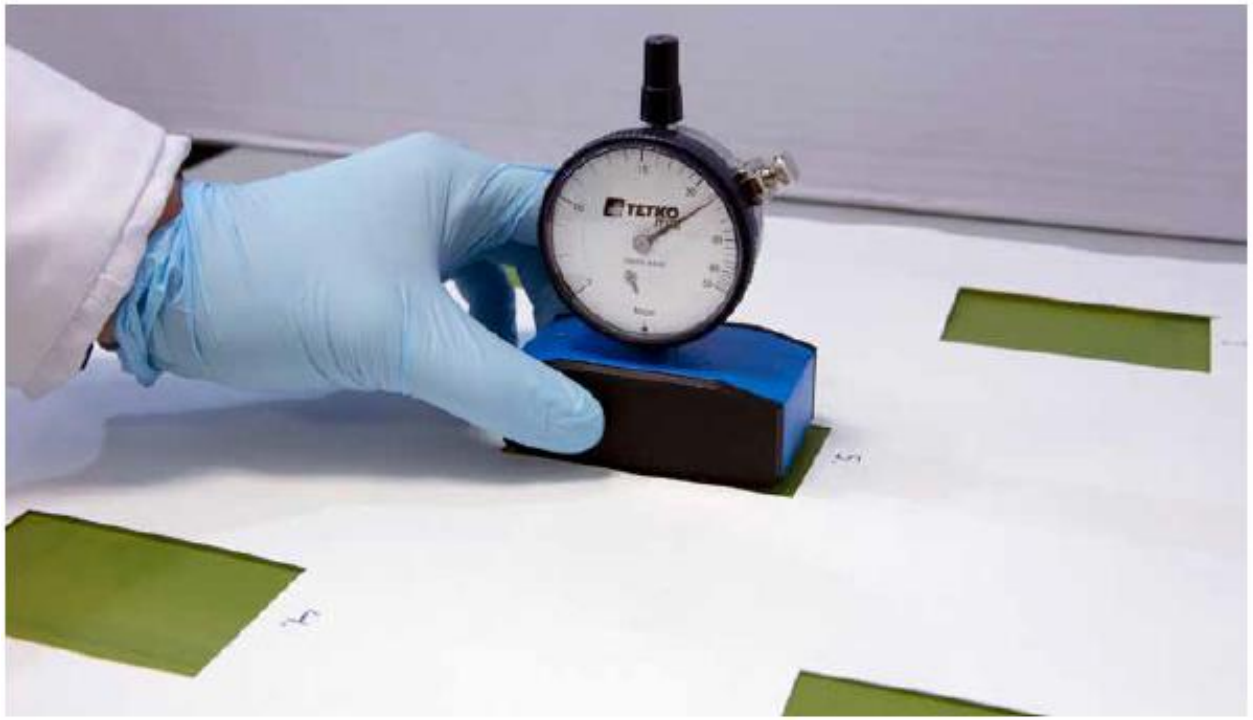


(Practical quide to screen printing in printed electronics, 2019)





Mesh tension, 18-50 N/cm



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

Process parameters

Process parameters and main screen printing variables

Printing equipment
- accuracy
- repeatability
- registration system
- automation
- parameter control
- substrate attachment
- speed

Ambient conditions
- cleanliness
- temperature
- humidity

Printing process
- squeegee pressure
- squeegee angle and speed
- print direction vs. image
- snap-off
- amount of ink on screen
- flood squeegee

Substrate
- material
- cleanliness
- surface energy
- roughness

Printing screen
- mesh count (tpi)
- thread diameter
- mesh thickness
- open area %
- mesh material
- mesh weave
- mesh angle
- emulsion thickness
- mesh tension
- image size
- frame size and material

Printing squeegee
- material
- hardness
- shape
- size

Printing ink
- rheology (viscosity)
- shear resistance
- particle size
- solid content
- homogeneity
- compatibility with emulsion and substrate
- solvent or water based

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

Distance between screen and substrate (Snap-off)

Usually snap-off distance is about 1,5 – 3 mm from the substrate but set it as near as possible
Lower tension screens needs higher snap-off distance

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

Squeegee speed and pressure

Squeegee speed can vary between 150 mm/s to 25 mm/s
Pressure as low as possible, usually 0,8 -1,2 bar

Correlation of the speed, ink viscosity and pressure

- Higher speed – less pressure
- Less speed – less pressure
- High viscosity – lower speed
- Low viscosity – higher speed

Squeegee

Different squeegee shapes

Rectangle

is widely applicable for different substrates, inks, generally used in graphics and textiles, also usable in printed intelligence.

Diamond

is a good blade for very accurate printing llines. It is popular in printed intelligence processes and in stencil printing.

S-cut

is used for uneven or irregular substrates.

Bull nose

is used for textile printings. It has maximum color transfer.

D-cut

is used for glass or plastic cylinder-shaped surfaces, including textiles.

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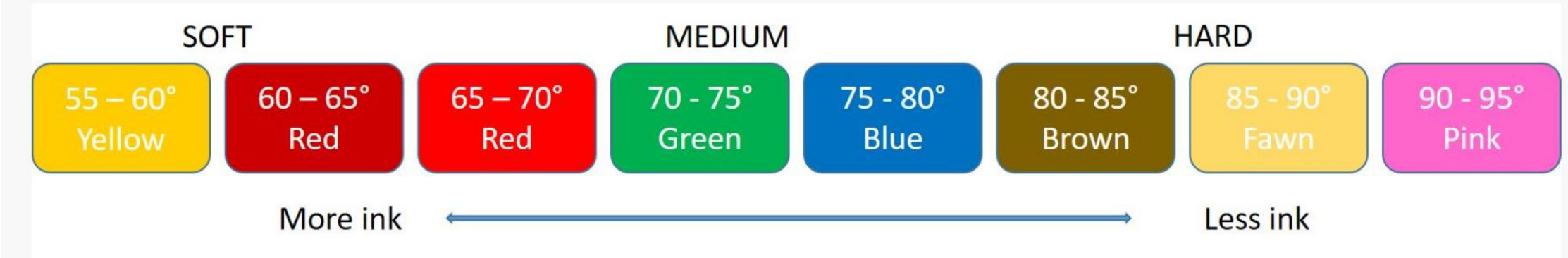

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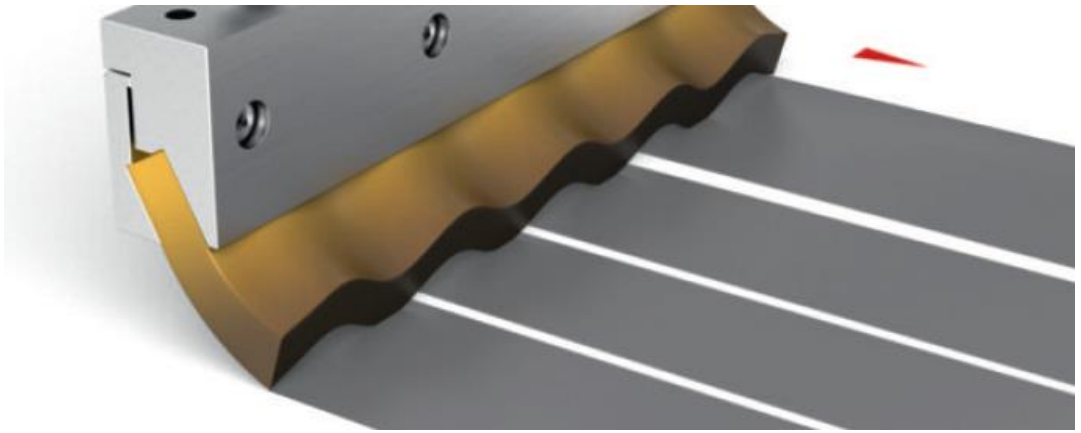
Difference between a basic Rectangular Blade and RKS Carbon S HQ Blade



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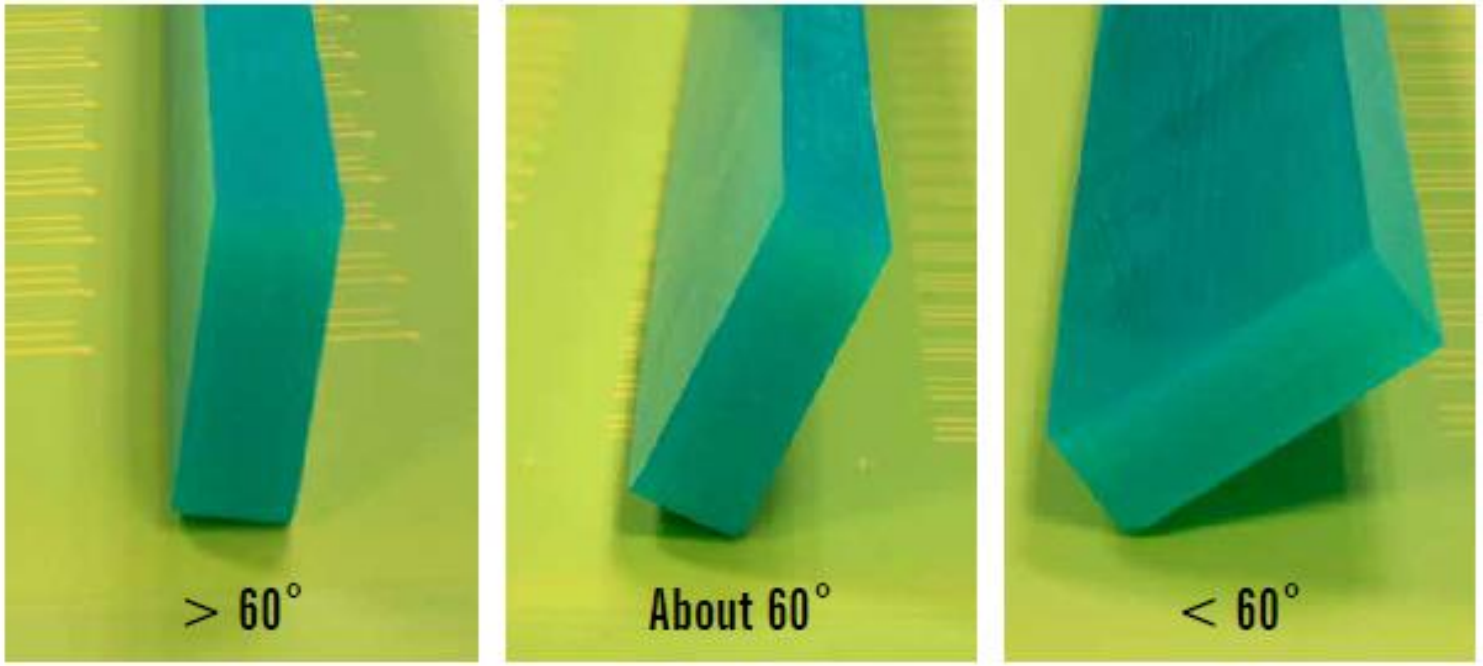
Squeegee angle and size



Poor filling, good clearance.

Good filling and clearance.

Smaller angle giving poor clearance, but good filling.

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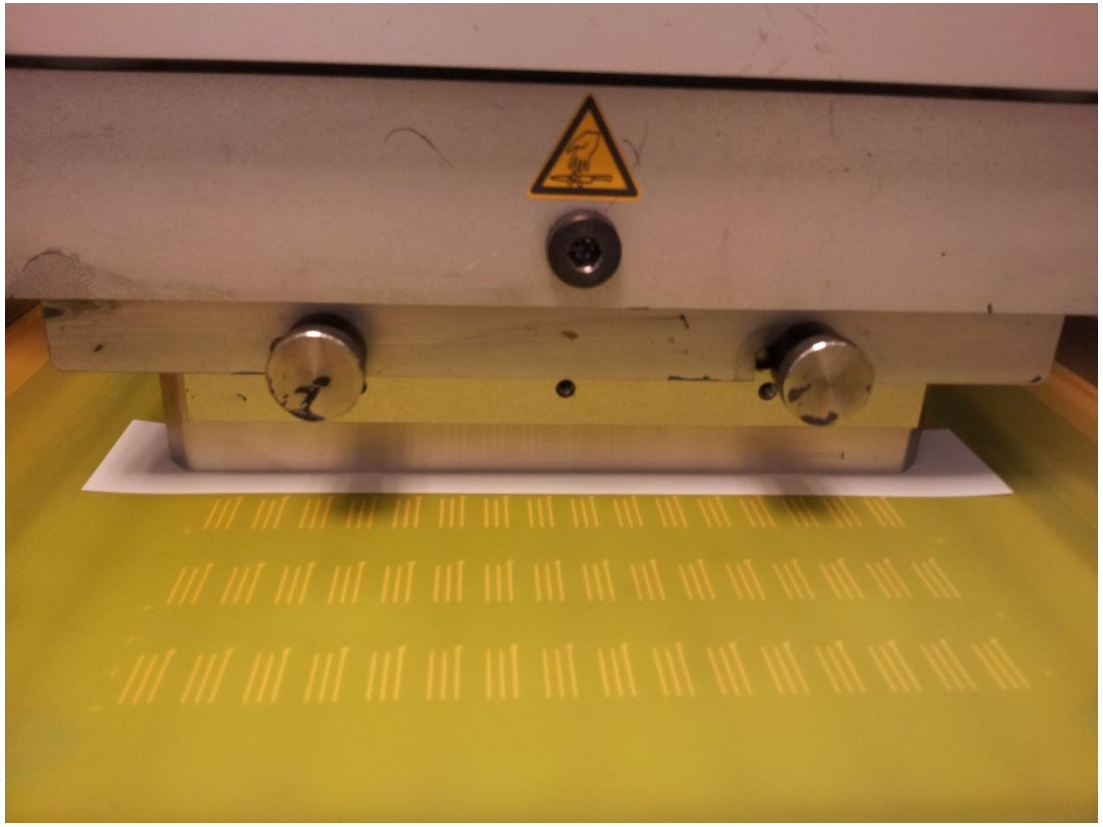
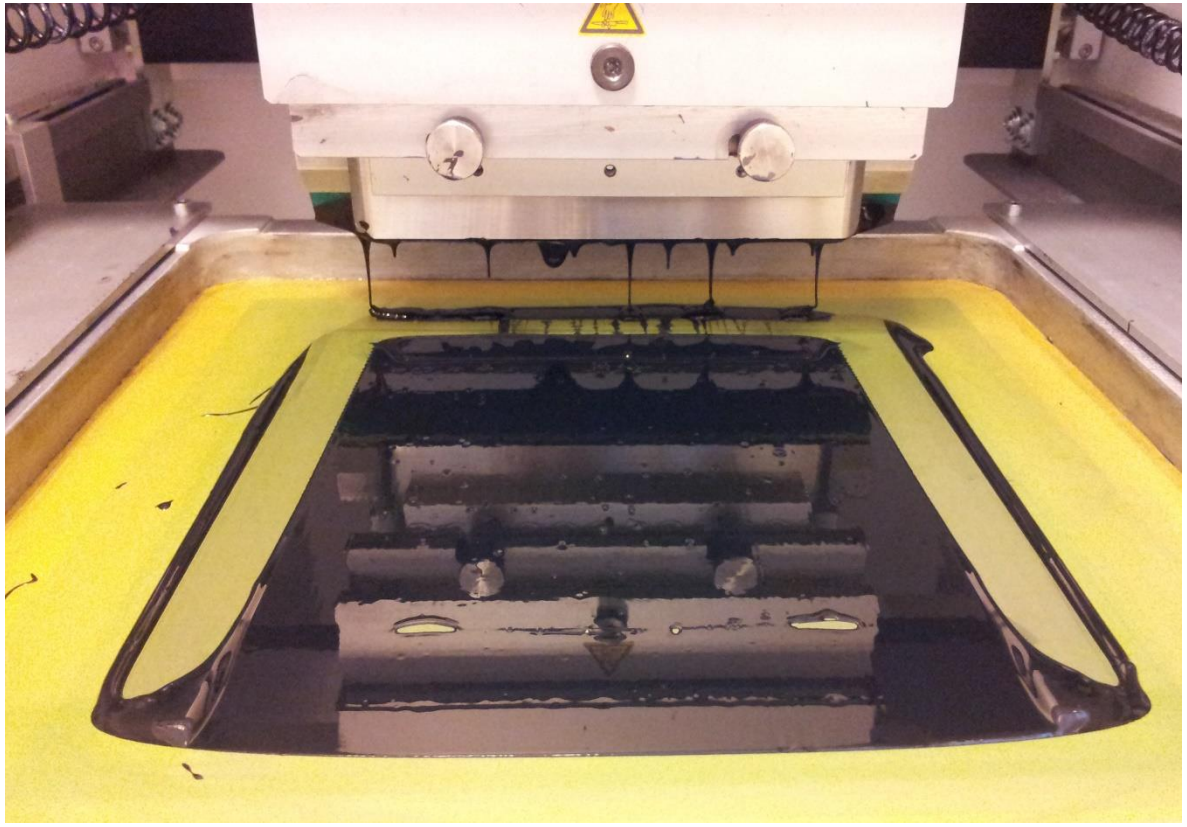
- Should be 1-2 cm wider than the pattern
- Frame inner width should be twice as large as width of the squeegee

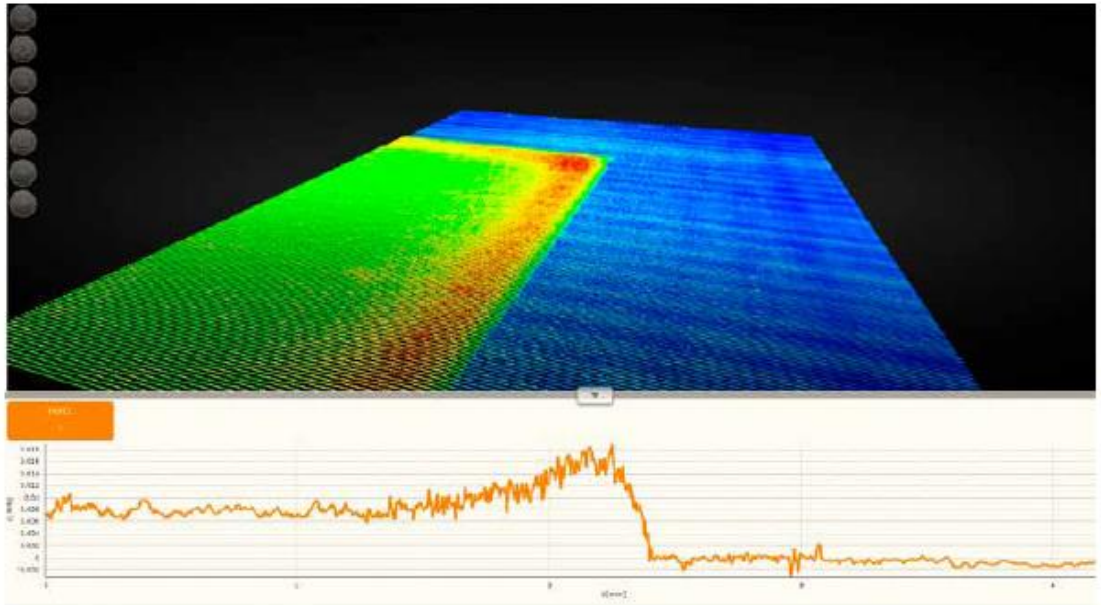
Set the flood squeegee as near as possible to the top of the screen

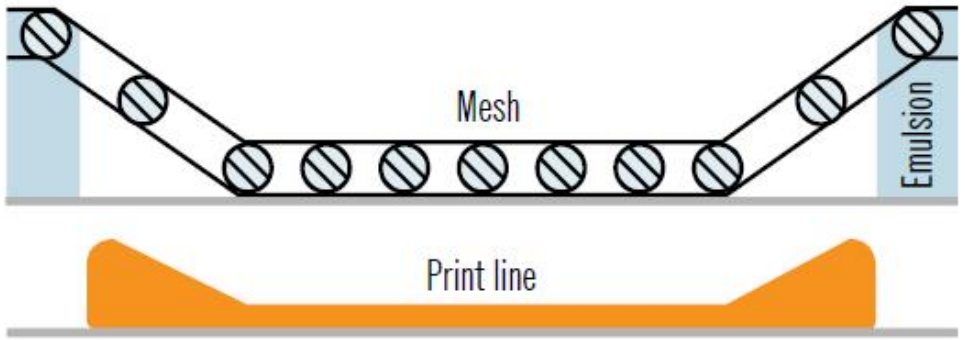




Emulsion

Examble of the print line if the thickness of the emulsion is high





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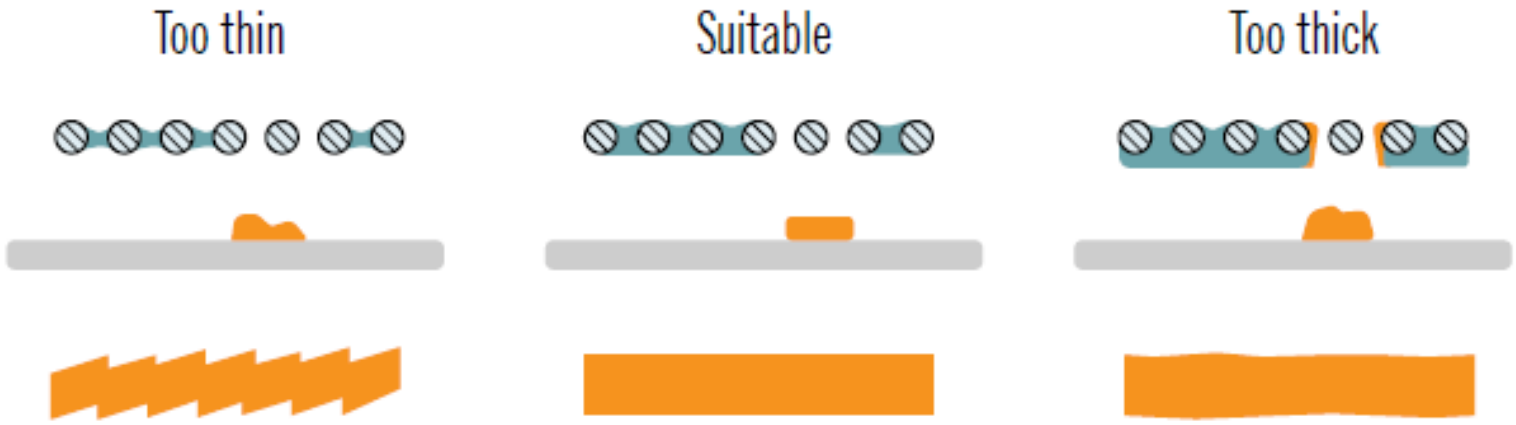
Thickness of the emulsion



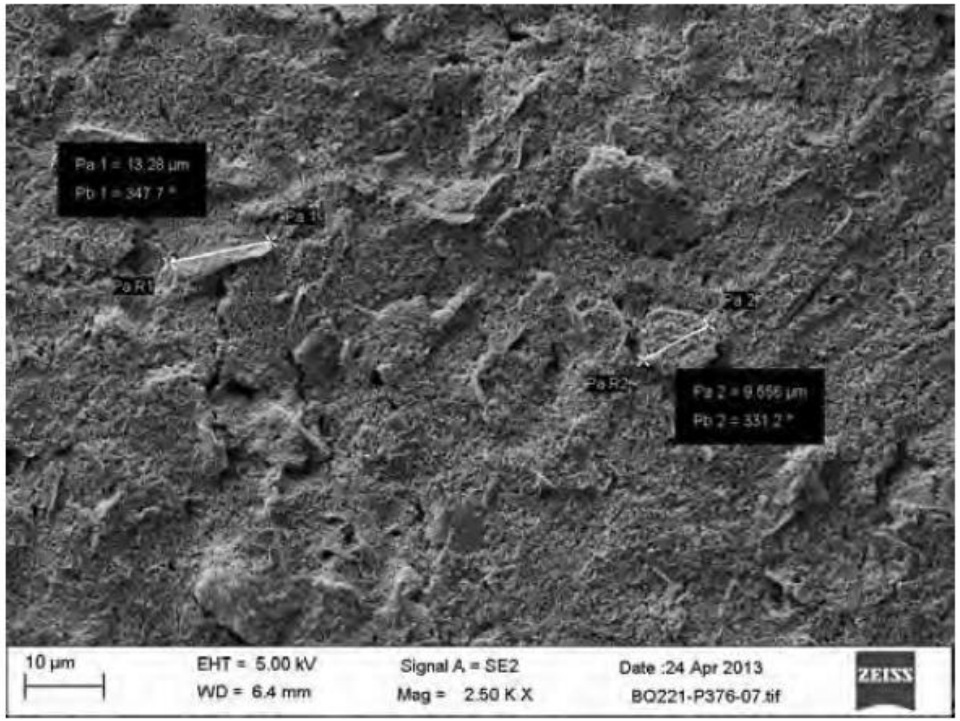
(Practical quide to screen printing in printed electronics, 2019)

Usually about 10 % of the thickness of the mesh, about 5 – 30 µm

Basics of the inks

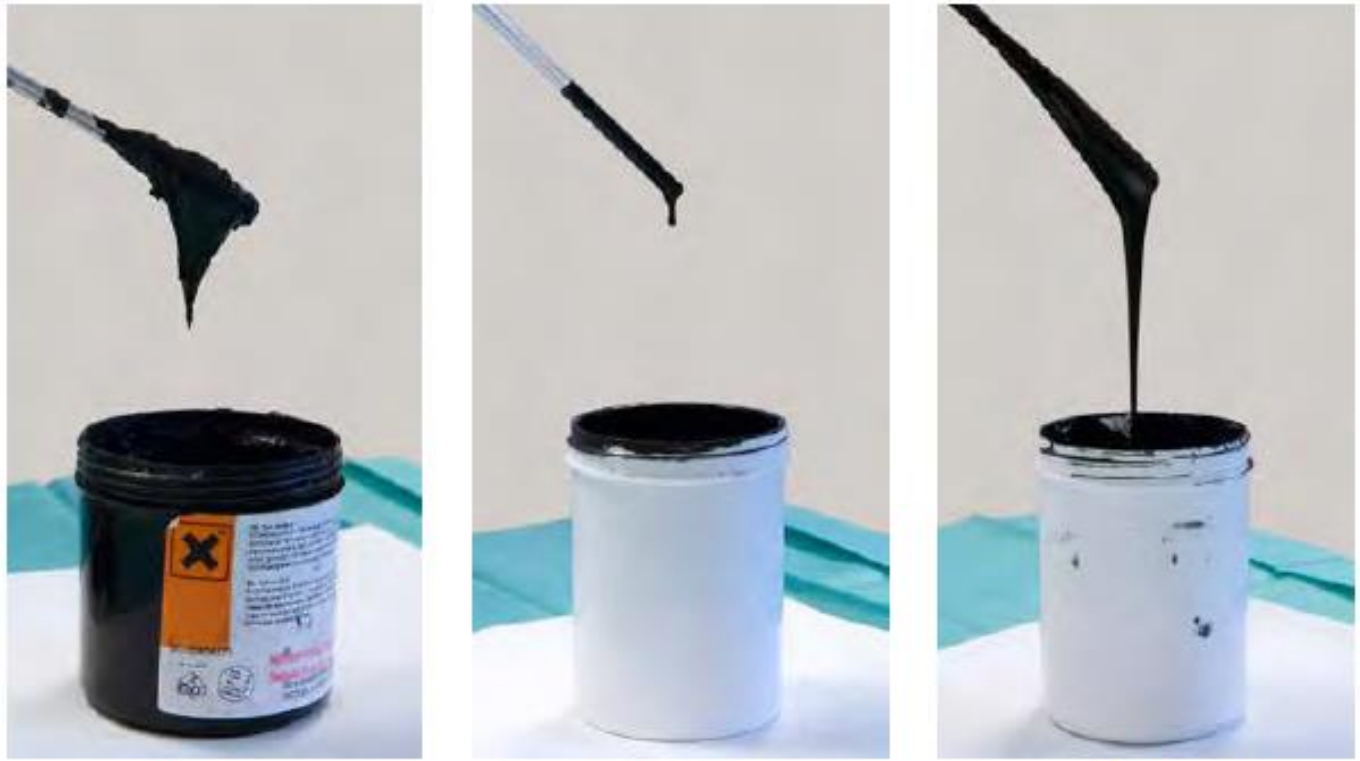
The printing ink usually consists of a pigment, a binder, solvents and other additives.

In printed electronics, there are also functional particles, such as graphite, silver, copper or other metals, metal oxides or organic materials.



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

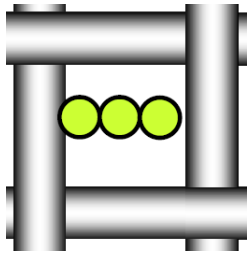
Viscosity of the inks may vary from 0,5 to 70 Pa s.



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

Grindometer tool check the particle size and quality of the ink

Distance between the mesh threads must be three times larger than the particle size of the printing ink



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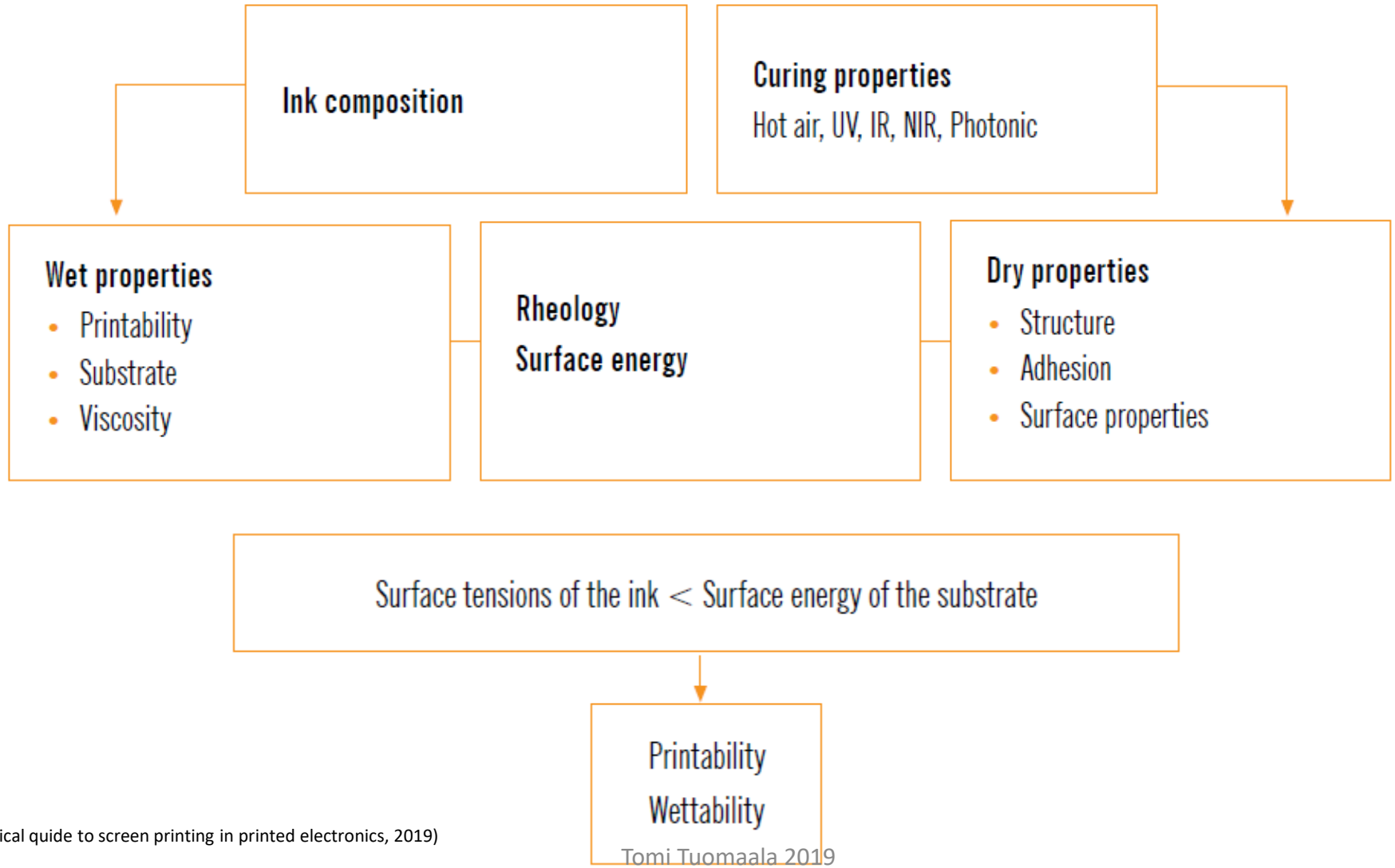
Main properties of the ink



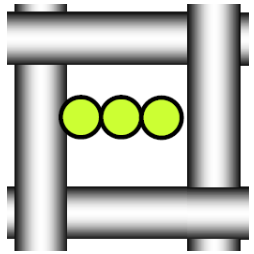
(Practical quide to screen printing in printed electronics, 2019)

Design rules of the screen

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

Desing tips

- The mesh thread diameter must be at least three times smaller than the narrowes line width of the pattern.
  - If you print lines 150µm wide, max thread diameter is 150/3=50µm
- The distance between threads must be at least 3x larger than the maximum particle size of the ink.
- TIV = theoretical ink volume = wet print thickness = thickness x open area %
- Thickness of the emulsion should be at least 10% of the mesh thickness



Preparation of the printing process

Basics of the printing process preparation

1. Cleaning of the laboratory table surfaces
2. Pretreatment of the substrates
3. Process parameters and mateterials selection
4. Condition check of the screen
5. Preparation of the print machine
6. Inks preparation
7. Printing and curing
8. Washing of the screen and equipments
9. Documentation

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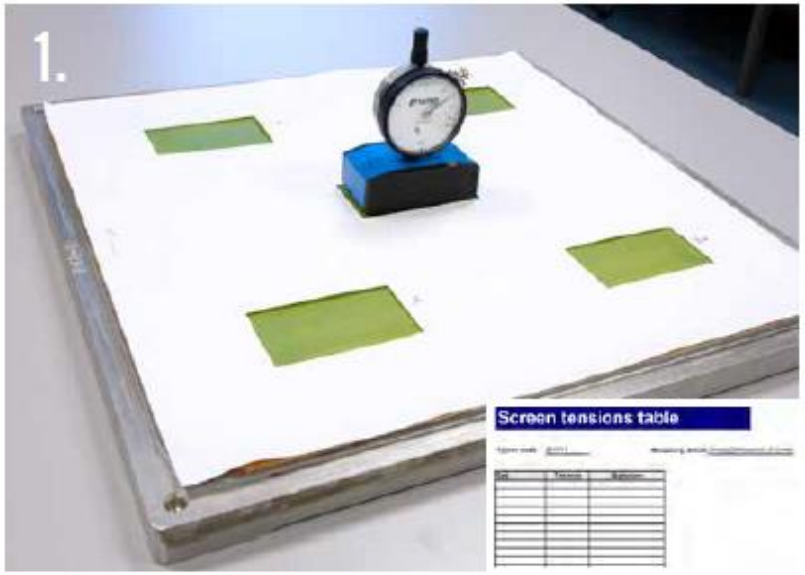
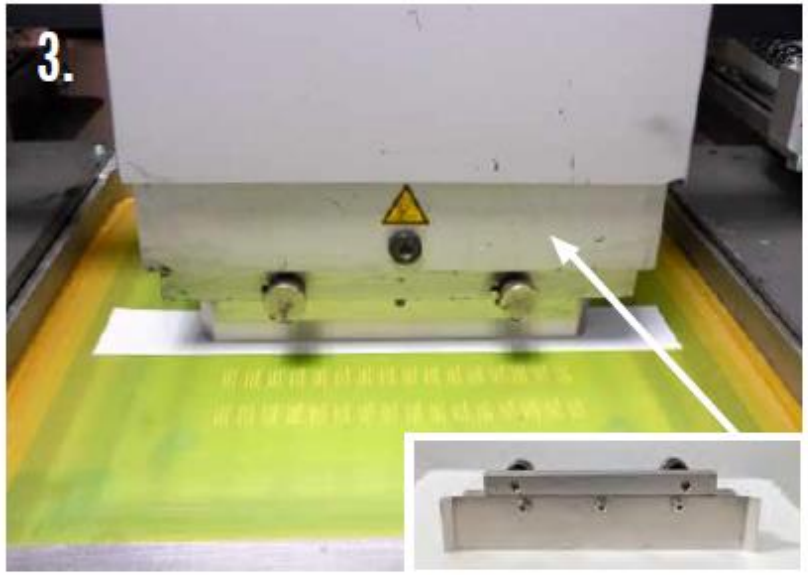
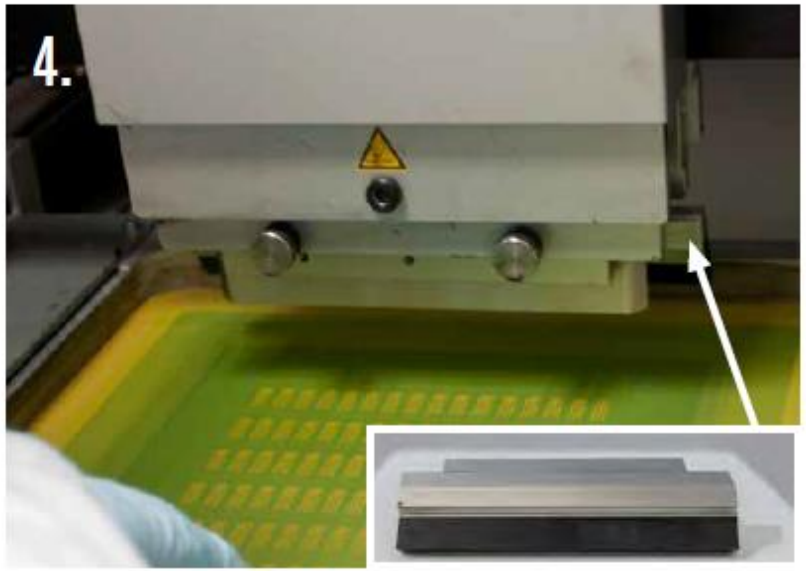
Print machine preparation







1. Checking the Tension of the Screen.
2. Attaching the Screen to the Adapters.
3. Setting the Flood Squeegee.
4. Installing the Printing Squeegee and Distance between the Screen and the Base.
5. Printing Parameters.

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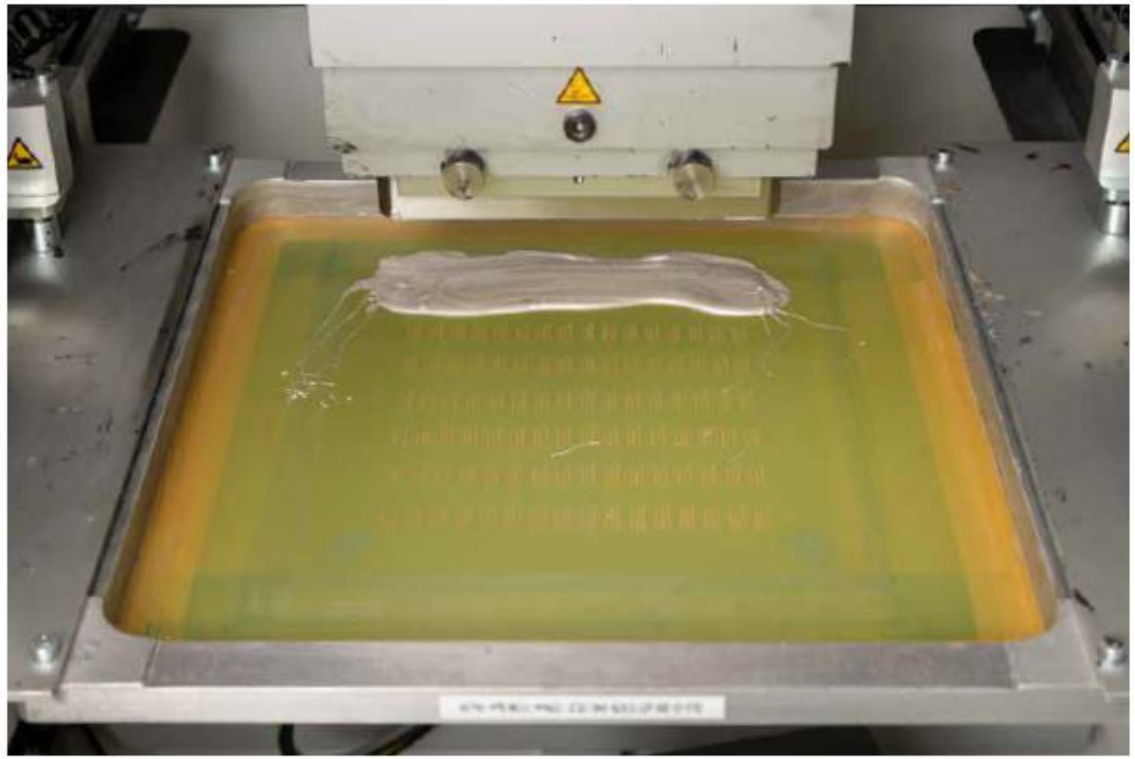
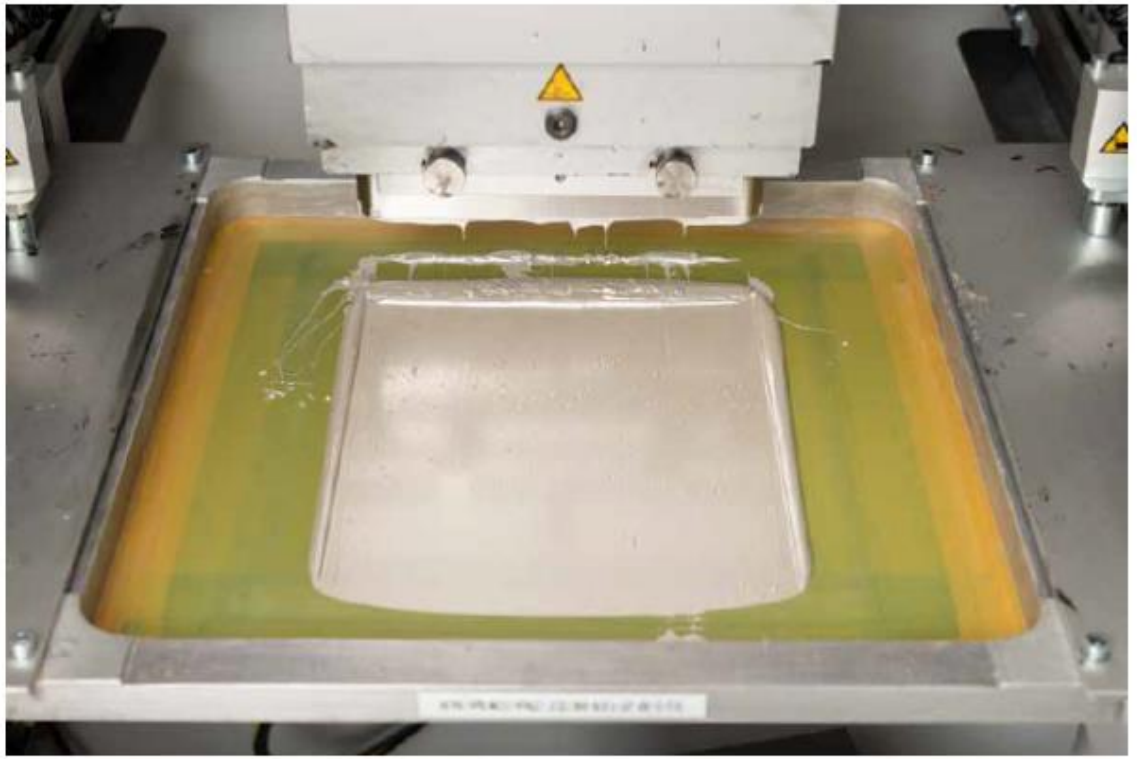
Optimal amount of the ink on the screen





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