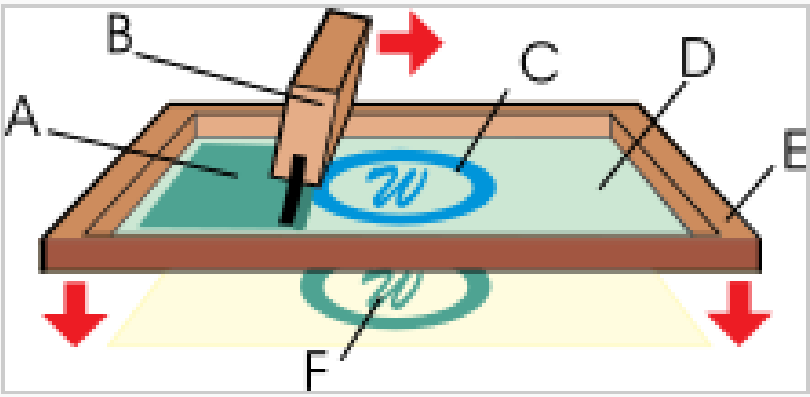
Screen Printing

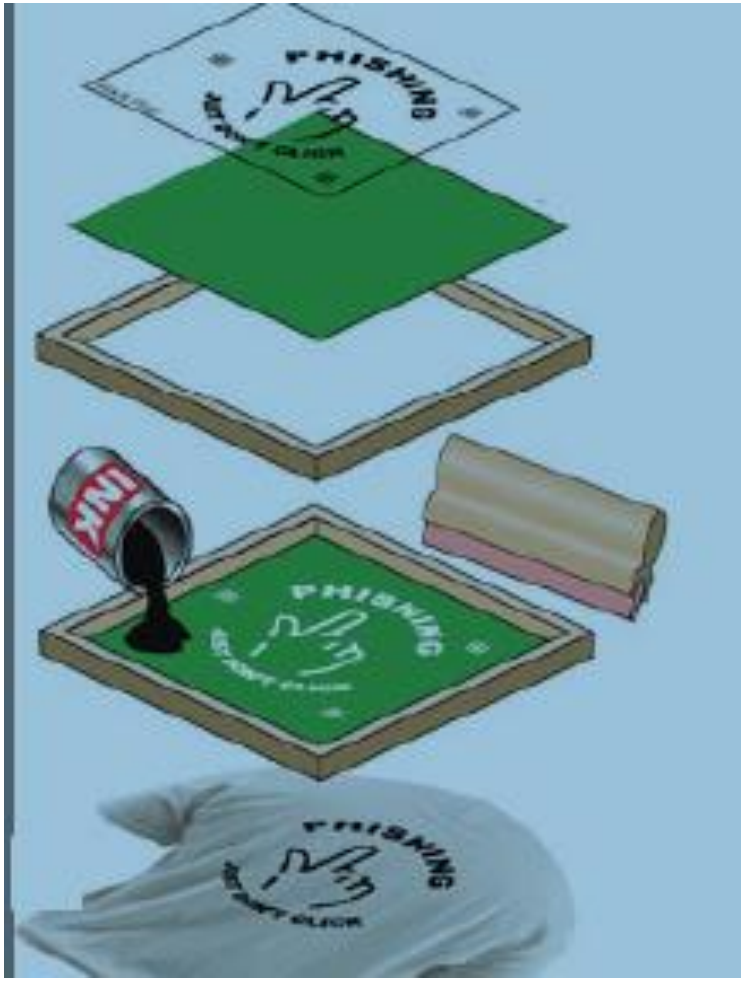
- Ink is squeezed through the screen and the printed image is formed on the material below.
- The screen comprises a metal frame that supports a mesh of tensioned polyester or stainless steel threads. The mesh supports a relatively thin layer of photo-emulsion, containing the image to be printed.
- A metal flood blade travels back over the screen, spreading the print material ready for the next print cycle

http://www.youtube.com/watch?v=9zVFYpxO7xQ



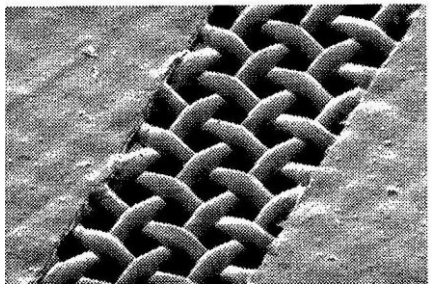
A. Ink. B. Squeegee. C. Image. D. Photo-emulsion. E. Screen. F. Printed image.

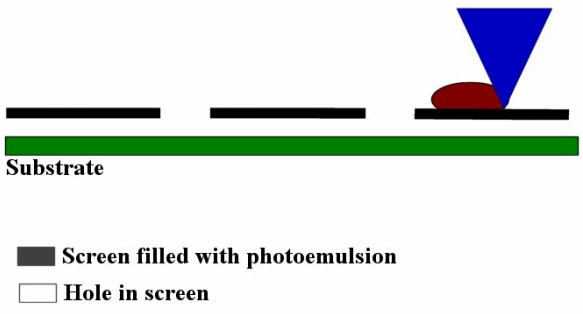
Screen Printing

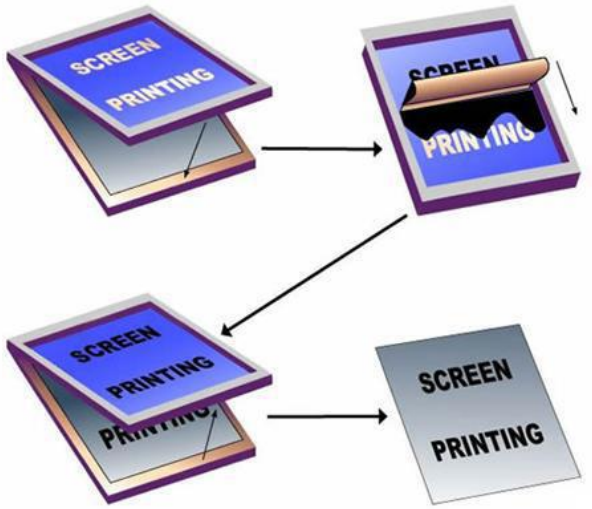


Screen Printing

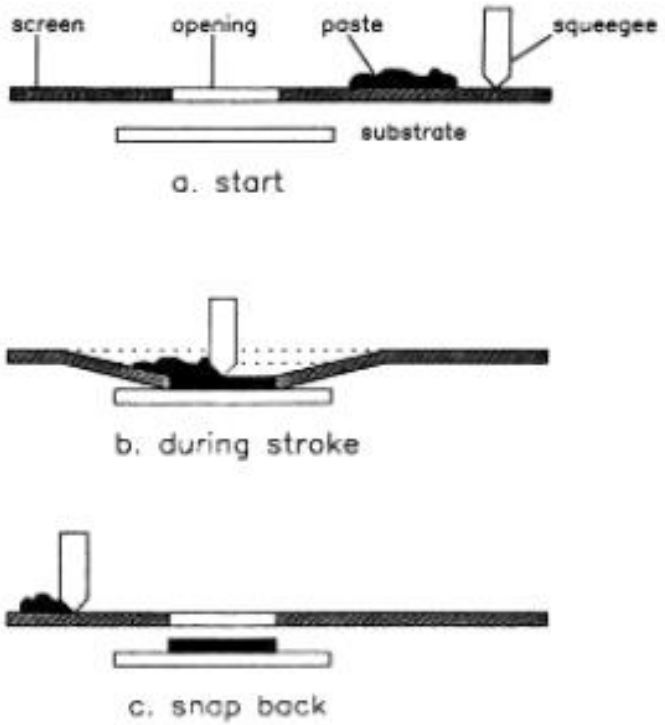
- Used for printing thick films
- Screen has the pattern to be printed
- *Squeegee* moves on top of the screen and forces the ink to the holes of the screen mesh







Screen Printing



Lawrence Chao-Shan Chou, Development of a glucose sensor using screen-printing and electrophoretic deposition

Screen Printing

Factors

- screen parameters
- snap-off distance
- screen tension (N/cm)
- print speed
- squeegee pressure
- Squeegee hardness
- angle of contact

Properties

- robust (+)
- simple (+)
- thick layers (+)
- large feature size (~100µm) (-)
- high ink viscosity (>10 Pas) (-)
- slower speed (5m/min) (-)

Screen Printing Parameters (by H Määttä)

General

- Ambient temperature 20 - 25 °C, RH 20-50 %
- Printing speed 10 – 50 mm/s
- Pressure 1 – 3 bar
- Snap off 0.5 – 2 mm
- Screen printing ink viscosity is high 0.5 – 50 Pas, which prevents it from flowing through the screen open area when not wanted.
- Formed thicknesses are high, even hundreds of µm, but usually in the range of 5 – 40 µm.

Layer thickness and resolution can be affected by changing:

- Fiber count
- Fiber thickness
- Emulsion thickness
- Screen material

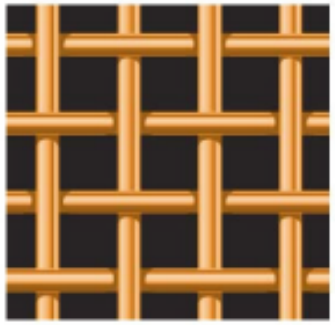
Screens

Screen materials are usually plastic (polyester) or metal (stainless steel) tensioned to metal frame.

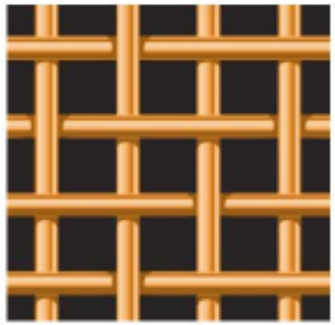
Screen features:

	Metal	Polyester
Flexibility		x
Resilience		x
Squeegee wear		x
Accidental damage		x
Cost		x
Image stability	x	x
Open area	x	
Ease of peel	x	
Ultra-fine lines	x	(x)

Plaine Weave



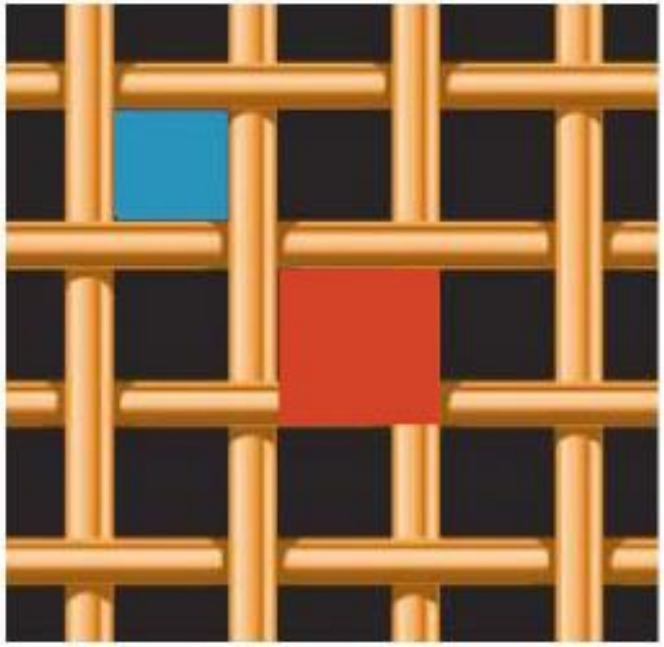
Twill Weave



Screen Parameters

thread type
thread count (tpi)
thread dia
opening
open area %
thickness
mesh angle
mesh tension
emulsion thickness

TIV

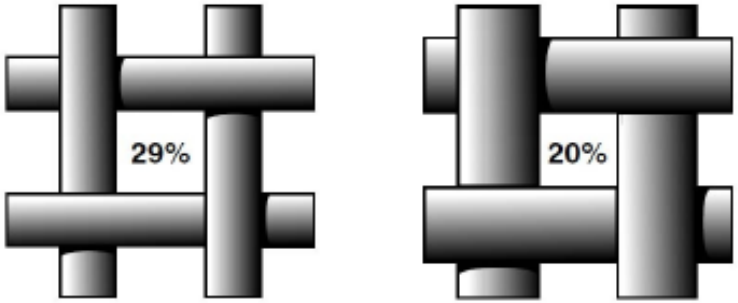


Some Design Thump Rules

The mesh opening should be at least 3x the maximum ink particle size

Thread thickness is chosen so that open area is sufficient enough for good ink penetration. Thicker thread can be used in less demanding applications and were good durability is needed.

Thread count is usually 100 – 400 tpi (threads per inch), lower tpi means bigger distance between adjacent threads -> heavier deposit.



120.34 (305) 120.40 (305)

Theoretical Ink Volume (TIV)

$$TIV = \frac{D_m}{100} \times open\ area\ \%$$

where D_m = screen thickness [µm]

Example: Screen thickness is 88 µm and open area 36 %
=> TIV is 88/100 x 36 = 31.7 (cm^3/m^2)

TIV can also be considered as the wet thickness (in microns). Emulsion on the screen will increase the print thickness.

Note: Only 50 – 75 % of the ink is released.
Drying of the ink reduces the wet thickness approximately 50 %.

Mesh tension

Mesh tension directly affects several variables, like for example:

- Image edge details
- mesh wearing
- pinholes
- registration of layers

Almost every mesh has recommended mesh tension given by the manufacturer

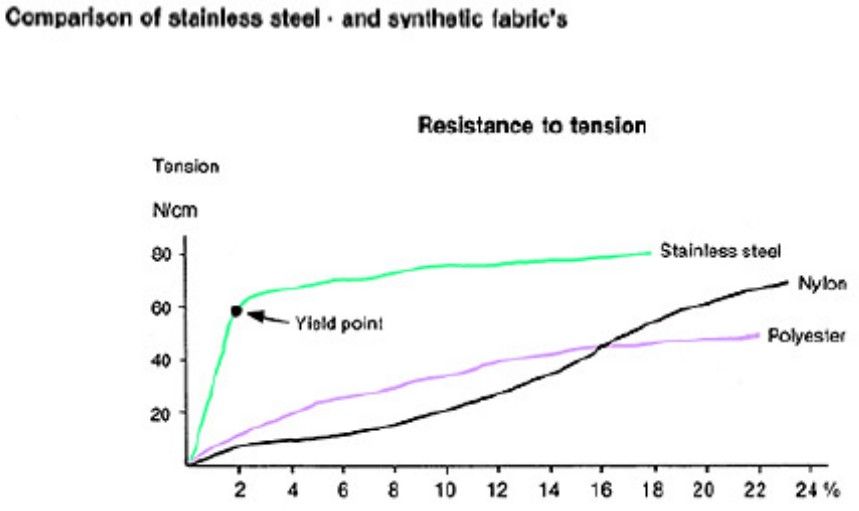
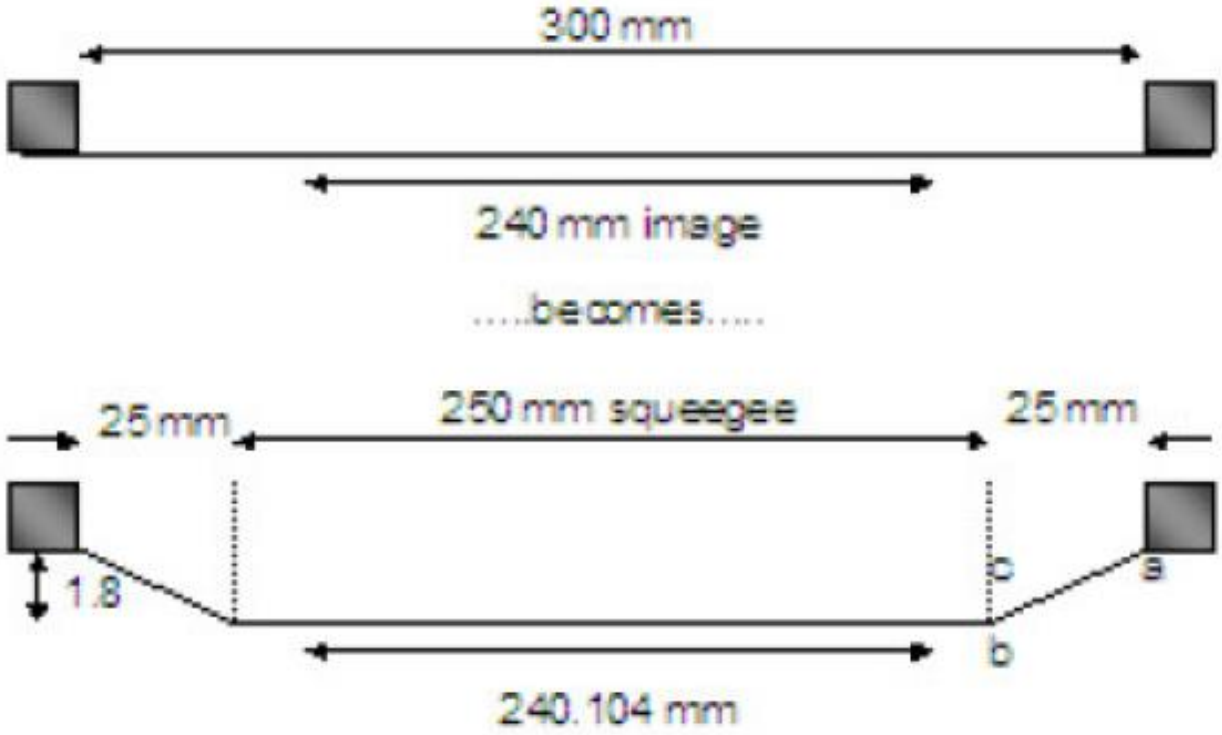
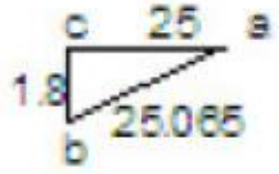


Image Stretching





Squeegees

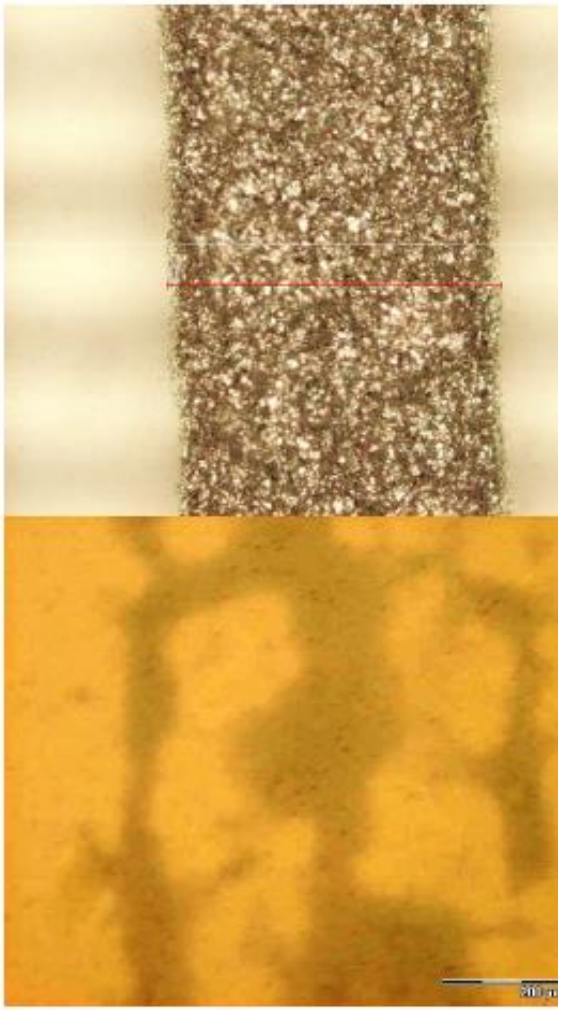
- Longer squegee than image is needed (3-5cm)
- Squeegee must be resistant to the solvent of used ink
- There are different profiles available for squeegees

Squeegee hardness

- Screen printing squeegee hardness is usually in the range of 55 – 95 Shore A (Shore durometer, type A)
- Softer squeegee gives you a thicker print and fewer pinholes and is suitable for uneven substrates
- Harder squeegee gives thinner print and better print accuracy
- Also the squeegee profile affects the print thickness

What makes Quality in Printing

- Precise and clean edges
- Flat and smooth top surface
- Consistent print thickness (from edge to edge)
- Good alignment with substrate and other print layers
- No bleed of print material outside



Screen Printing, Pros and Cons

Advantages

- Traditional, well-known method
- Screens easily manufactured and available
- Simple machinery (flat bed)
- Wide selection of inks and substrates
- Printing on conformal substrate
- Thick layers

Disadvantages

- slow speed
- relatively low accuracy