TISK 2
TISKARSKI POSTOPKI 2

SITOTISK 2019 / 2020

Deja Muck

UVOD

Tehnika sitotiska je stara že več kot 14 000 let
(v jamah odtisi …)
Kitajci > Songova dinastija (960-1279).

18. st. preko Azije > Z EU (visoka cena svile)
L. 1907 Simuel Simon patentiral sitotisk –
uporaba mlinarske tkanine iz naravne svile.

Prepustni tisk

- sitotisk
- ciklostil
- digitalni propustni tisk (Riso)

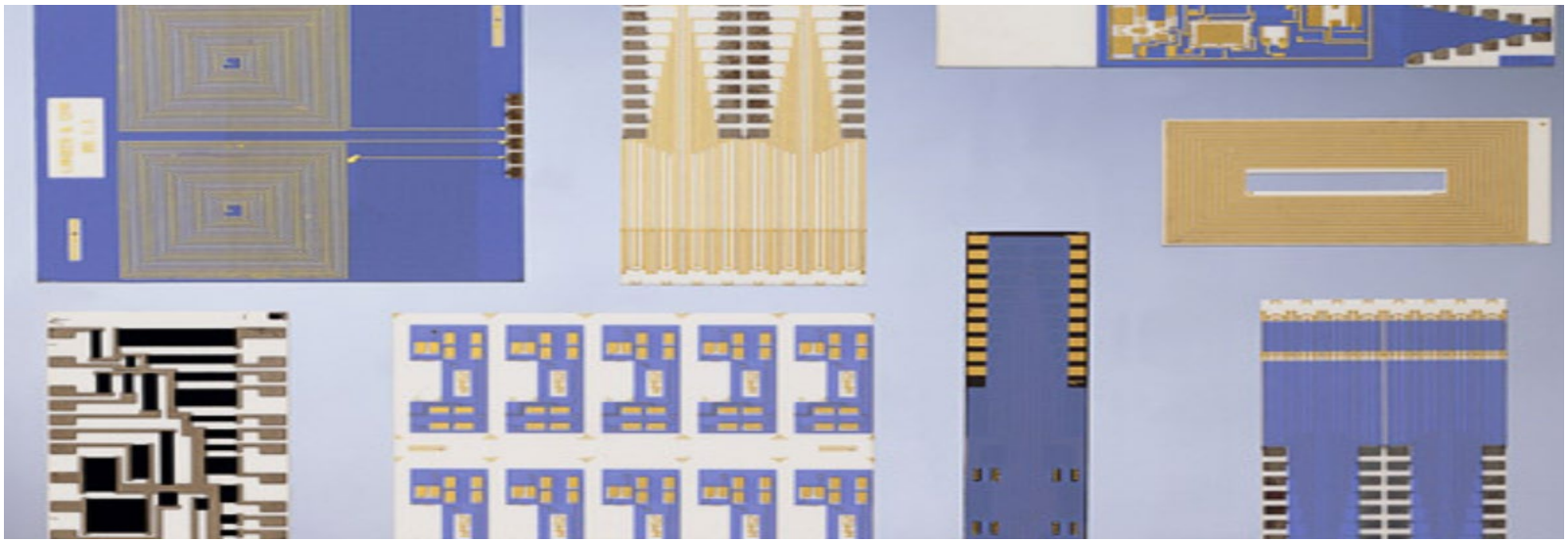
Serigrafija

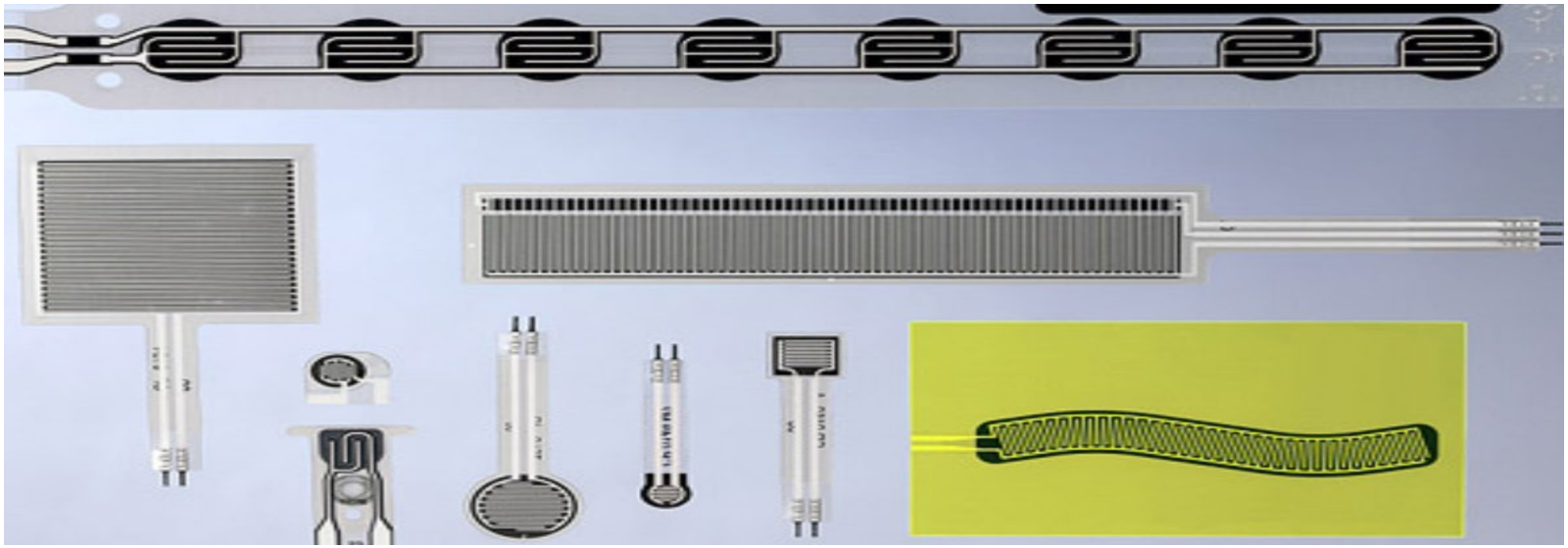
UVOD


NEW!
MAGNETIX
USA
HELLER FORD HYUNDAI
760-745-6830
760-294-5198
ASK ME ABOUT
ToyotaCare
Golden Ink
Heller Ford
800-427-3585

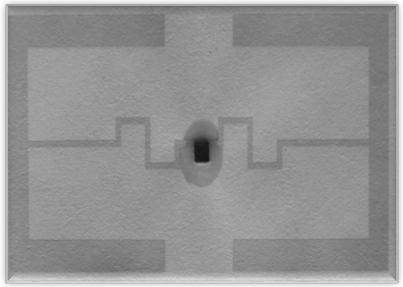

KRATT
Jog-A-Thon 2011
BULLDOGS
PIKE
Golf Club
13
5

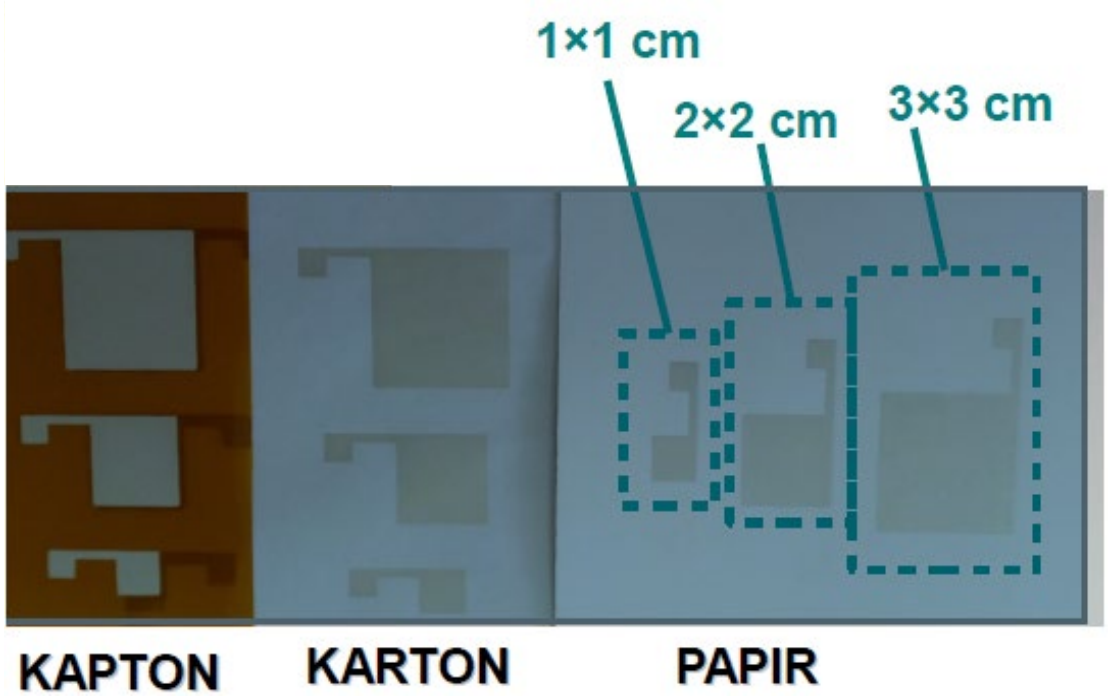
UVOD

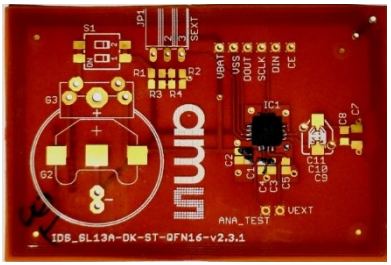




UVOD




1×1 cm
2×2 cm
3×3 cm
KAPTON
KARTON
PAPIR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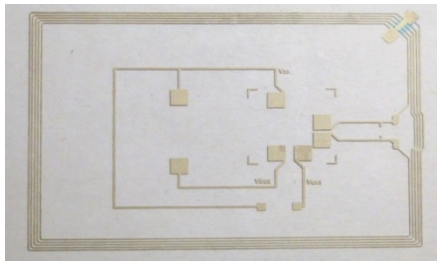
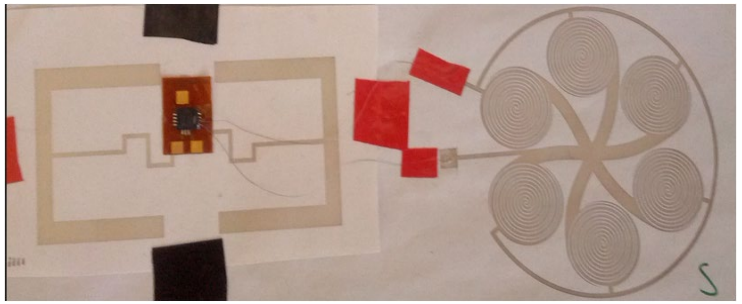
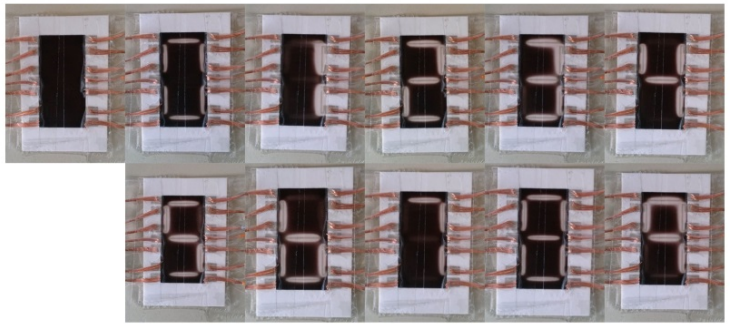






UVOD

Največji del trga je sitotisku prevzel kapljični tisk.
(Fespa > Fespa Digital)

Je standardizirana tehnika tiska – SIST ISO12647-5: 2015

Prednosti

- visoka tiskarska prehodnost
- tisk na različne materiale, različnih formatov
- velik nabor barv
- …

UVOD

Debelina odtisa:

- nekje med 8 in 125 µm
- odvisna je od:

mrežice 50%
izbira emulzije 20%

} objektivni vpliv – 70 %

	Flexography	Offset lithography	Gravure printing	Screen printing	Inkjet printing
Printing form	Relief (polymer plate)	Flat (Al plate)	Engraved cylinder	Stencil and mesh	Digital
Typical resolution (lines/cm)	60	100-200	100	50	60-250
Ink viscosity (Pas)	0.05-0.5	30-100	0.01-0.2	0.1-50	0.002-0.1
Substrates	Paper, boards, polymers	Paper, boards, polymers	Coated paper and boards, polymers	All	All, 3D possible
Film thickness (µm)	0.5-2	0.5-2	0.5-2	5-25	0.1-3
Line width (µm)	20-50	10-15	10-50	50-150	1-20
Registration (µm)	<200	>10	>10	>25	<5
Throughput (m^2 /sec)	10	20	10	<10	0.01-0.1
Printing speed (m/min)	100-500	200-800	100-1000	10-15	15-500

SITOTISKARSKA MREŽICA

- svila
- **poliester – PES**
- **poliamid – PA (nylon)**
- nerjaveče jeklo
- nikelj, karboniziran poliester, metaliziran poliester …

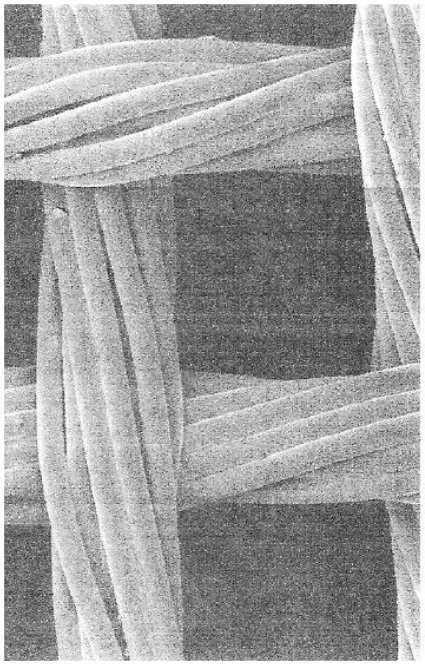
Tradicionalno se je uporabljala svila
(silk screen printing – še ohranjen izraz)

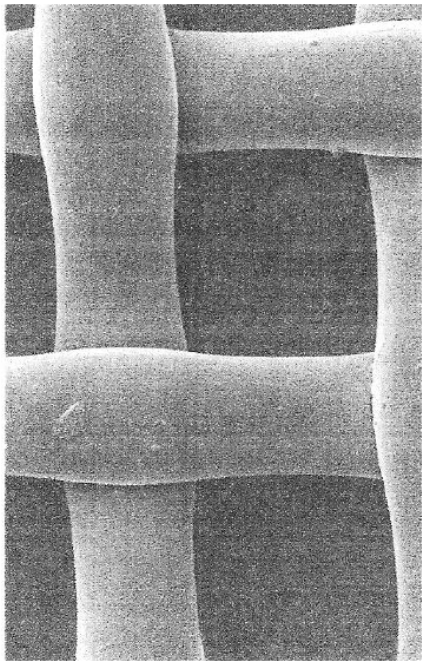
Svila:
- mehansko ni dovolj trdna – trganje vlaken
- preveč elastična
- hidroskopična
- …

SITOTISKARSKA MREŽICA

Multifilamenti, multifilne

Monofilamenti, monofilne
(200 niti/cm)





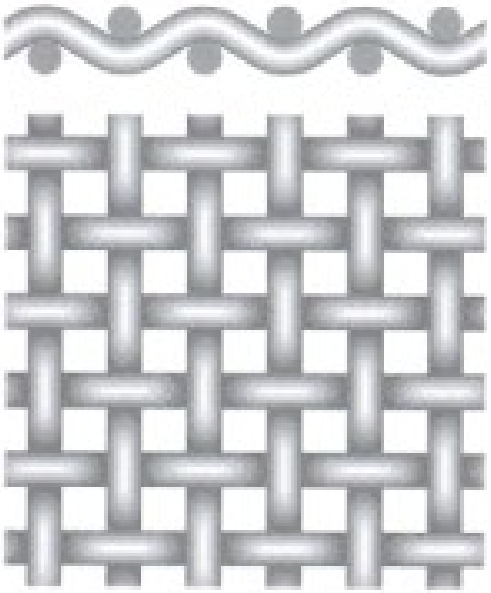
Monofilne mrežce

- ❑ večja trdnost
- ❑ manjša elastičnost
- ❑ boljši prenos TB
- ❑ lažje čiščenje
- ❑ boljši oprijem kopirnega sloja

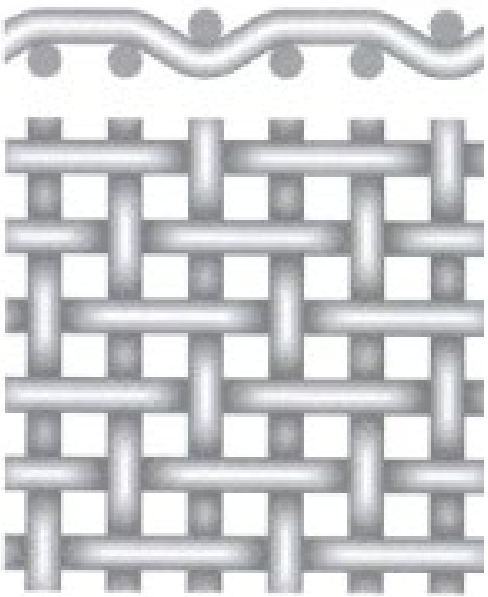
SITOTISKARSKA MREŽICA

- vezava platno
(osnove : votka = 1:1)
- vezava keper
(pri visokih gostotah tkanja, gre za prepletanje 2:1, 2:2, 3:3)

Pri vezavi keper (nevarnost moarea) > uporaba vezave platno.

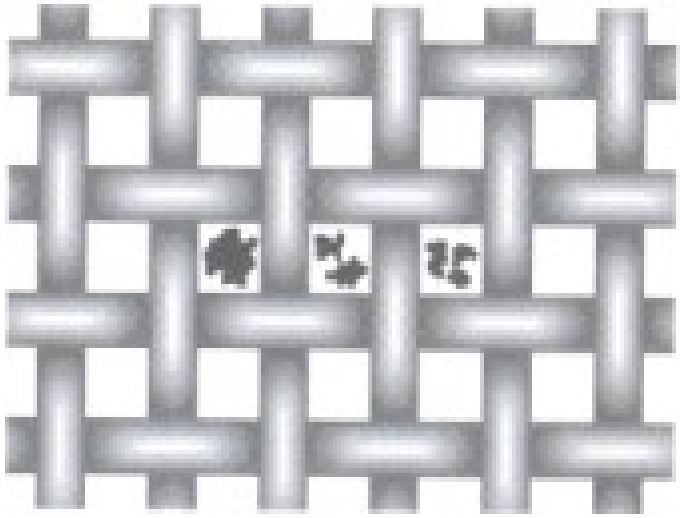


Slika vezave platno in



keper 2:1

SITOTISKARSKA MREŽICA



GEOMETRIČNE LASTNOSTI

Velikost odprtin med nitmi – w (µm):
❑ ustrezna prepustnost TB, pigmentni delci za faktor 0,3 manjši od velikosti odprtin w.

Stopnja odprtosti sita – a0 (%):
❑ vsota vseh odprtin na celotni površini sita (npr. 30,5 %)

Teoretični barvni volumen – Vth (cm^3/m^2):
❑ stopnja odprtosti sita – a0, debelina mrežice - D
(a0 × D)/100 = Vth

SITOTISKARSKA MREŽICA

GEOMETRIČNE LASTNOSTI

- osnova – št. (na cm) in debelina niti (premer – surove pred tkanjem!)

Geometrija določa:

- kakovost tiska rastrskih slik
  - sposobnost iztiskanja TB
  - hitrost tiska
  - debelino nanosa (porabo TB, sušenje)

Parametri:

- velikost odprtin med nitmi, W (µm)
- stopnja odprtosti sita, ao (%)
- debelina sita (tkanine), D (mm)
- teoretični barvni volumen, Vth (cm^3/cm^2)

Primer: PET 1000 **140-34** Y PW OSC

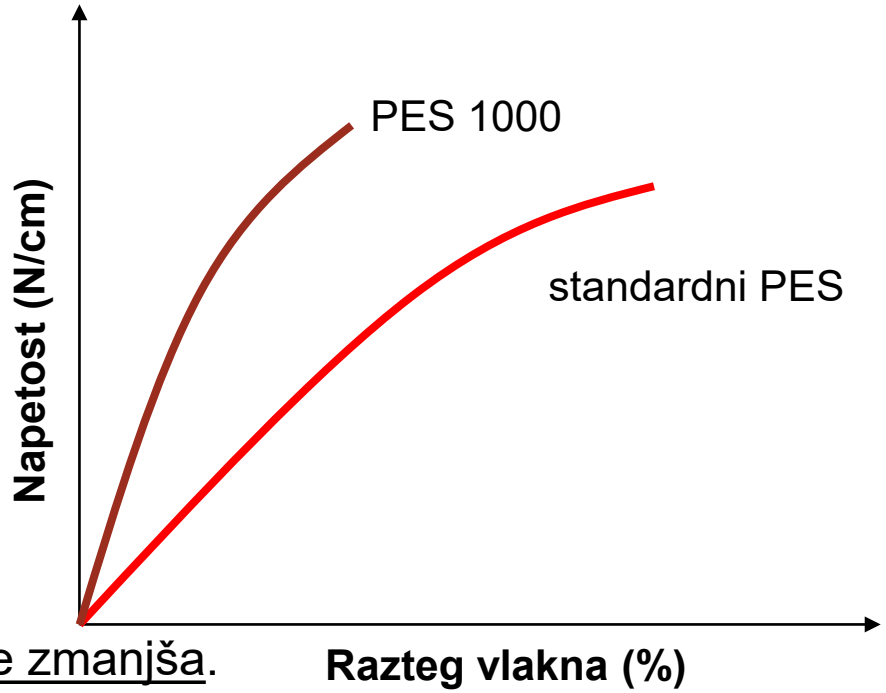
SITOTISKARSKA MREŽICA

POLIESTER - PES

Prednosti:

- visoka natezna trdnost
- dobra mehanska obstojnost
- dobra odpornost na obrabo
- neobčutljivost na klimatske razmere
- zelo odporen proti mineralnim kislinam

…



Slabosti:

Občutljiv na alkalije – trdnost se zmanjša.

SITOTISKARSKA MREŽICA

POLIAMID PA (NYLON)

- zelo dobre mehanske obstojnosti
- visoka odpornost na obrabo
- dobra omočljivost
- visoka elastičnost
- dobra povratna elastičnost (100% pri 2% raztezku)
- …

Slabosti:

- občutljiv na kisline - vlakno oslabi, se razkroji.

Modificiran PA 2000 – boljši odlep, barvna iztisljivost z dobro elastičnostjo omogoča dobro naleganje na neravne površine.

https://www.macrokun.com/product/Polyester-Screen-Printing-Mesh/list_3.html

SITOTISKARSKI OKVIR

Izdelava TF poteka v dveh delih:

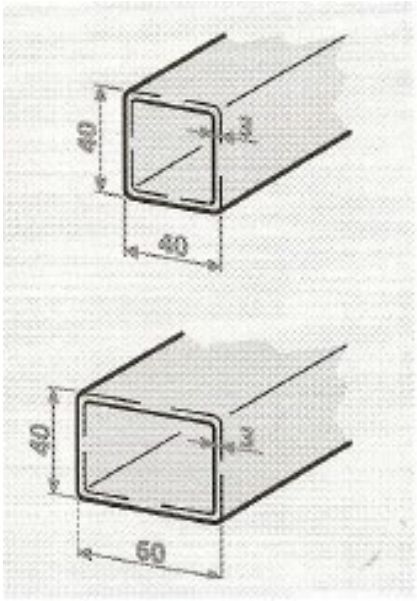
1. izdelava sita
2. izdelava TF na situ

Izdelava sita - mrežica in okvir.

- leseni (dimenzionalno nestabilni, občutljiv na vlago, T…)
- kovinski (npr. Al ali korozijsko zaščiten Fe…)
  - zagotoviti togost in trdnost
  - spojen vijačno, z varjenjem ali v enem kosu

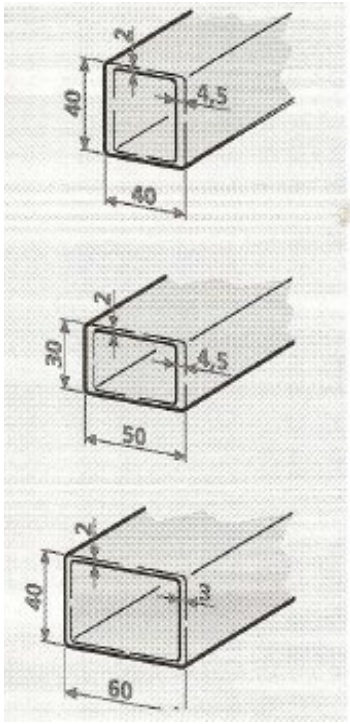
SITOTISKARSKI OKVIR

Profili okvirjev



pravokotni profili

Profili z enako debelimi stenami



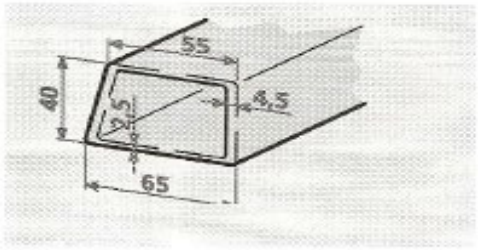
posebni profili

Profili z ojačanimi vertikalnimi stenami

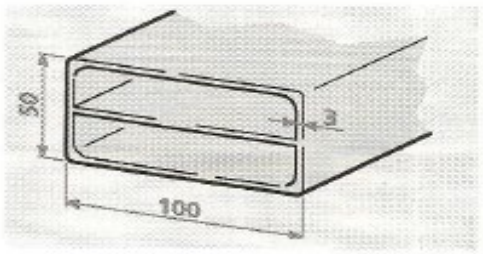
SITOTISKARSKI OKVIR

Profili okvirjev

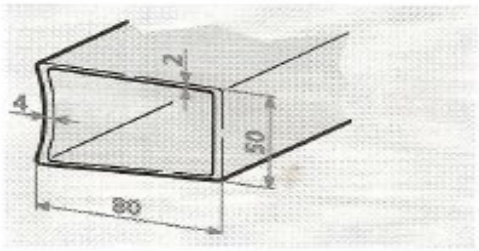
posebni profili



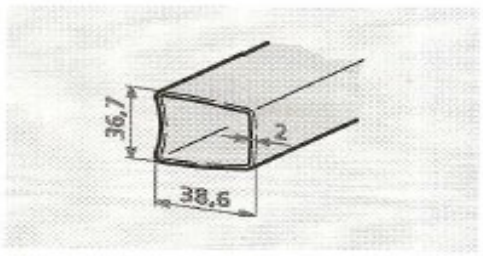
Profil z poševnim notranjim robom (slope)



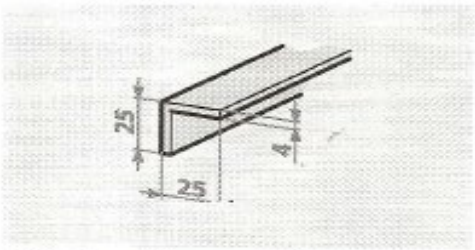
Profil z vmesno steno



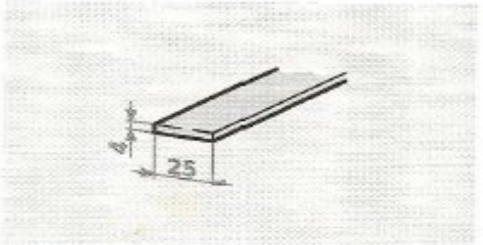
Profil z votlim klinom



Profil z votlim klinom in ožjo zunanjo stranico (tekstilni tisk)



Kotni profil za posebne zahteve (tisk teles)



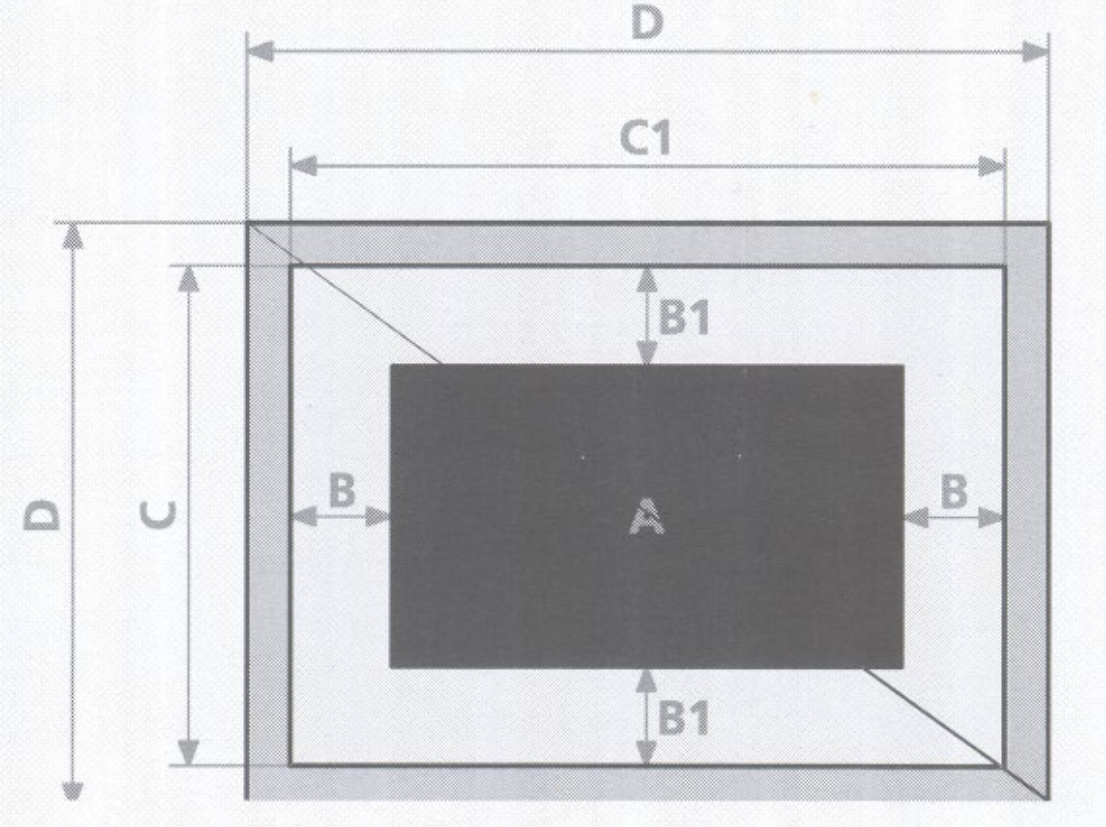
Plosko jeklo za okvirje za tisk CD

SITOTISKARSKI OKVIR

Velikost

- ❑ vsaj en formatni razred večji od tiskovne površine.

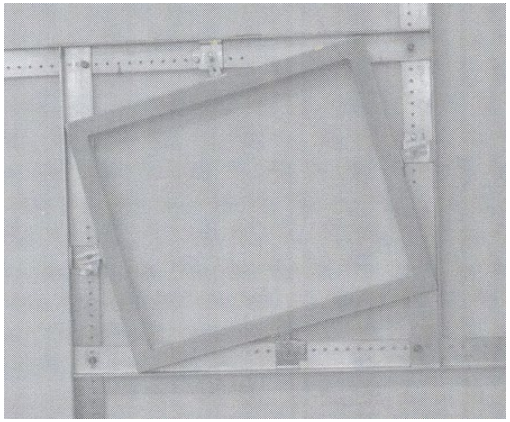
Upoštevati pas, kjer puščamo TB - prištejemo k meri slike.
Premajhen pas za TB - težave z naležno piko.

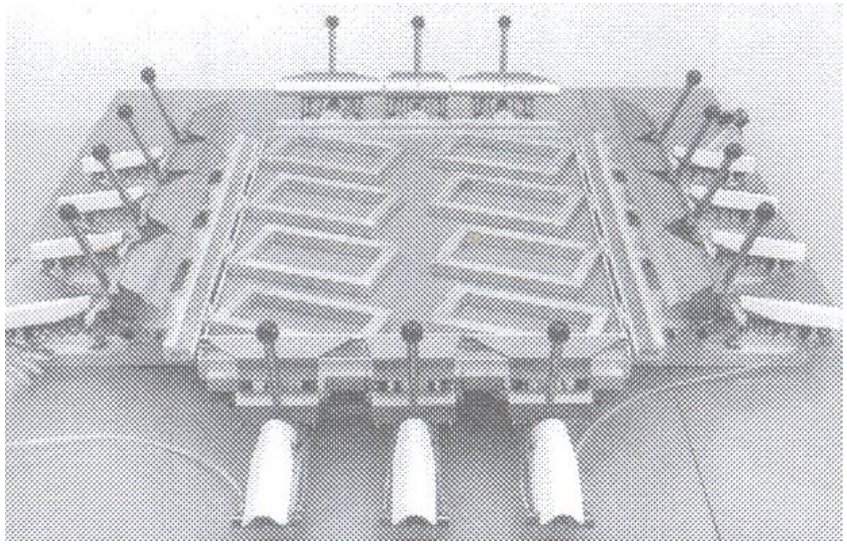


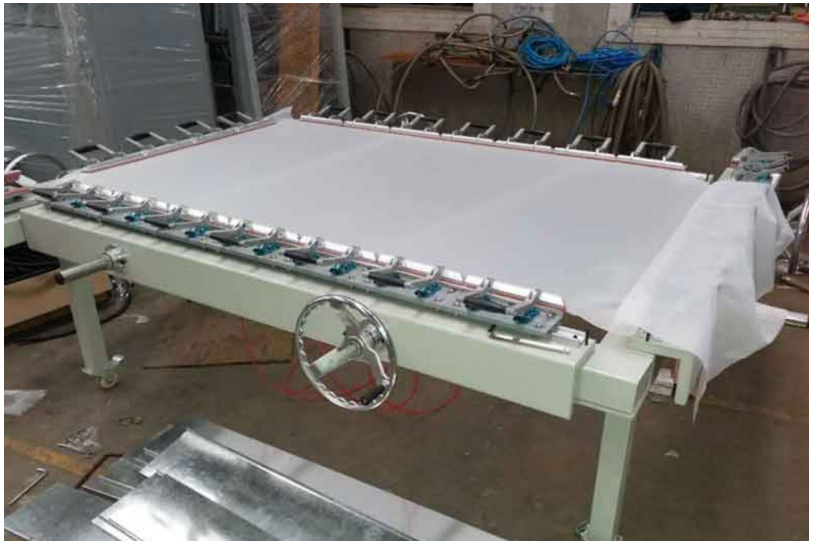
SITOTISKARSKI OKVIR

Napenjanje mrežice

- ročno
- mehansko
  - samonapenjalni okvirji
  - napenjanje z vreteni
- pnevmatsko



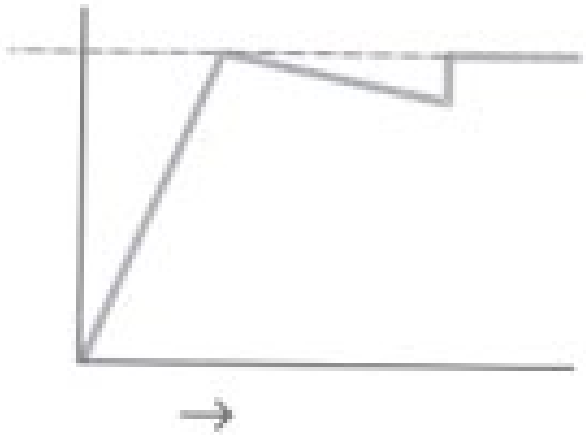




SITOTISKARSKI OKVIR

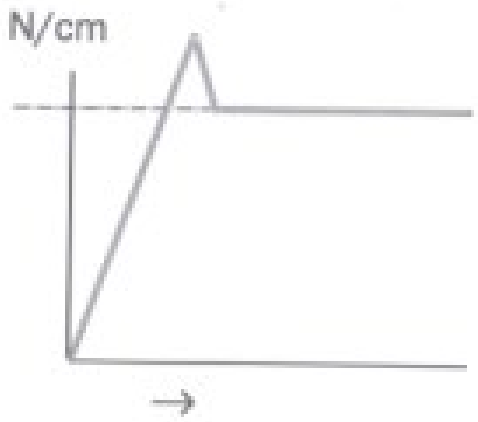
Standardna metoda napenjanja

- tkanino napnemo na želeno napetost
- počakamo nekaj minut
- ponovno napnemo na končno napetost
- manjši kasnejši padec napetosti



Hitra metoda napenjanja

- tkanino napnemo na 15 % višjo vrednost od želene napetosti
- prilepimo (brez faze relaksacije)



Paziti moramo na klimatske razmere!

TISKOVNA FORMA

Izdelava predlog za kopiranje:

- ročno
- preko izdelave filma
- CTS (Computer to screen)

- fotoemulzija (diazo - fotopolimerne …)
- 340 – 440 nm
- TF - šablona
- **film – pozitiv!!!**

TISKOVNA FORMA

Izdelava kopirne predloge z CTS (Computer to Screen)

- ❑ podatki iz računalnika > na RIP > odtisnemo s kapljičnim tiskalnikom
- ❑ neposredno brizganje UV voska ali UV nepropustne TB na premazano mrežico
- ❑ sledi osvetlitev in izpiranje

konvencionalna izdelava	CTS
barvna separacija	barvna separacija
izdelava filma	
razvijanje filma	
izdelava celotnega filma	
montaža na šablono	nanašanje emulzije IJ - izdelava TF in osvetlitev
arhiviranje filmov	
razvijanje TF	razvijanje TF

TISKOVNA FORMA

Izdelava kopirne predloge s CTS (Computer to Screen)

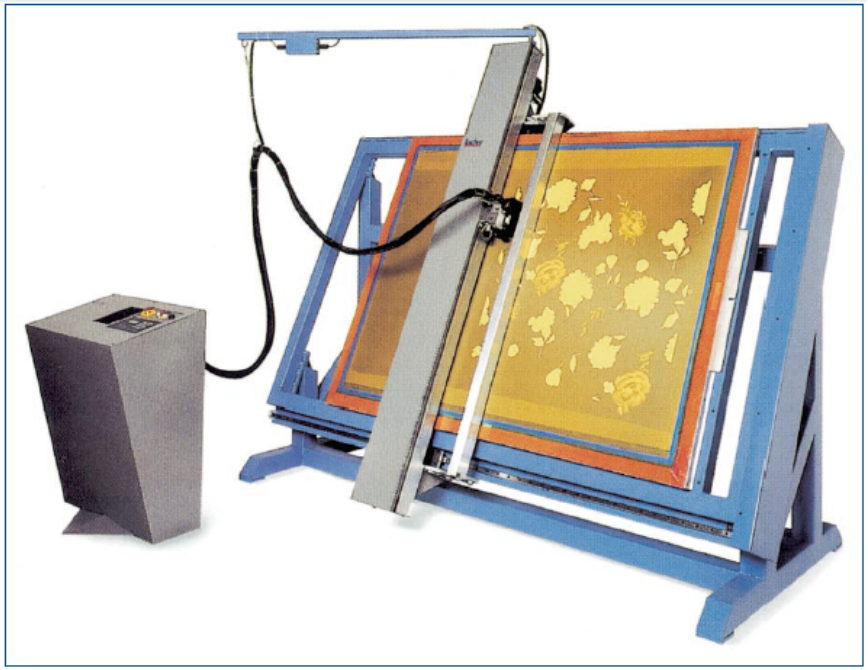


Fig. 2.4-8
Imaging a screen printing plate (creating a mask) using the ink jet process, wax-type ink, 1016 dpi resolution (JetScreen, Lüscher) (Note: light yellow areas (wax emulsion) correspond to the print image, the wax emulsion is washed off with water after exposure)

https://www.youtube.com/watch?v=H_7FzEtRQ5c

https://www.luescher.com/en/product-lines/jetscreenlt

TISKOVNA FORMA

INDIREKTEN POSTOPEK IZDELAVE TF

- suho sito omočimo z vodo
- položimo kopirno folijo – namesto emulzije
- sito pustimo da se posuši
- s posušenega sita odstranimo zaščitno folijo
- dodamo film in osvetljujemo
- po osvetljevanju očistimo sito in ga posušimo
- nanesemo tiskarsko barvo

prednosti

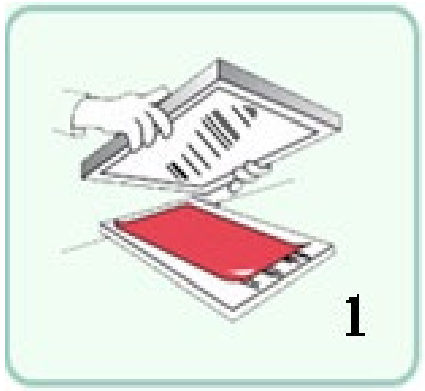
- visoka kakovost odtisa
- ni vpliva na čas osvetljevanja

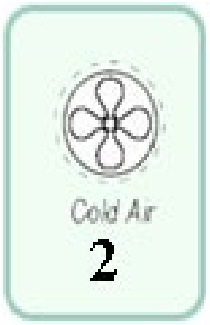
slabosti

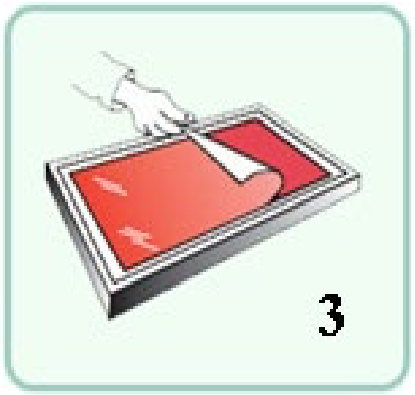
- samo za manjše naklade

TISKOVNA FORMA

INDIREKTEN POSTOPEK IZDELAVE TF







1. na mokro sito položimo folijo
2. vse skupaj posušimo
3. odstranimo zaščitni sloj
4. skupaj s filmom osvetljujemo
5. očistimo sito in ga posušimo

TISKOVNA FORMA

DIREKTNO-INDIREKTEN POSTOPEK IZDELAVE TF

- sito omočimo in odstranimo vso maščobo
- na zunanji okvir položimo folijo
- notranjo stran oslojimo z emulzijo
- posušimo
- odstranimo folijo
- osvetljujemo

TISKOVNA FORMA

DIREKTNO-INDIREKTEN POSTOPEK IZDELAVE TF

1. na mokro razmaščeno sito položimo folijo
2. z notranje strani nanesemo emulzijo
4. osvetljujemo
3. vse skupaj posušimo
5. očistimo sito in ga posušimo

TISKOVNA FORMA

DIREKTEN POSTOPEK IZDELAVE TF

- čisto sito oslojimo z emulzijo
- pustimo da se emulzija posuši
- skupaj s filmom osvetljujemo
- po osvetljevanju sito očistimo in ga ponovno posušimo
- nanesemo tiskarsko barvo

prednosti

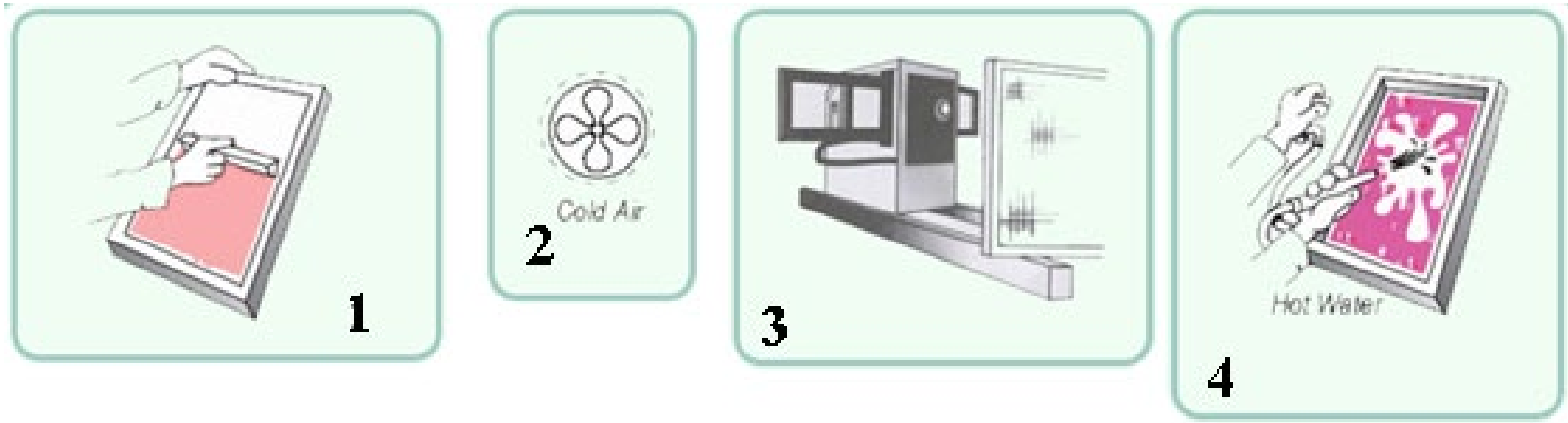
- za večje naklade

slabosti

- slabša kakovost tiskovne forme
- dolgotrajen postopek

TISKOVNA FORMA

DIREKTEN POSTOPEK IZDELAVE TF

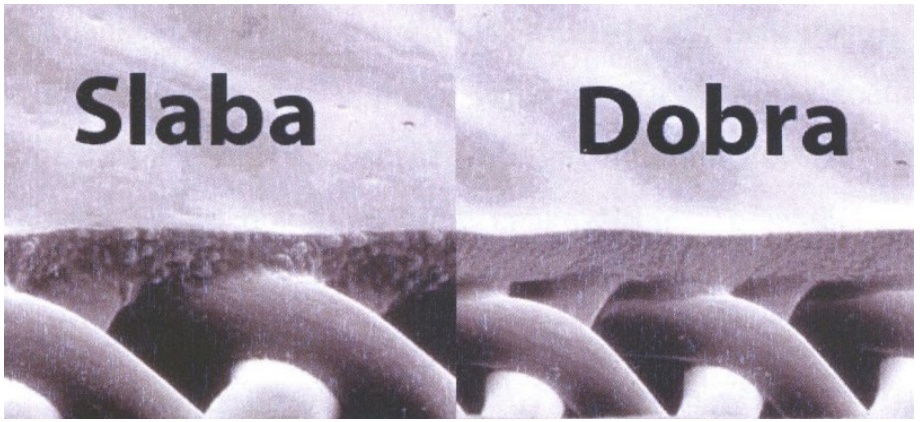


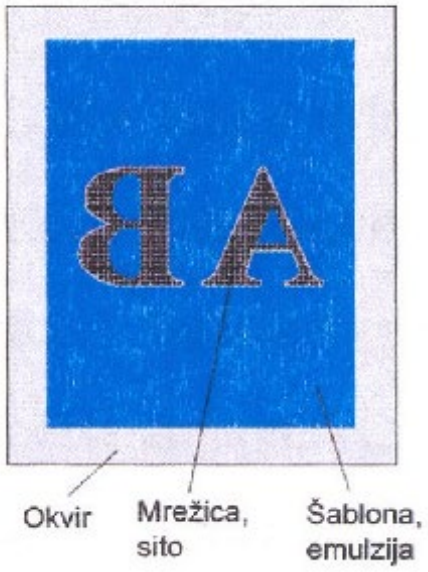
1. čisto sito oslojimo z emulzijo
2. sito dobro posušimo
3. skupaj s filmom osvetljujemo
4. očistimo sito in ga posušimo

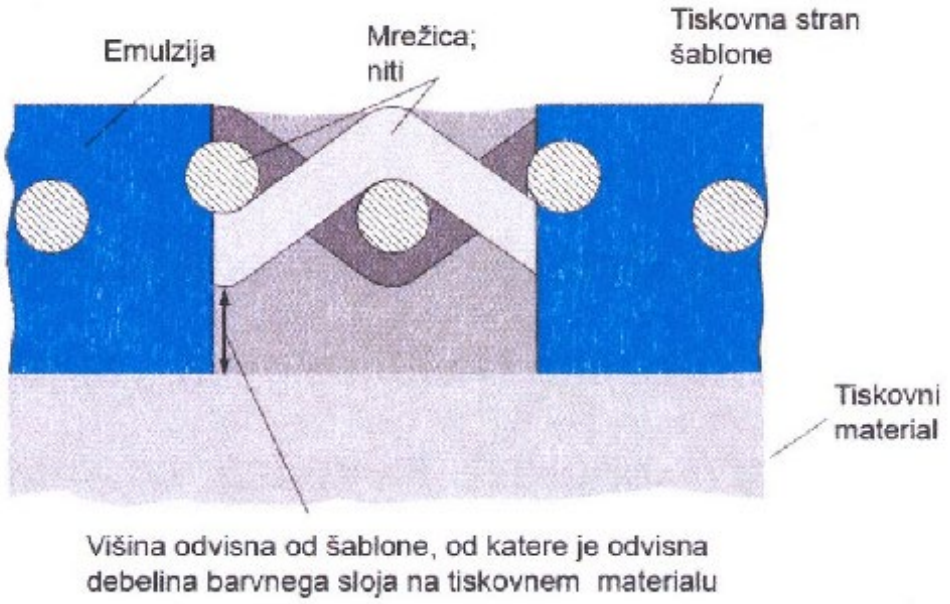
TISKOVNA FORMA

Kakovostna TF – šablona

- odpornost na vodo in topila
- mehanska odpornost
- ostri robovi, ostre, gladke vertikalne stene





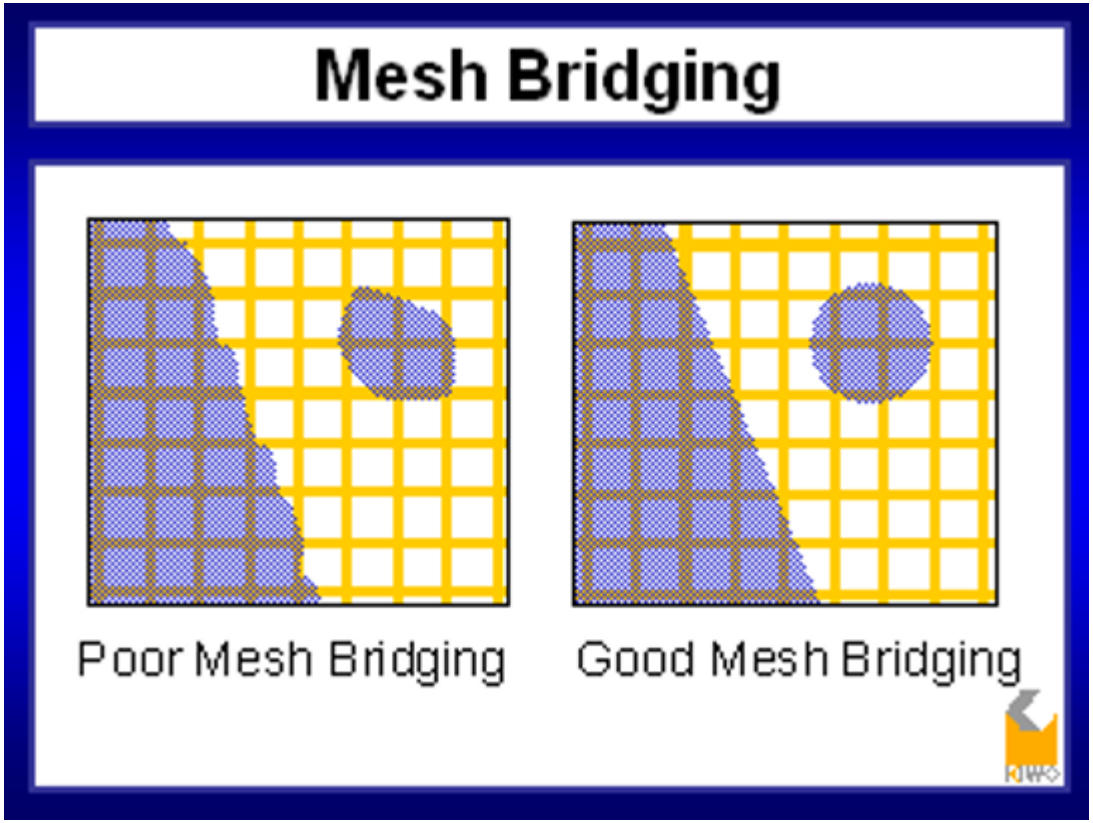


TISKOVNA FORMA

DIREKTEN POSTOPEK IZDELAVE TF

Zahteve za kakovostno šablono

- ″Mesh bridging″ > sposobnost emulzije, da ″prečka″ odprtino sita (pretanek nanos >″grdo prečkanje″ > nazobčanje robov)

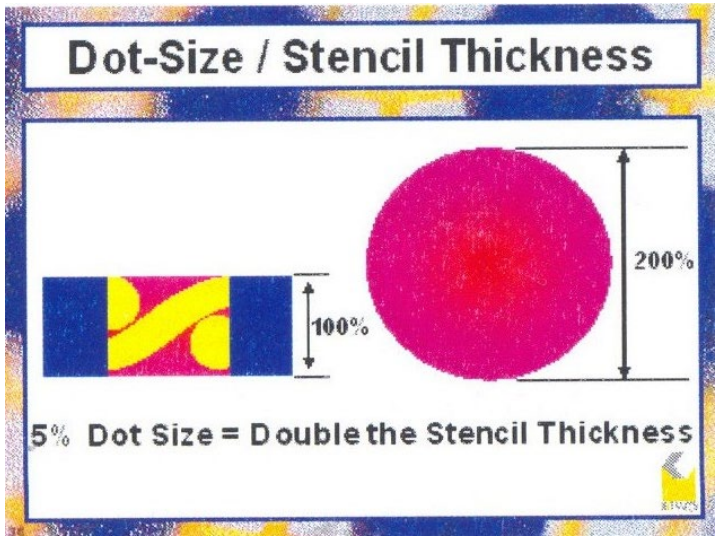


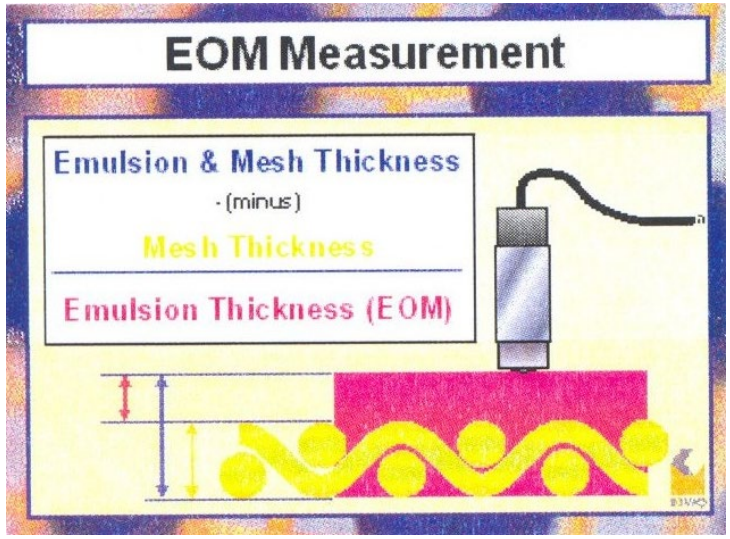
TISKOVNA FORMA

DIREKTEN POSTOPEK IZDELAVE TF

Debelina sloja emulzije
- odvisna tudi od debeline mrežice.

Premer najmanjšega detajla > 100 % večji od višine šablone (mrežice in emulzije skupaj)
Najfinejši detajl = 2×premer niti + premer odprtine mrežice





TISKOVNA FORMA

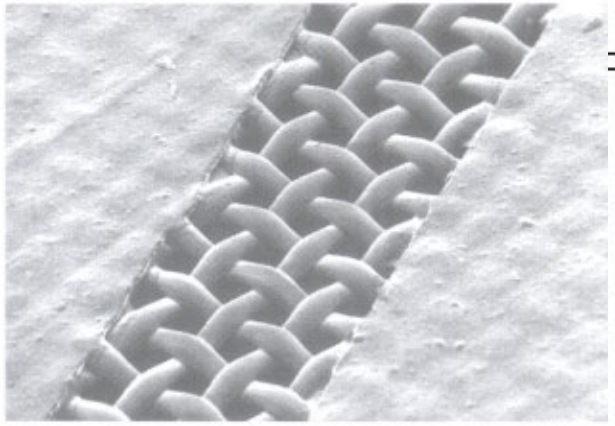
DIREKTEN POSTOPEK IZDELAVE TF

Zahteve za kakovostno šablono:

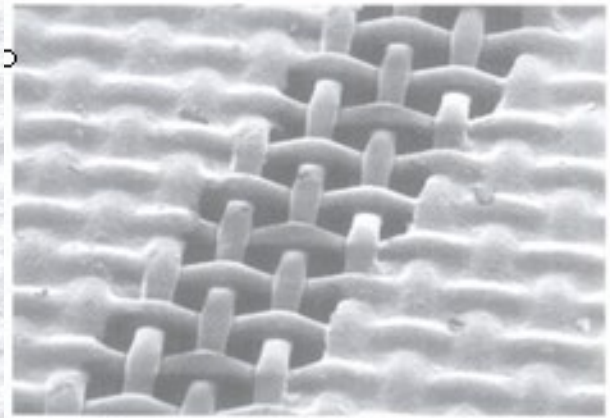
- ločljivost > sposobnost emulzije, da reproducira najfinejši detajl

debelina sloja emulzije

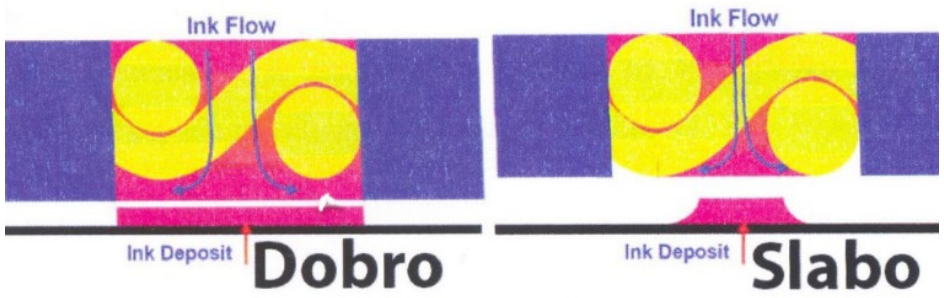
Pri tisku zelo finih detajlov - debelina šablone čim tanjša.



Korektni premaz



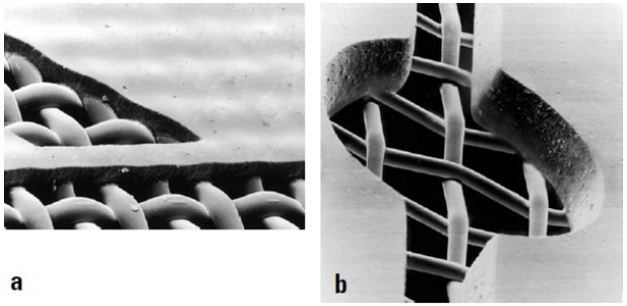
Pretanki premaz



Pretanek sloj emulzije
– sledi mreže sita na odtisu.

TISKOVNA FORMA

Prerez tkanine emulzija film	Direktna šablona z emulzijo	Direktna šablona s filmom in emulzijo	Direktna šablona s filmom in vodo (kapilarni film)	Indirektna šablona
Mehanske lastnosti	Zelo dobre	Zelo dobre	dobre	Zadovoljivo
Obstojnost na topila	Dobra	Dobra	Dobra	Dobra
Ostrina robov	Dobra - zelo dobra	Zelo dobra	Zelo dobra	Zelo dobra
Naklada povprečno	50 - 70000	20 - 50000	10 - 30000	2000 - 5000
Stroški	Velik	Velik	Majhen	Srednji
Področja uporabe	Ploski tisk, tisk teles	Ploski tisk, tisk teles	Ploski tisk, tisk teles omejeno	Ploski tisk
Odstranjevanje	Težko	Težko	Lahko	Lahko



a Direct stencil;
b Direct/indirect stencil

TISKOVNA FORMA

VPLIV BARVE MREŽICE

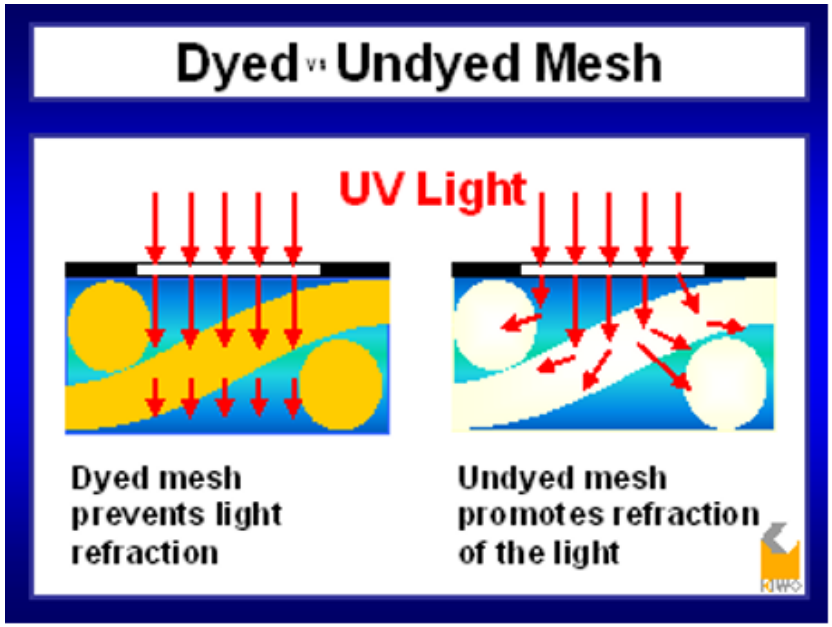
Emulzija oz. kopirni sloj ima največjo spektralno občutljivost v UV delu spektra, 350 – 450 nm. Mrežica mora absorbirati čim več svetlobe; komplementarna – rumena barva.

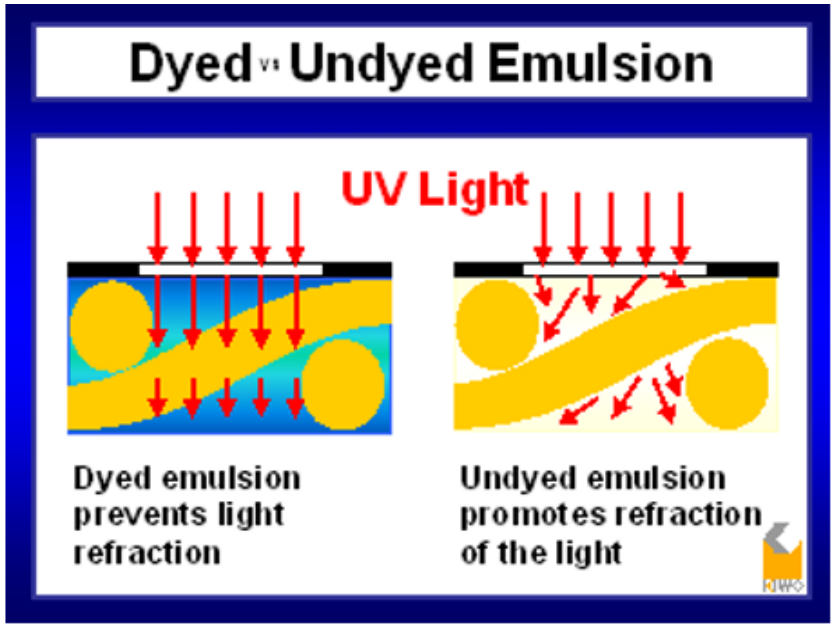
Bela mrežica – pojav podkupiranja:

- svetlobo ne le reflektira, deluje kot opični kabel, svetloba potuje po vlaknu podosvetlitev šablone (**vedno pozitivni film!!!!**)
- izguba ostrine TE

TISKOVNA FORMA

Vpliv barve mrežice, emulzije





https://www.youtube.com/watch?v=YYhQUsIZN4M

TISKOVNA FORMA

Svetlobni vir mora imeti spekter v UV delu:

- **fluorescentne**
- **halogenska**

šibkejši UV spekter, cenejše

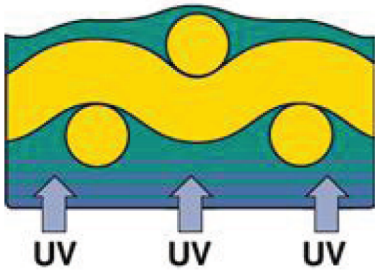
- **ksenonove žarnice**
- **živosrebrne**
- **metal-halidne**

bogatejši UV spekter, dražje

- **…**

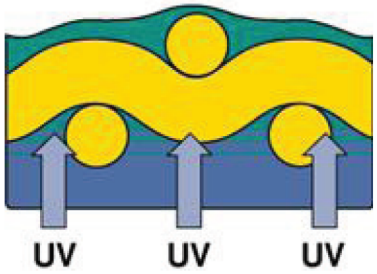
Če poznamo spekter občutljivosti emulzije in sevalni spekter luči, lahko določimo osvetlitvene parametre (oddaljenost luči od šablone in čas osvetljevanja).

1/4 full exposure



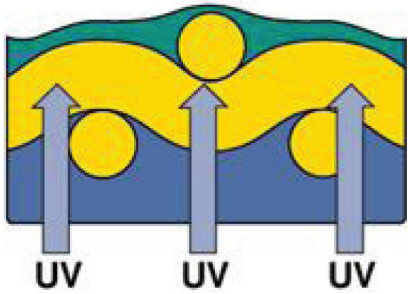
EFFECTS: During washout the image would appear and the stencil would probably start to come away during washout.

1/2 full exposure



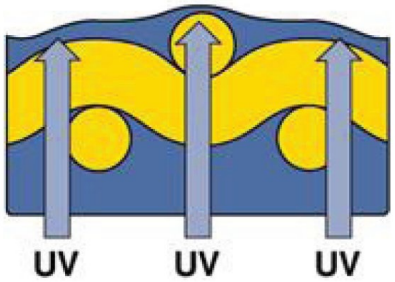
EFFECTS: The stencil would probably be damaged by a strong washout spray. The emulsion appears soft on the squeegee side.

3/4 full exposure



EFFECTS: Emulsion appears slightly soft on squeegee side. Stencil will scum if not washed out properly. Durability is compromised. Stencil is harder to de-coat.

Full exposure



EFFECTS: All the emulsion is fully hardened and the stencil will provide the optimum resistance and durability.

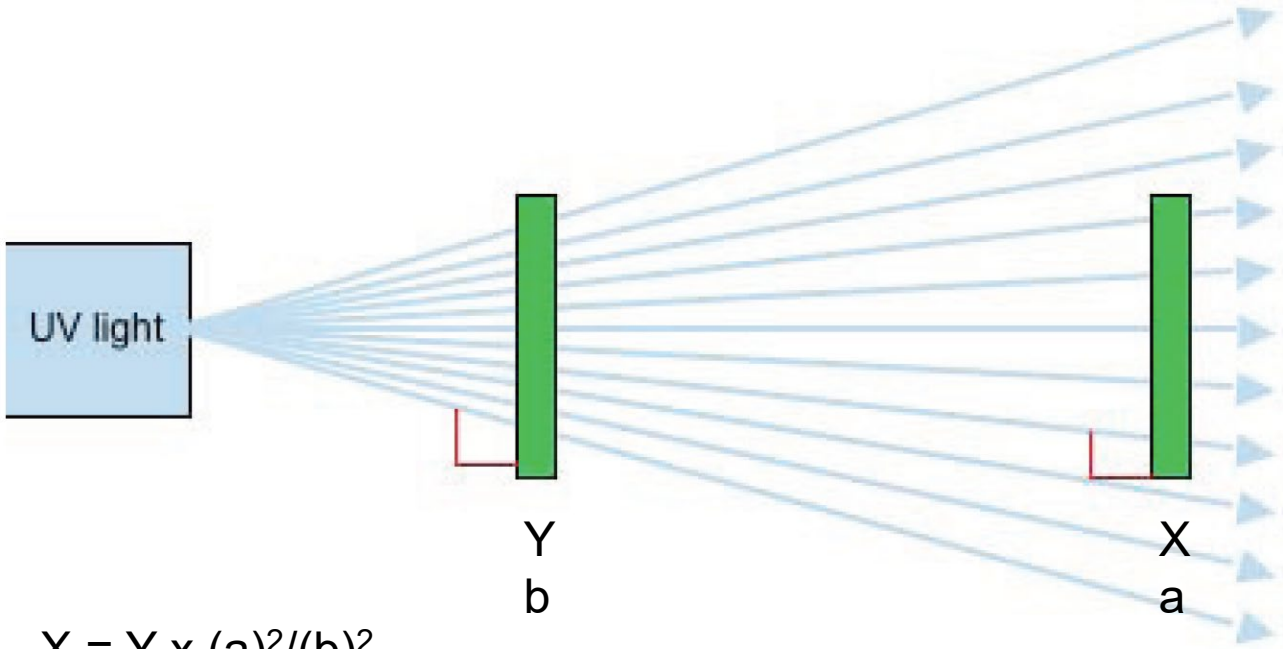
TISKOVNA FORMA

Čas osvetlitve, ekspozicije je odvisen od:
• vrste mrežice
• šablone (TF), uporabljena emulzija (debelina nanosa)
• svetlobni vir (vrsta, oddaljenost, starost svetila, dizajn reflektorja …)

Splošno pravilo:

- Minimalna razdalja med svetlobnim virom in vakuumskim okvirjem naj bo enaka diagonali površine, ki jo osvetljujemo (to zagotovi enakomerno osvetljevanje po celotni površini TF)

TISKOVNA FORMA



$X = Y \times (a)^2/(b)^2$

X = novi čas ekspozicije
Y= izvorni čas ekspozicije
a = nova oddaljenost
b = „izvorna“ oddaljenost

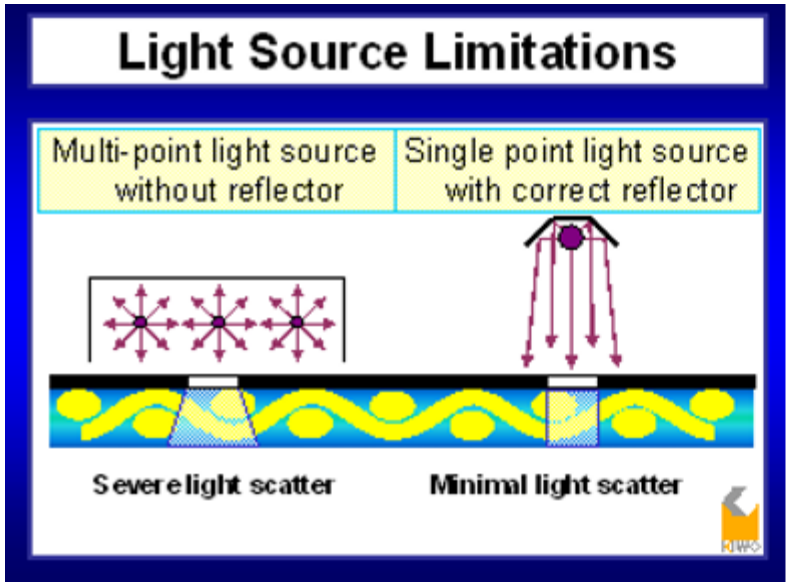
TISKOVNA FORMA

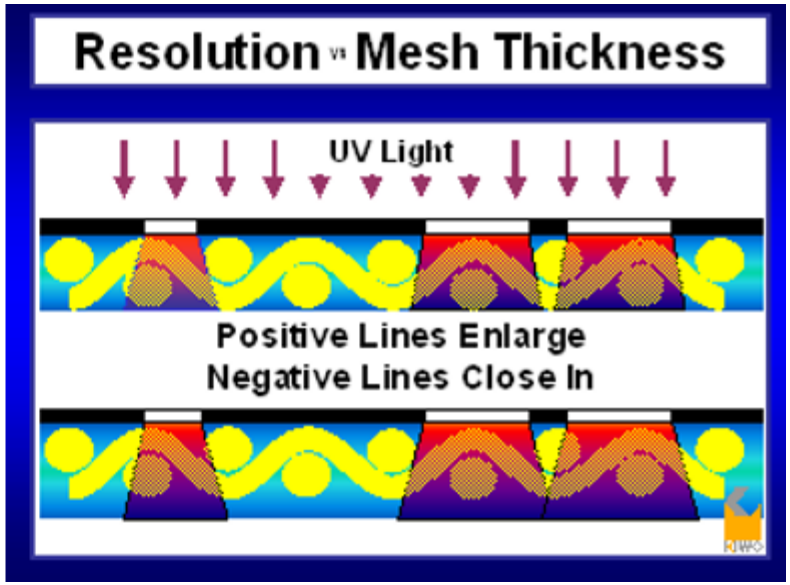
PREPREČITEV PODSVETLITVE

- skrajšamo čas osvetlitve

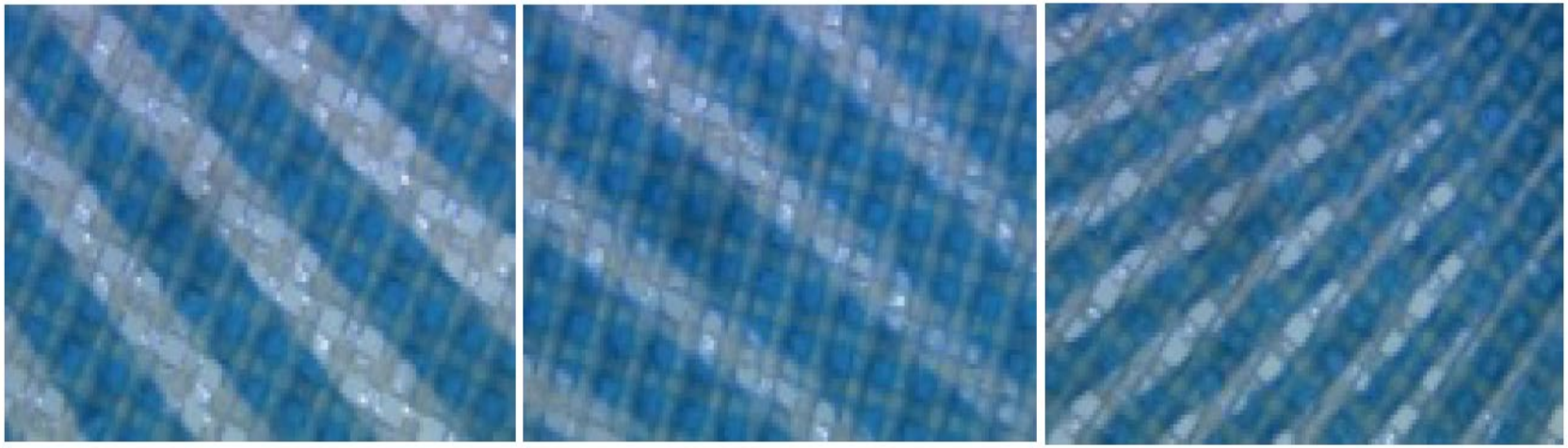
(slabost – lahko se pojavi slaba odpornost na topila in vodo)

- obarvana emulzija
- obarvana mrežica
- izbira svetlobnega vira





TISKOVNA FORMA



Ideal exposure

Over-exposure

Under-exposure

TISKARSKI SISTEMI

Tiskovne geometrije:

- ravno – ravno
- ravno – okroglo
- okroglo - okroglo

TB se prenaša le linijsko v tiskovni črti – tudi pri geometriji ravno – ravno.

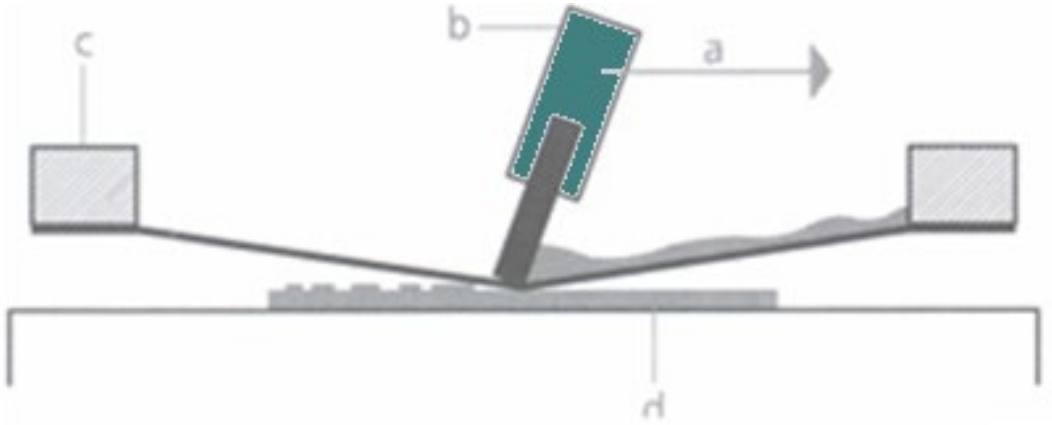
Različne stopnje avtomatizacije strojev:

- ročni
- polavtomatski
- avtomatski

TISKARSKI SISTEMI

Ploski tisk

- tisk elastičnega in čvrstega, togega TM:
  - papir,
  - karton,
  - folije,
  - les,
  - keramika,
  - tekstil…



a. smer tiskanja
b. tiskarski nož
c. šablona
d. tiskanec

TISKARSKI SISTEMI

Fig. 2.4-14
Semi-automatic screen printing machine for printing on flat substrates (Siri/Bochonow)

Fig. 2.4-12 Flat-bed screen printing equipment (Siri/Steinmann)

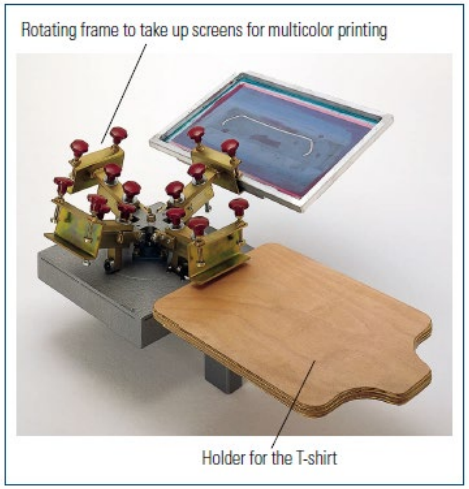
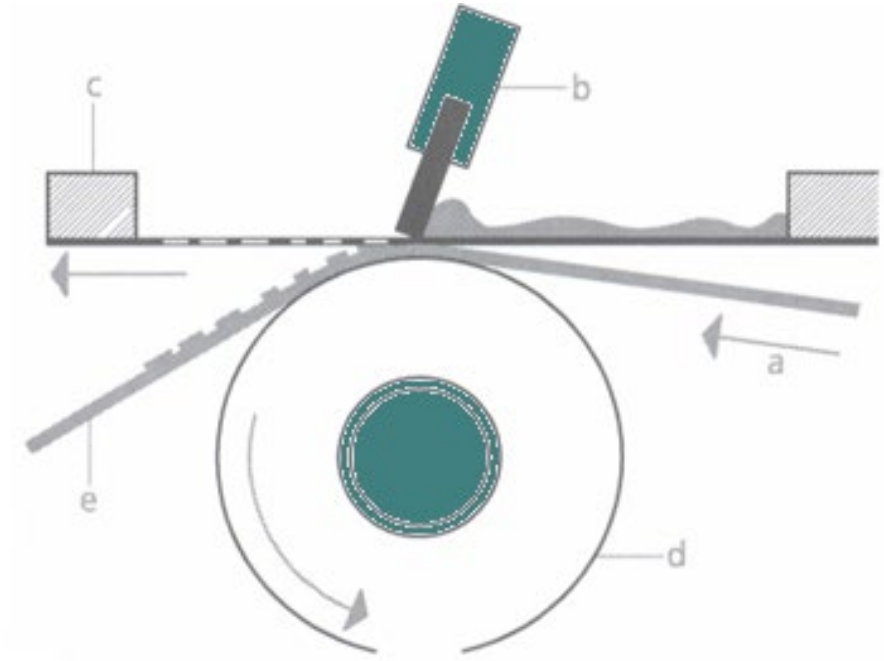


Fig. 2.4-13
Screen printing equipment for multicolor printing of T-shirts (Siri/Steinmann)

TISKARSKI SISTEMI

Cilindrični tisk

- tisk netogih, pregibnih materialov:
  - papir,
  - folije...

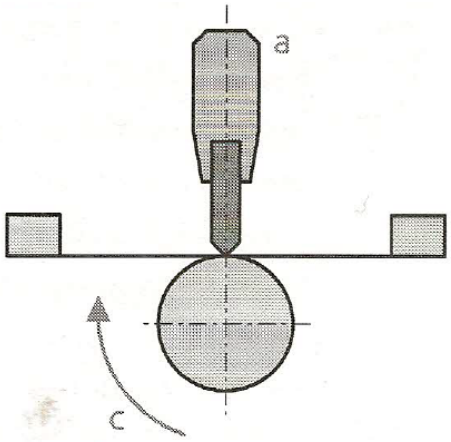


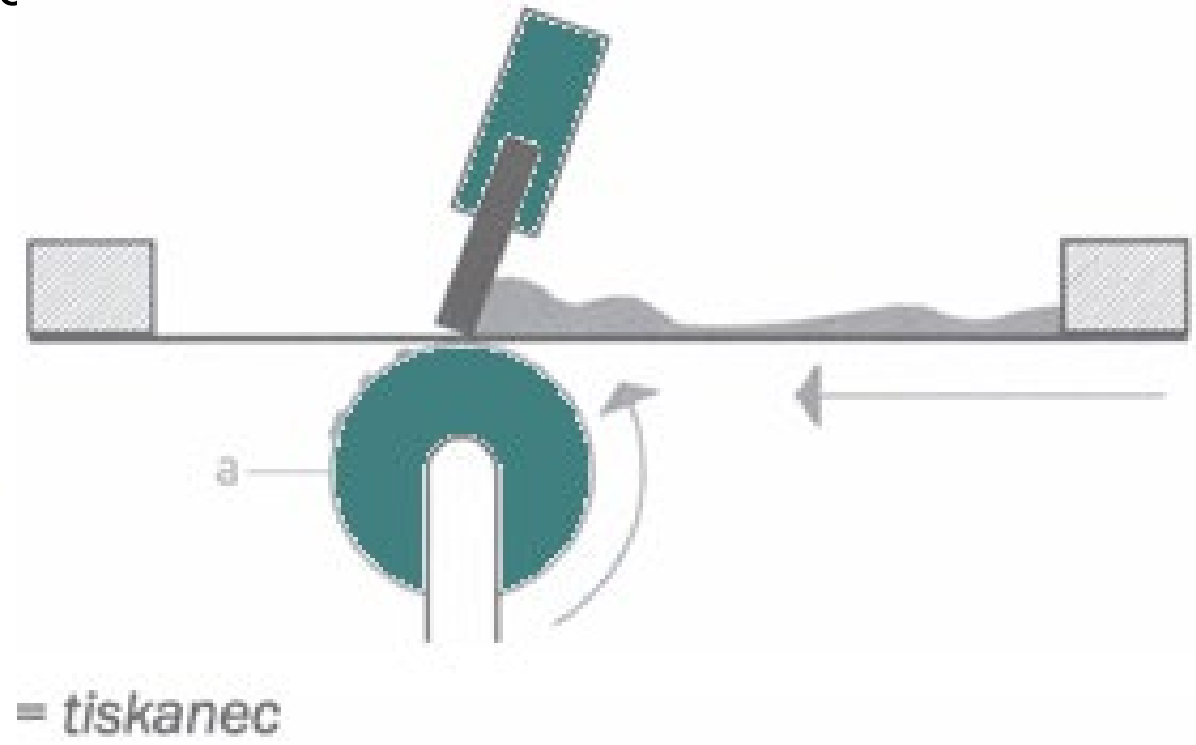
a. smer tiskanja
b. tiskarski nož
c. šablona
d. cilinder za protipritisk
e. tiskanec

TISKARSKI SISTEMI

Okrogli tisk – tisk teles

- tiskanec deluje kot tiskovni valj – omogoči nasprotni pritisk. Tisk:
  - steklenice,
  - tube,
  - pločevinke
  - lončki…





TISKARSKI SISTEMI

Fig. 2.4-15
Screen printing device for printing on curved objects/bodies (RokuPrint/Steinmann)

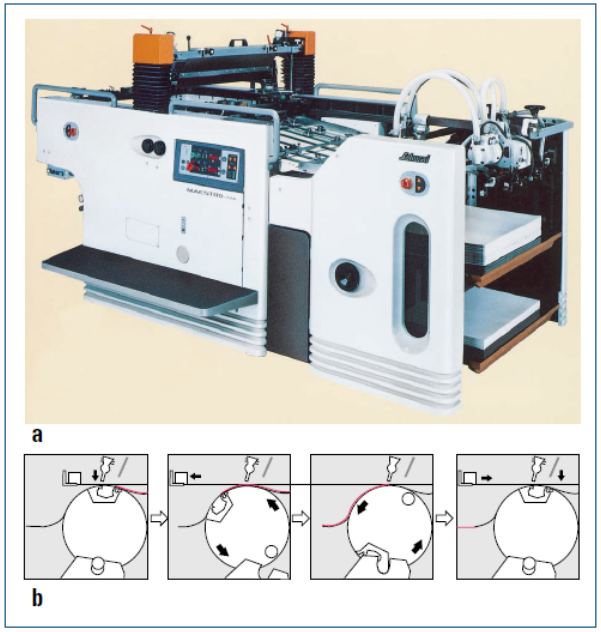
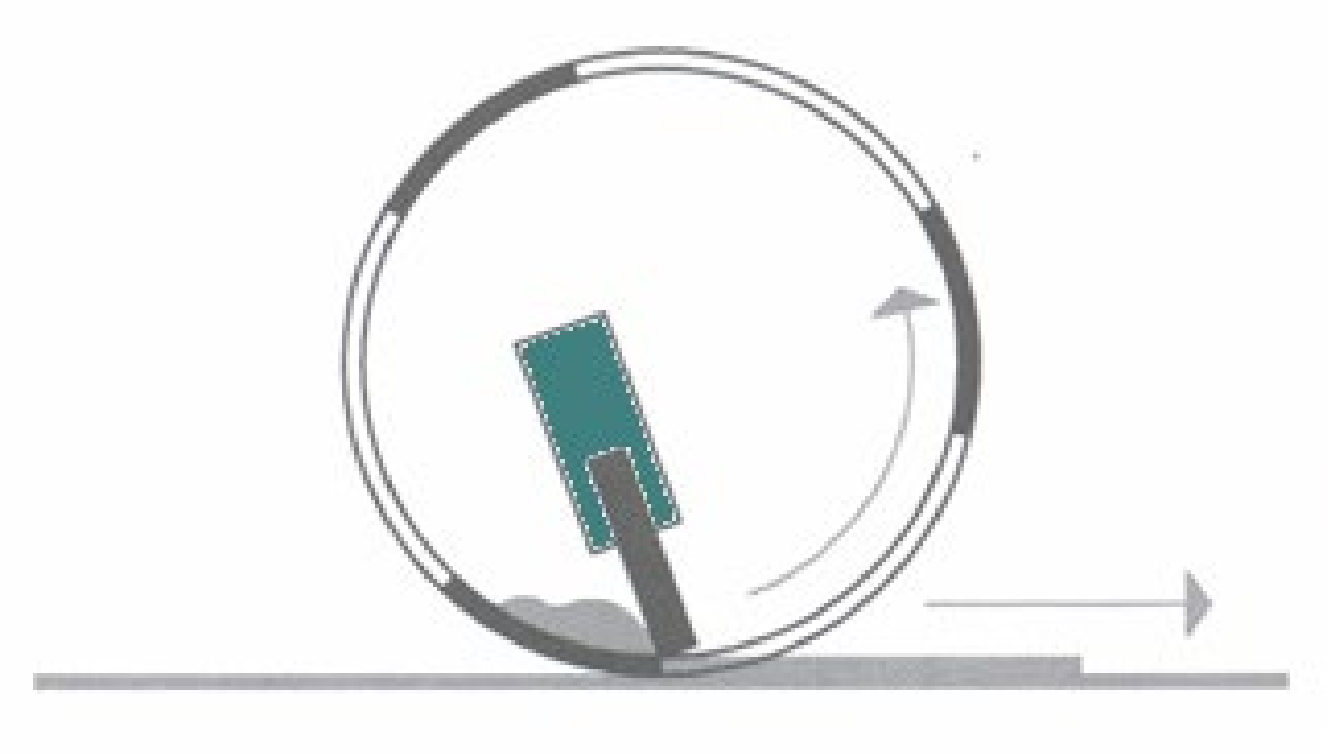


Fig. 2.4-17 Cylinder screen printing press (flat-round).
a Printing system (model: Maestro, Sakurai);
b The printing sequence

TISKARSKI SISTEMI

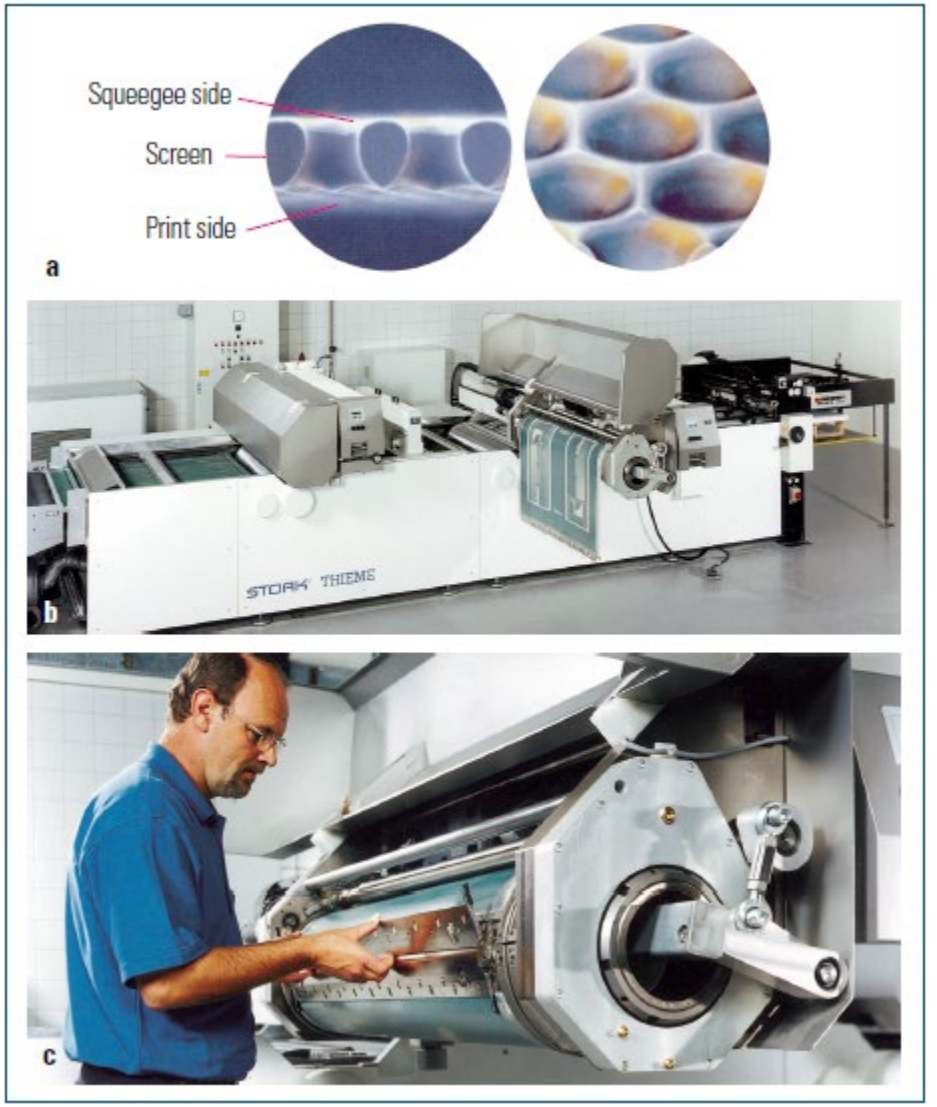
Rotacijski tisk

- npr.: tisk keramičnih ploščic



TISKARSKI SISTEMI

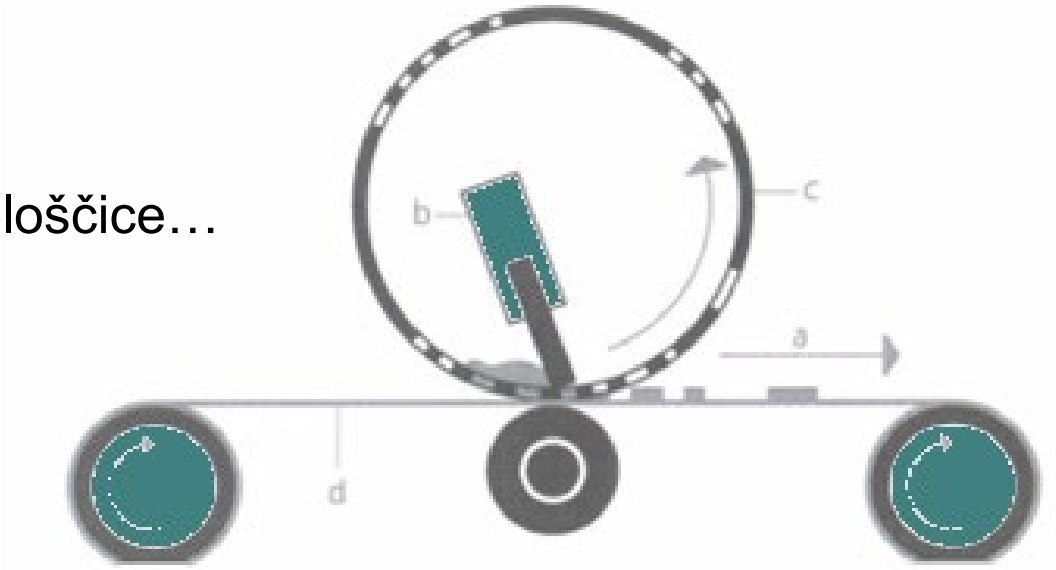
Fig. 2.4-9 Electroformed nickel screen.
a Structure of the openings (min. diameter up to 24 µm, up to 305 holes/inch, plate thickness 80 µm);
b General view of the rotary screen press;
c Fitting the flat printing plate on the cylinder (RotaPlate, Stork/Thieme)



TISKARSKI SISTEMI

Rotacijski tisk – z valja na valj

- tiskarski valj je hkrati šablona. Lahko tiskamo na pole ali zvitke.
- tiskamo:
  - folije,
  - papir,
  - tekstil,
  - keramične ploščice…



a. *smer tiskanja*
b. *tiskarski nož*
c. *okrogla šablona*
d. *tiskanec na valju ali transportnem traku*

TISKARSKI SISTEMI

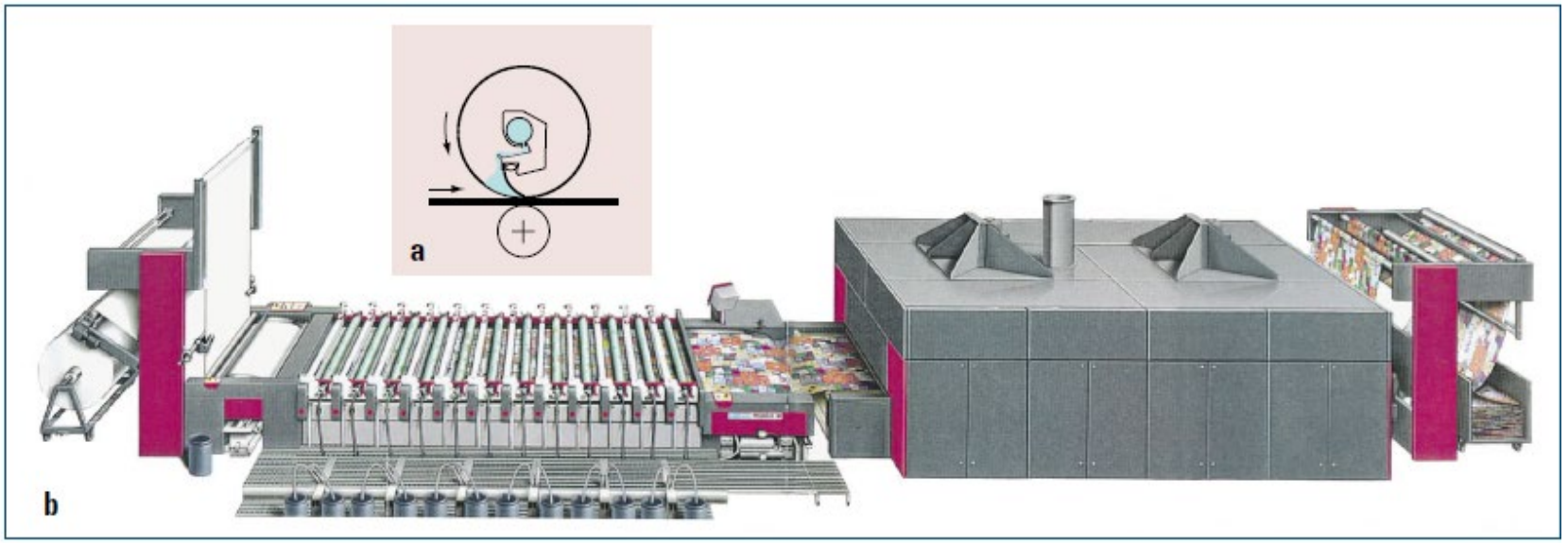


Fig. 2.4-19 Screen printing system for multicolor textile printing.
a Diagram of a rotary screen printing unit;
b "Pegasus" 12-color textile printing press with "RotaMesh" seamless rotary screens (Stork)

KONSTRUKCIJSKE ZNAČILNOSTI

Tiskanje:
kakovost tiskanja je odvisna od:

- vrsta geometrije, tiskarskega stroja
- stabilnosti tiskarske mize
- kakovosti tiskarske šablone, napetosti tkanine…
- tiskarskega noža
- nastavitve odmika

….

Nastavitev vakuumskega tiskarskega stroja:

- odmik – razdalja med sitom (šablono) in tiskancem
- priporočen odmik za format:
  - A3; 1-3 mm
  - A0; 3-5 mm

TISKARSKI NOŽ, STRGALO

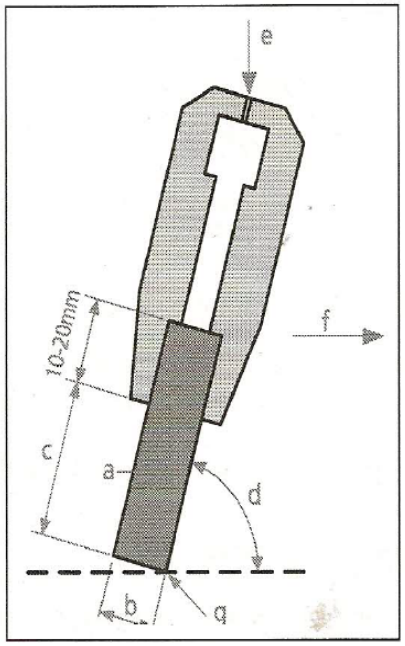
Lastnosti noža / strgala: oblika, kemijska odpornost, trdota, dolžina

- **material**
  - gumjasta strgala - večja obraba, minimalna elektrostatičnost
  - poliuretanska strgala – manjša obraba, odpornost na topila
  - …

- **trdota** (50 – 75 ° Shore A)
  - 50 do 65

  tisk ploskev, neravnih površin
  - 70 do 75

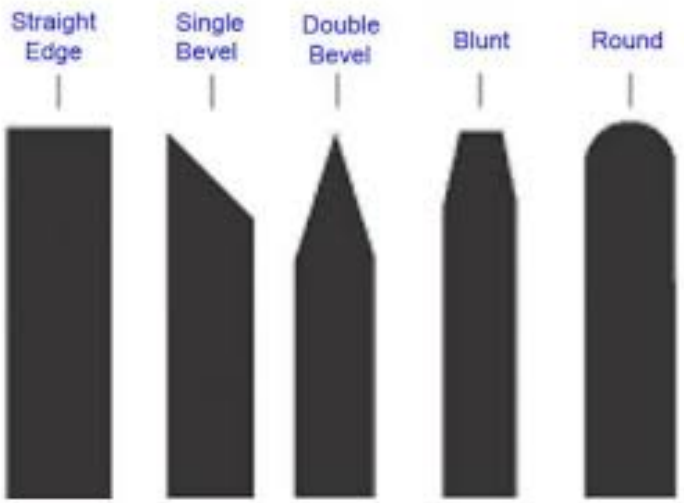
  rastrski tisk, veliki formati



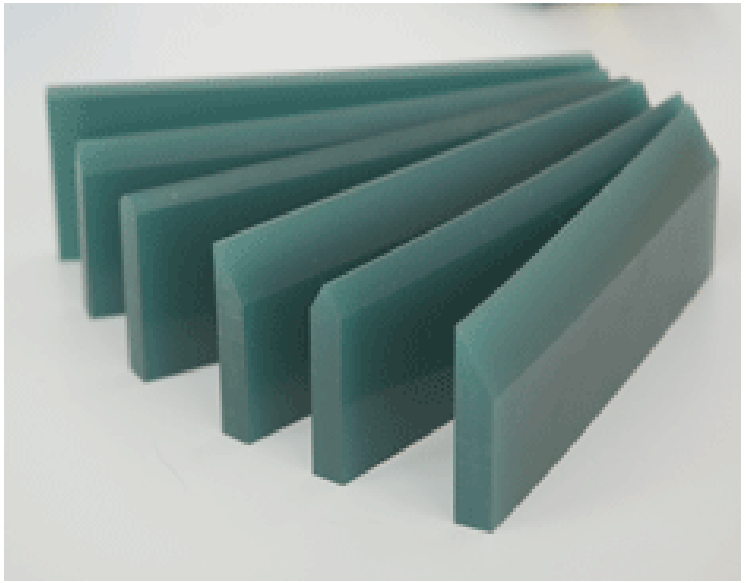
a. *trdota tiskarskega noža*
b. *debelina lista tiskarskega noža*
c. *višina tiskarskega noža - prosta*
d. *kot tiskarskega noža*
e. *pritisk tiskarskega noža*
f. *hitrost tiskarskega noža*
g. *brus tiskarskega noža (profil, površina)*

TISKARSKI NOŽ, STRGALO

- **oblika**

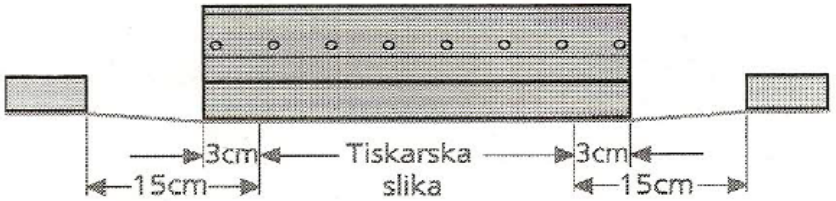


- straight edge – tisk na ravne površine
- blunt – za keramične materiale
- double bevel – za neravne površine in tisk detajlov, tankih linij …
- single-bevel – za tisk na steklo
- round – za prenos debelih plasti barve



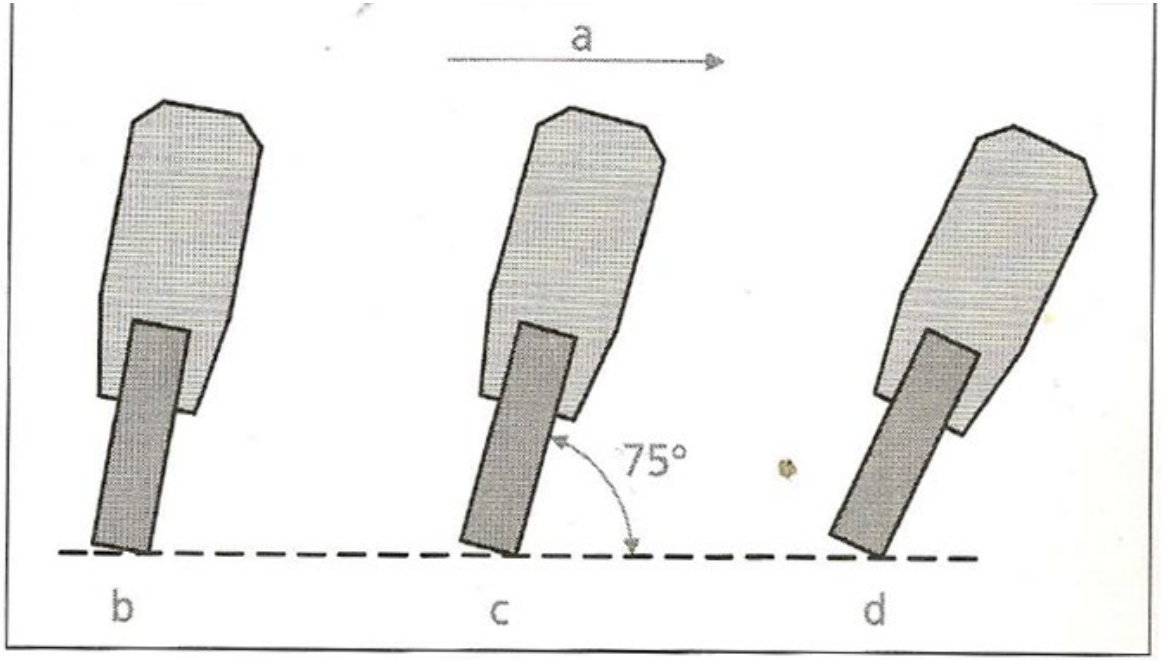
TISKARSKI NOŽ, STRGALO

- **dolžina** (vsaj 12 cm na obeh straneh od okvirja)



- **kot tiskarskega noža**

nanos TB, skladje, priporočeno 70°



Kot tiskarskega noža *a. smer tiska*
b. pokončen *c. normalen* *d. ploski - poševni*

KAKOVOST ODTISA

Golden Rule 1

Let the mesh do the metering, let the stencil do the shaping and let the ink do it's thing!

- The amount of ink going onto your print should be governed almost entirely by your mesh.
- The shape of your print should be controlled only by the shape of your stencil – and the stencil should be doing nothing else.
- The ink should be formulated for just one thing – to give you the right colour, conductivity, enzymic function or whatever is the prime purpose of the ink.

Golden Rule 2

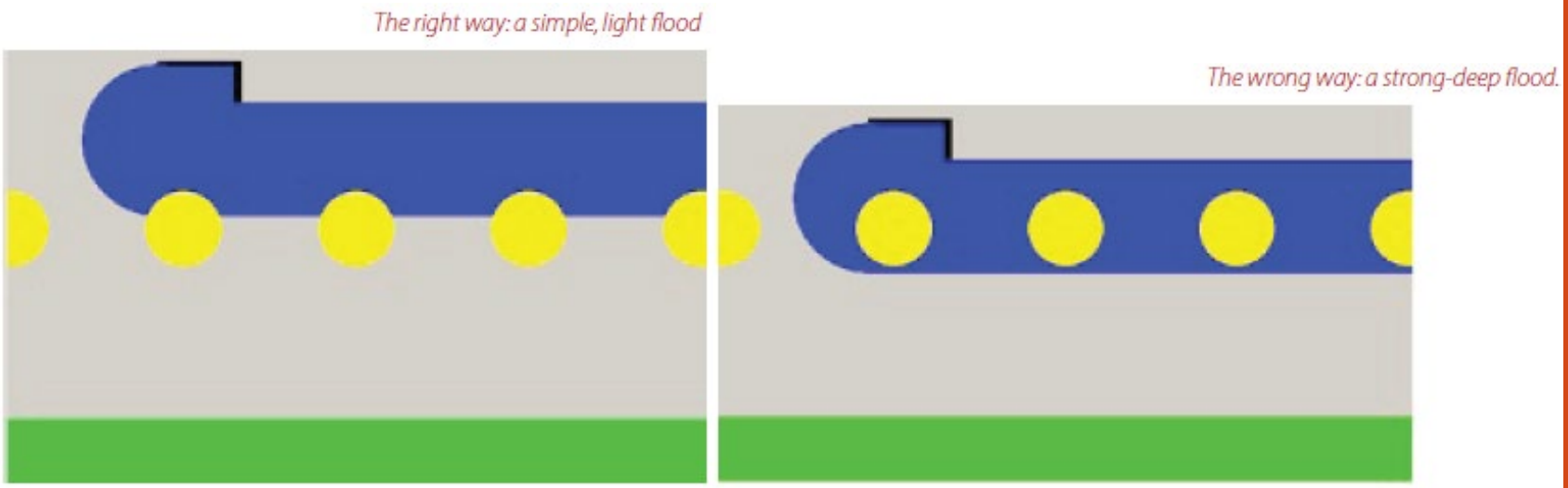
Set up your press the same way each time, with the minimum pressure, the minimum flood and, especially, with the minimum fuss.

KAKOVOST ODTISA

Dobro tiskovno prehodnost lahko dosežemo s tremi koraki:

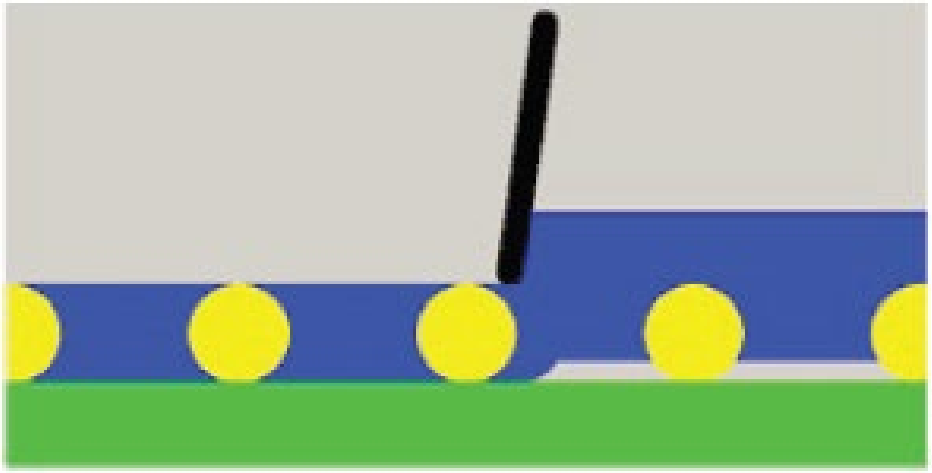
1. korak: Pripraviti ustrezno tiskarsko barvo
2. korak: Nanos barve na mrežico/šablono (TF) in po tisku le to popolnoma očistiti
3. korak: Kakovosten prenos barve skozi mrežico

1. **korak:** Pripraviti ustrezno tiskarsko barvo za tisk

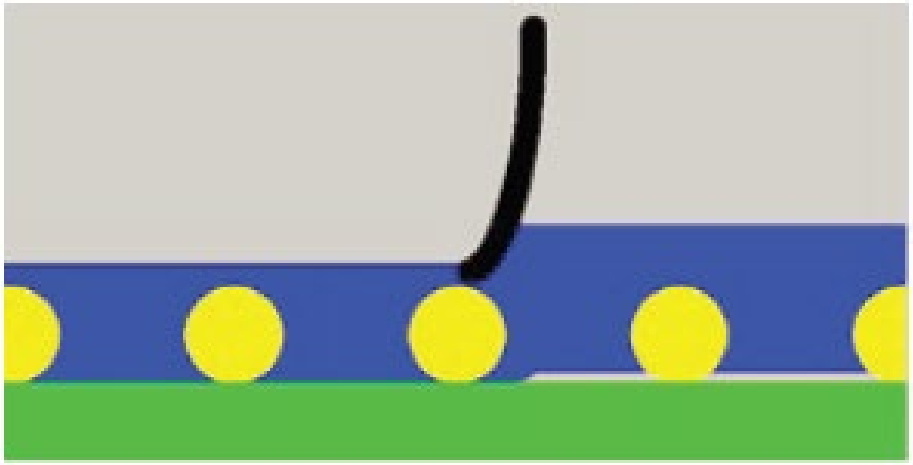


KAKOVOST ODTISA

2. korak: Nanos barve na mrežico/šablono (TF) in po tisku le to popolnoma očistiti.



In control: the squeegee filling the mesh and scraping off the excess ink



Out of control: a soft squeegee leaves a layer of ink above the mesh.

KAKOVOST ODTISA

3. korak: Nanos barve na mrežico/šablono (TF) in po tisku le to popolnoma očistiti. Kakovosten prenos barve skozi mrežico.

A filled mesh, ready to print

The mesh starting to come out of the ink

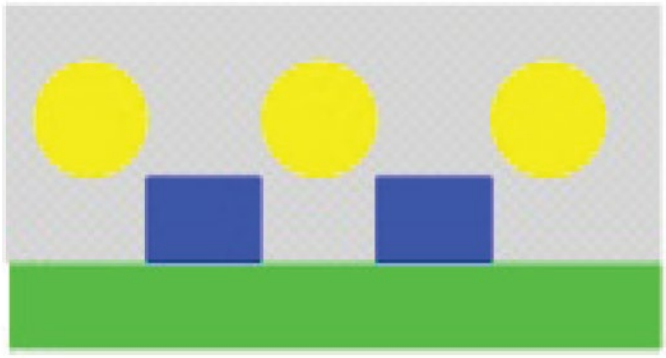
The formation of the liquid bridge is inevitable

The bridge has snapped leaving a drop

The drop has disappeared into the print

KAKOVOST ODTISA

Prenos barve skozi mrežico.



How printers think that screen printing works

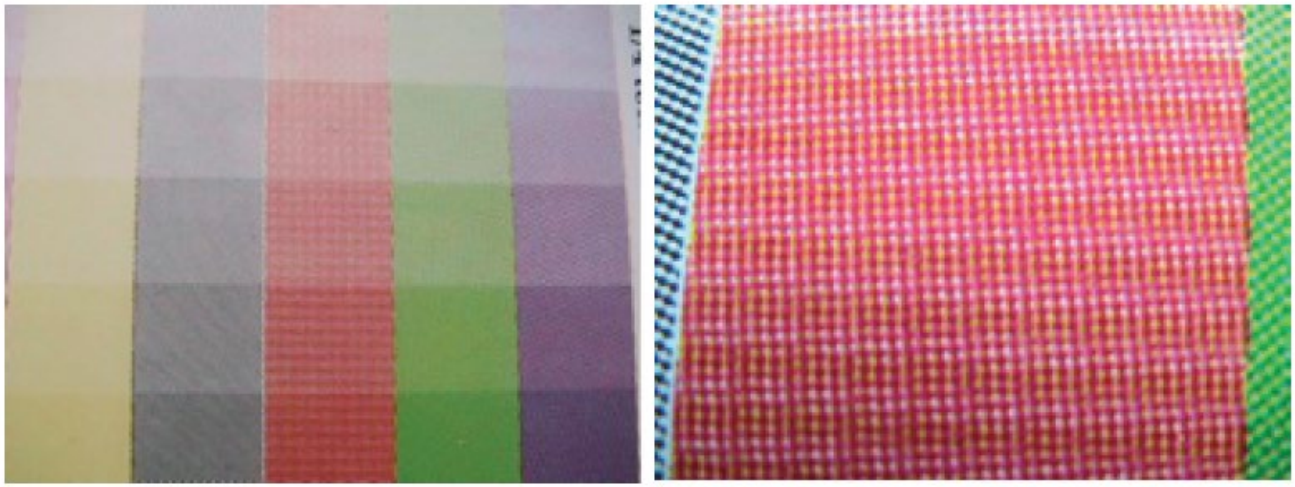
How screen printing actually works

- 30 % TB ostane na situ
- viskoznost TB nima vpliva na končno depozicijo

IZZIVI V SITOTISKU

Moire
Nepričakovan vzorec, vedno vezan na pravilen ponovljiv vzorec pik (linij). Lahko se pojavlja le na določenih mestih na odtisu. Gre za interferenco pravilnih ponavljajočih vzorcev; pika na piko, pika na mrežo ali linija na linijo ali linija na mrežo…

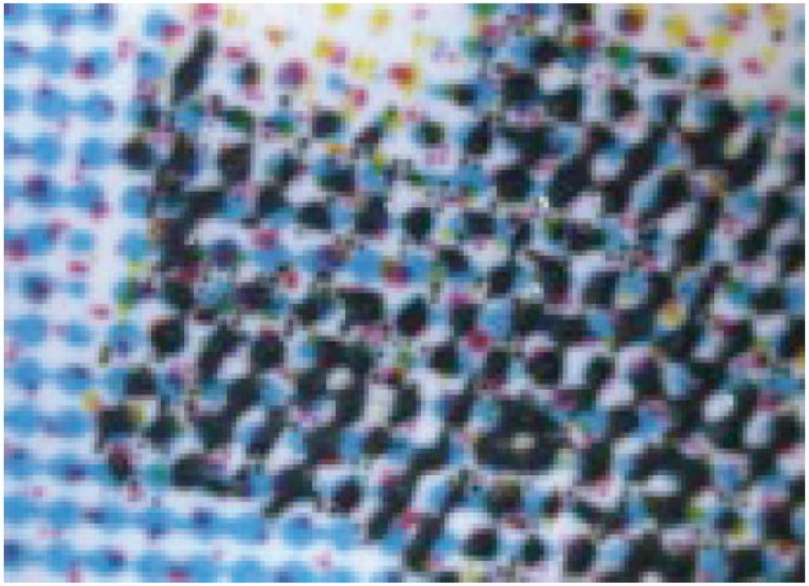
Uporabiti MMC, da najdemo optimalno razmerje mreža / LPI, spremenimo kot rastra, uporabimo problematični kot za Y, spremenimo gostoto mrežice …

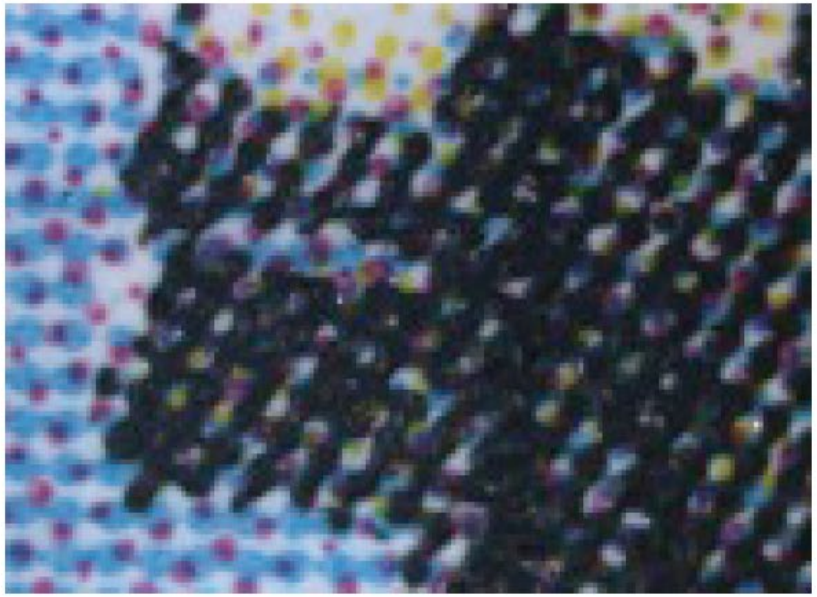


This is an example of classic 15° moiré

IZZIVI V SITOTISKU

Skipping (preskakovanje)
Pikast vzorec pri 4 barvnem tisku pri uporabi UV TB. Opazno kot pasje tačke. Pike niso jasno tiskane – mrežica ni v popolnem stiku s TM zaradi predhodno tiskanega rastra. (UV – mokro na suho!). Lahko zmanjšamo višino sloja TB z nižjim EOM.

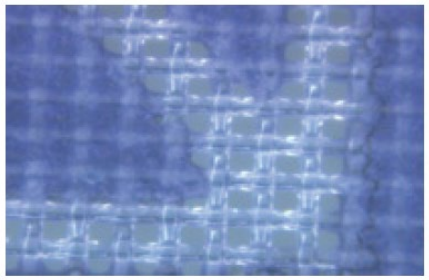


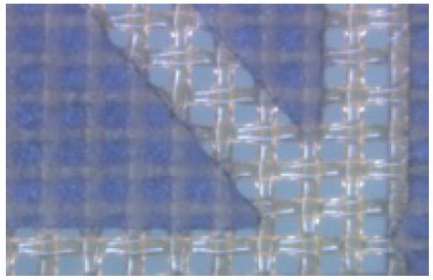


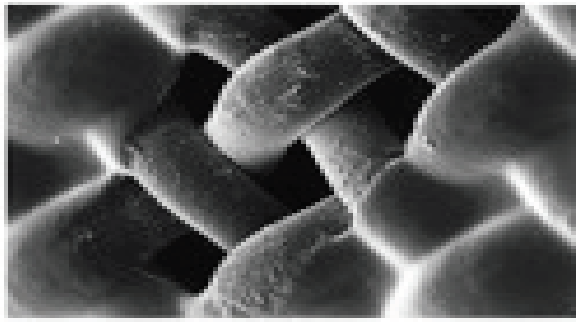
IZZIVI V SITOTISKU

Mesh marks (sledi mrežice)
Neustrezna konsistenca TB – problem z viskoznostjo, tekočnostjo, po ločitvi mrežice ostaja vidno markiranje. Priporočljivo je podaljšati čas med tiskom in sušenjem, spremeniti mrežico – manjši premer, zamenjati TB > z boljšo tekočnostjo.

Nazobčanje linij ali rastrskih pik (saw toothed lines or dots)
Posledica; (1) Rz previsok, (2) prekratek ali predolg čas ekspozicije TF, (3) uporaba bele mrežice, (4) stopničasta linija zaradi napačnega kota TF glede na mrežico.



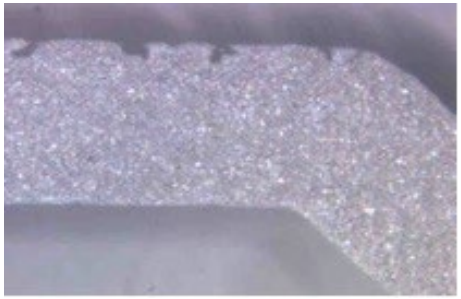


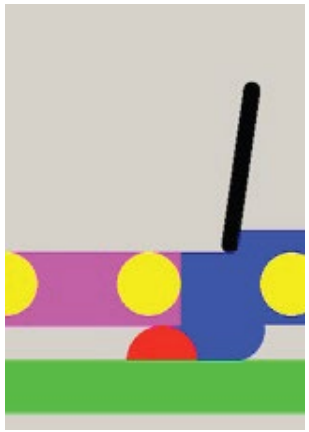


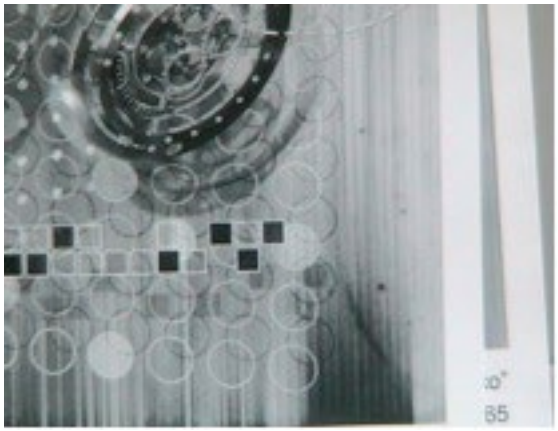
IZZIVI V SITOTISKU

Negative sawtoothing (negativno nazobčanje)
Nazobčanost notranjosti roba linije. TB nima ustrezne viskoznosti, ne zapolne odprtin mrežice. Uporabiti nižjo EOM TF.

Dark spots / Hickies (temni madeži)
Madeži premera 0,5 do 2 mm. Vzrok je prah, delci nečistoč, ki ne omogočajo dober stik med sitom in TM. TB steče pod sito > povzroči madeže. Nečistoče lahko ostanejo oprijete na TM ali pa na situ …

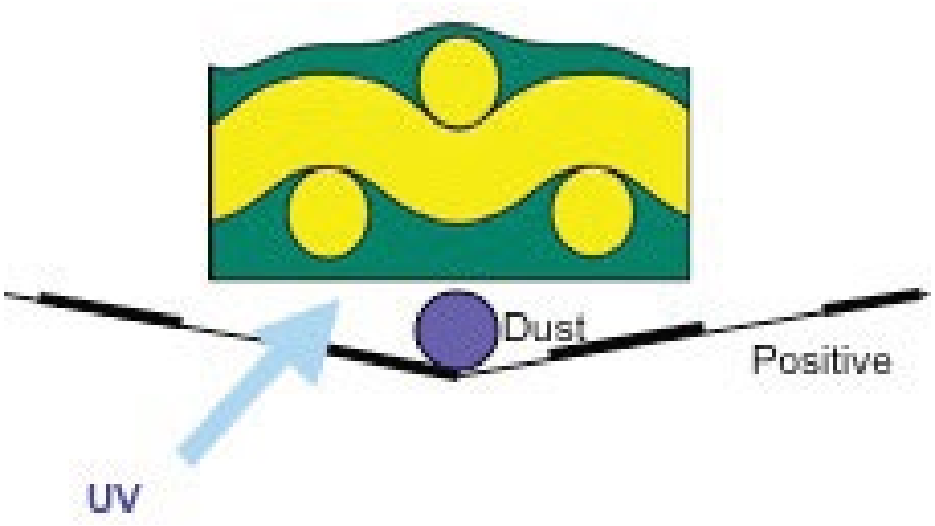


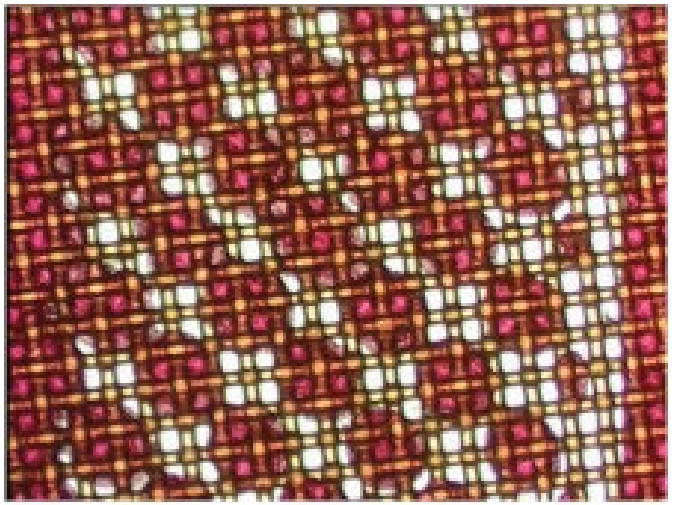




IZZIVI V SITOTISKU

Light spots (svetli madeži)
Madeži nastanejo kot posledica prirasta na šabloni.
Delci nečistoč med TF in filmom med ekspozicijo
Povzročijo nastanek svetlih madežev.

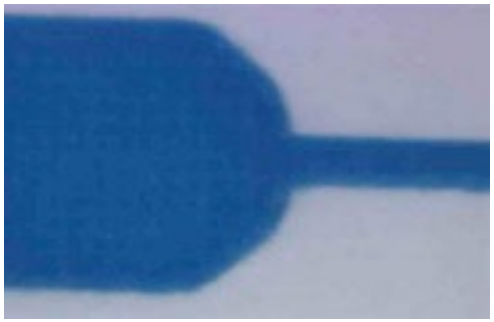


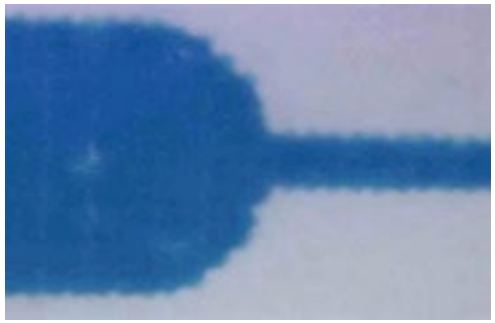


Pred razvijanjem (obsevanjem) TF moramo očistiti površino sita in filma.

IZZIVI V SITOTISKU

Printed line/dot larger than positive (Tiskane linije/pike večje kot na filmu)
Vzrok razlivanje TB ali pa nazobčanje linij (sawtooth). Zamenjati TB, zmanjšati Rz ….

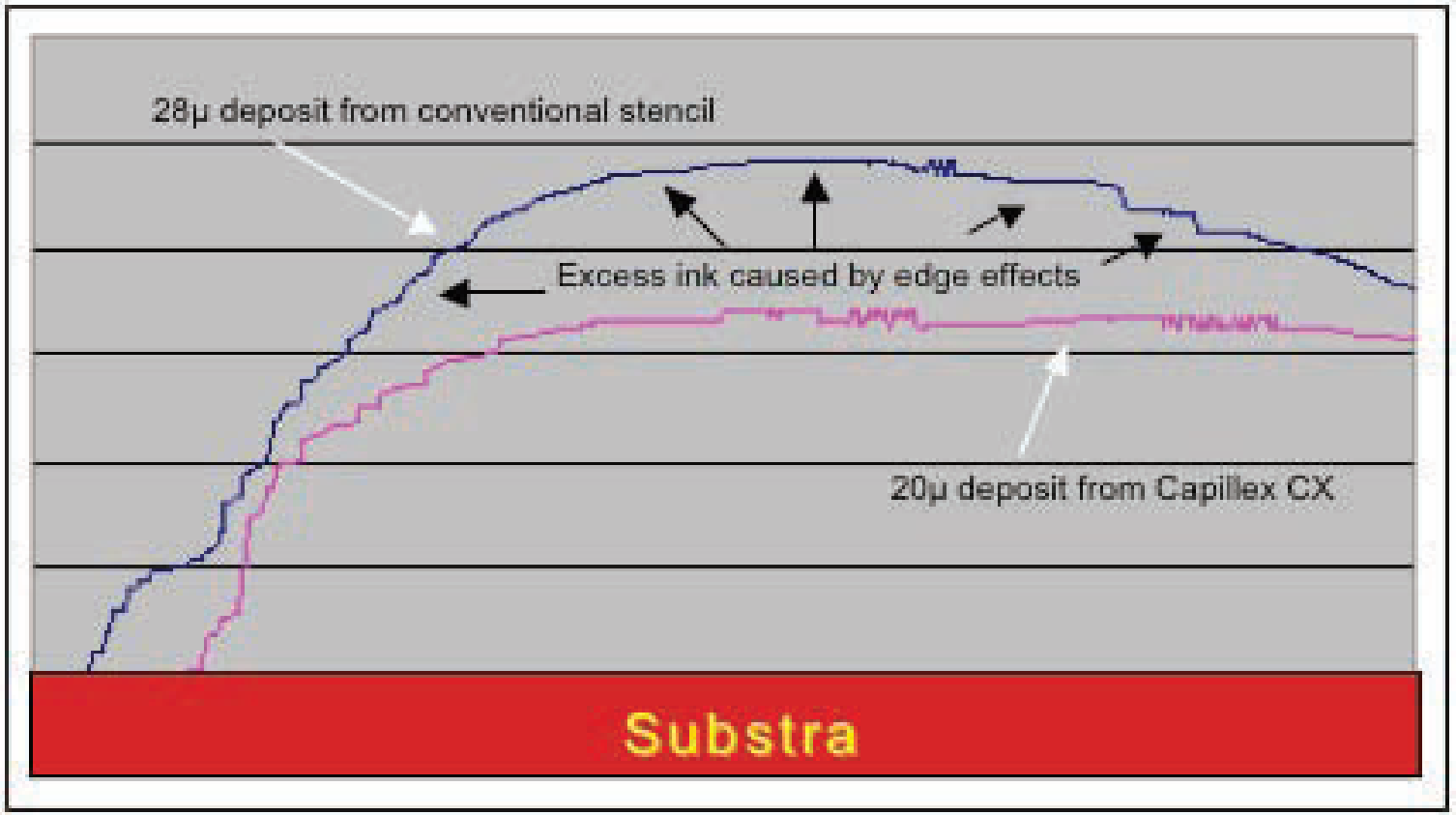




Printed line/dot smaller than positive (Tiskane linije /pike manjše kot na filmu)
Problem pri izpostavitvi – razvijanju TF (preslab vakuum, napačno obrnjen film, zaščitni film ni bil odstranjen …, predolga osvetlitev).

IZZIVI V SITOTISKU

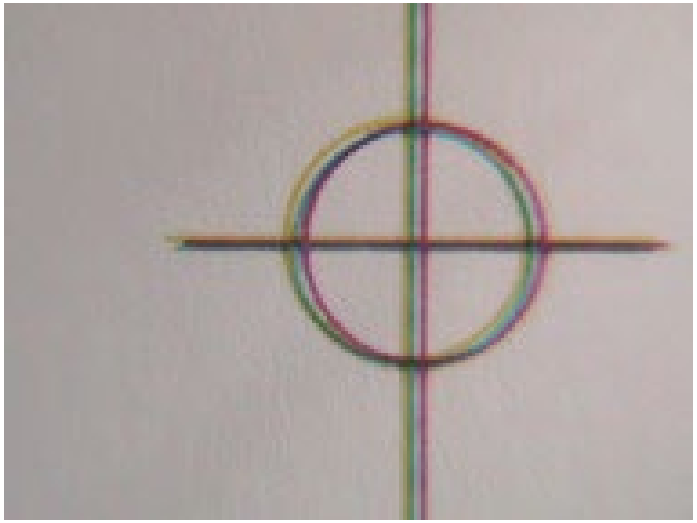
Thick edges to print (debeli robovi na odtisu)
Posledica previsoke EOM. Zmanjšati EOM > boljše uporabiti kapilarni film, ki omogoča kontrolirano nizko EOM.



IZZIVI V SITOTISKU

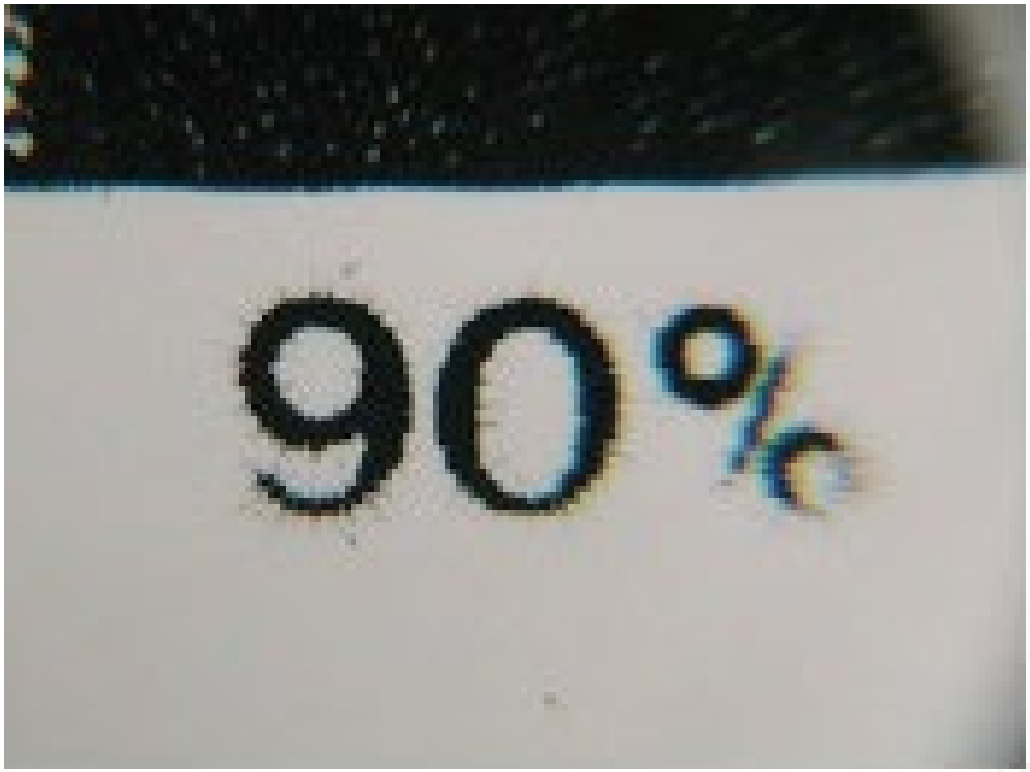
Image distortion (problemi skladja)
Problem skladja pri barvnem tisku. Prenizek kontakt, previsok pritisk strgala, slika preblizu kota rastra, mrežice različnih TB z različno napetostjo, preveč fleksibilna mrežica, nestabilen TM, sprememba T ali vlage med izdelavo šablone.

Zmanjšati pritisk strgala z nižjo EOM (nižji EOM > potreben nižji pritisk rakla), uporabiti večje sito, uporabiti mrežico iz nerjavnega jekla > manjši raztezek, predhodno kondicionirati TM, vedno osvetljevati in tiskati pri konstantni T in vlažnosti.



IZZIVI V SITOTISKU

Cobwebbing
Naključen prenos TB na odtisu, vzrok statični naboj. Potrebno je ozemljiti tiskalnik, povišati vlažnost, ali uporabiti deioniziran zrak, ki zmanjša statični naboj na TM.



IZZIVI V SITOTISKU

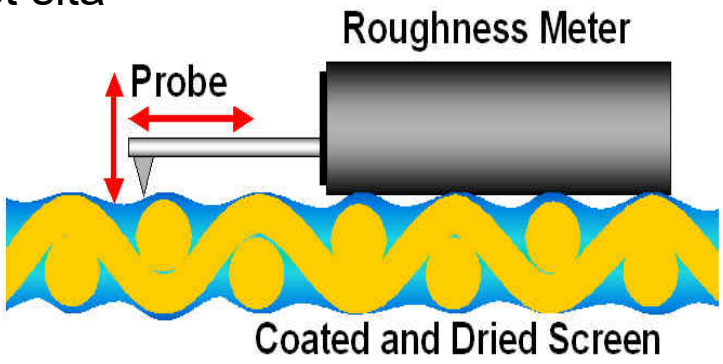
Colour shift (zamik barvitosti)
Kontroliran prirast > nizek EOM, nizek Rz! Priporočeno > uporaba kapilarnega filma (folije) s 3 µm EOM in Rz < 4 µm, uporaba kar se le da tanke mrežice > kontroliran nanos TB.
Uporaba TB, ki omogočajo tanek nanos (TB na osnovi organskih topil…) … Priporočljivo testirati vrstni red TB tiska.

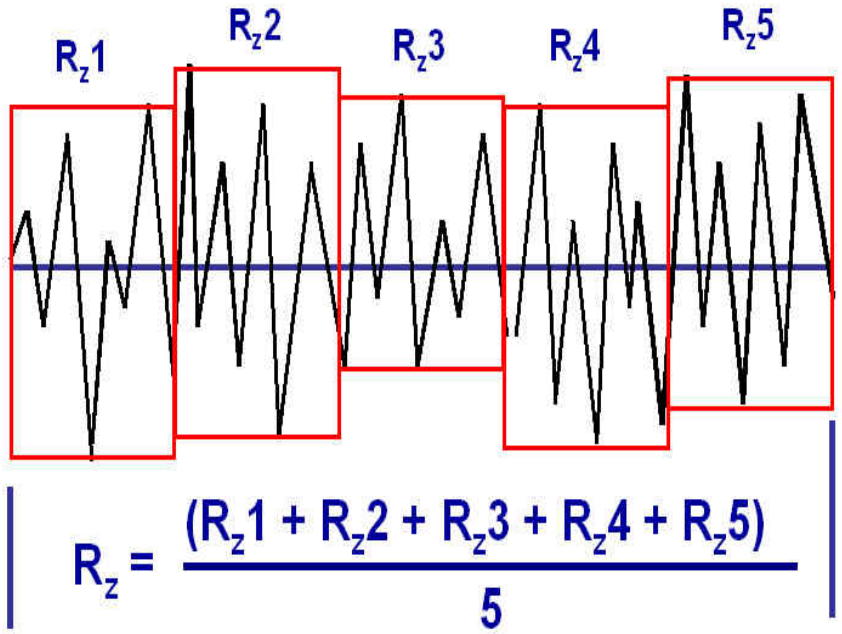
1	CYMK
2	KCMY (Caza b)
3	YMCK
4	MCYK
5	MYCK
6	YCMK
7	CMYK
8	CMKY (Caza a)

This portion of one of the Linotype-Hell test images shows the wide colour variation from four of the eight test sequences. Clockwise from the top left, 4:MCYK, 5:MYCK, 6:YCMK, 8:CMKY

IZZIVI V SITOTISKU

Kakovosten tisk: tanek nanos / hrapavost sita

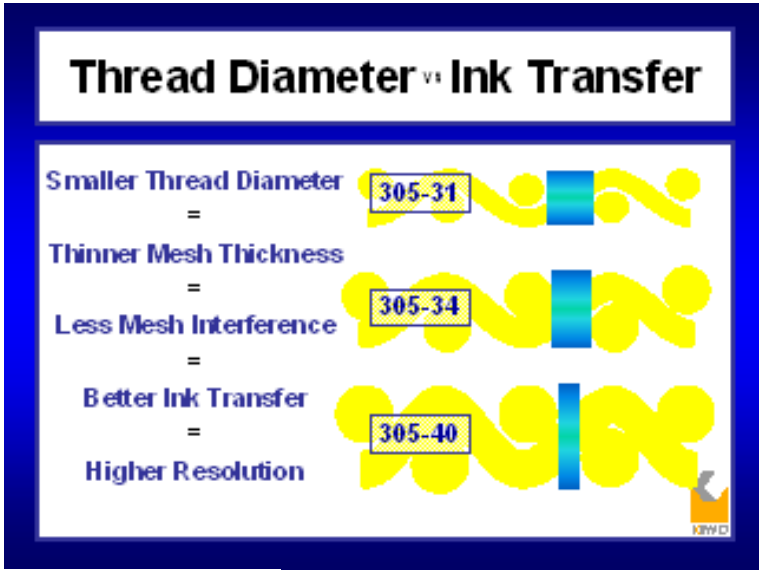




For each of the five secctions, the Rmin and Rmax are added together (each is a positive number) and then the totals are added and averaged to determine the final Rz value for the stencil coating on this particular mesh.

IZZIVI V SITOTISKU

Kakovosten tisk: tanek nanos



Mesh cross-section	comparative ink deposit:
	100 %, uncalendered mesh
	Approx. 10 – 15 % reduction calendered side = squeegee side
	Approx. 15 – 25 % reduction calendered side = printing side

INTERNATIONAL STANDARD

ISO 12647-5

First edition
2001-12-15

Graphic technology — Process control for the manufacture of half-tone colour separations, proof and production prints —

Part 5:
Screen printing

SIST ISO 12647-5:2015
Grafična tehnologija - Vodenje procesa izdelave rastriranih barvnih izvlečkov, preskusnih in proizvodnih odtisov - 5. del: Sitotisk

Objavljen: 01-mar-2015

STANDARD SIST ISO12647-5

4.2 Colour separation films

4.2.1 Quality

Unless otherwise specified, the core density shall be at least 3,5 above the transmission density of the clear film (film base plus fog). The transmission density in the centre of a clear half-tone dot shall not be more than 0,1 above the corresponding value of a large clear area. The transmission density of the clear film shall not be higher than 0,15. Both measurements shall be made with a (UV) transmission densitometer whose spectral products conform to ISO type 1 printing density as defined in ISO 5-3. The fringe width shall not be greater than one fortieth of the screen width; the half-tone dot shall not be split up in distinct parts. The colour separation film quality shall be evaluated according to ISO 12647-1:1996, annex B. '

D – min. 3,5 – pri kontaktnem kopiranju mora biti čim večja razlika v optični gostoti med filmom samim in počrnitvijo na polnem polju.
(2.5 – ofsetni tisk, 4.5 – fleksotisk)

STANDARD SIST ISO12647-5

4.2.2 Screen **ruling**

The screen ruling (screen frequency) shall be within the range 20 cm^{-1} to 40 cm^{-1}.

NOTE 1 Outside of the 20 cm^{-1} to 40 cm^{-1} range the general principles of this part of ISO 12647 remain valid but specific values may differ.

NOTE 2 With computer generated screening, the parameters "screen ruling" and "screen angle" may be varied slightly in conjunction, from one process colour to another, in order to minimize moire patterns.

- **Liniatura rastra**
  - 20 – 40 lcm^{-1}, 40 lcm^{-1} - z mrežicami nad 180 nitk/cm.

Gostota tkanja: 4 - 5 × večja od liniature rastra – sicer ne dosežemo zadovoljivega tonskega območja (5 - 95%).

- tiskarji določajo glede razdalje opazovanja:

pri razdalji < 0,5 m, linijatura 36-48 (pik) l/cm, pri 3-20 m 12 (pik) l/cm

STANDARD SIST ISO12647-5

4.2.3 Screen angle

The angles of the screen mesh shall be 0° and 90° with respect to the frame.

For half-tone dots without a principal axis, the nominal difference between the screen angles for cyan, magenta and black shall be 30°, with the screen angle for yellow separated by 15° from another colour. A typical example is shown in Figure 1. No colour should align with mesh warp or weft, or diagonal. In order to achieve this, one colour should be rotated by 7,5° with respect to the mesh. These values refer to the films; right reading, emulsion up.

For half-tone dots with a preferential axis, the nominal difference between the screen angles for cyan, magenta and black shall be 60°, with the screen angle for yellow separated by 15° from another colour. A typical example is shown in Figure 2.

- **Koti rastrov**

Mrežica mora biti napeta pod kotom 0°ali 90°

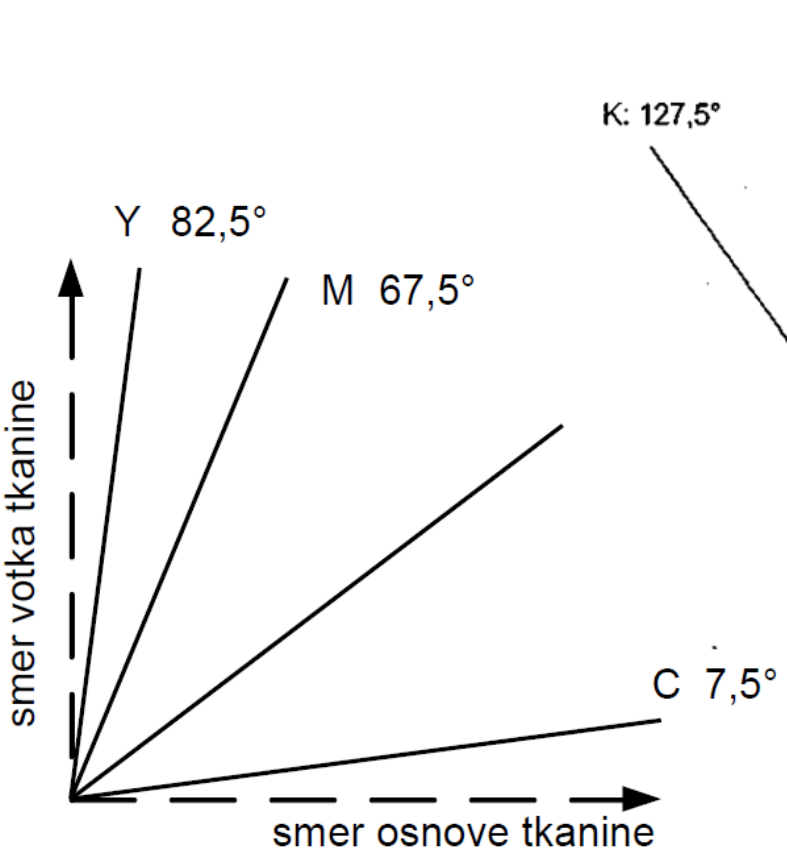
- rastrske pike brez dominantne osi (C, M, K) oddaljene za 30°, Y 15°.

Nobena barva ne sme biti v smeri osnovnih/votkovnih niti tkanine
ali v smeri njihove diagonale!
rastrske pike z dominantno osjo (C, M, K) oddaljene za 60°, Y pa za 15°.

STANDARD SIST ISO12647-5

Različna priporočila za kote rastrov:

- 7,5° naklon v primerjavi s smerjo niti v tkanini (izogib moarea)
- bolj fina tkanina v primerjavi z rastrom manjša možnost moareja.



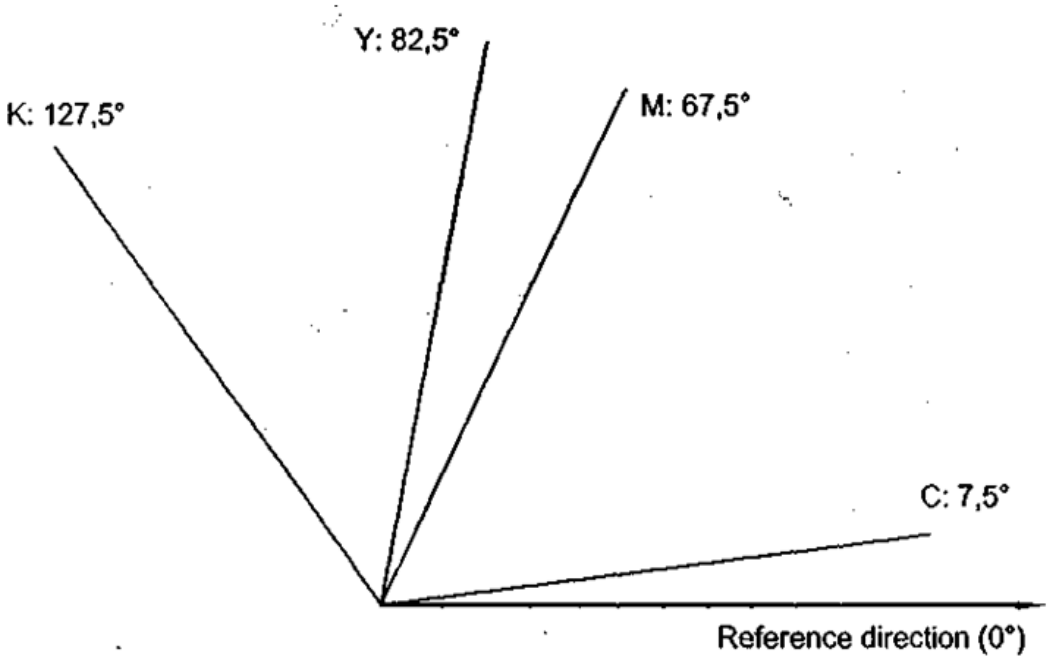


Figure 2 — Typical screen angles for half-tone dots with a principal axis

STANDARD SIST ISO12647-5

4.2.4 Dot shape and its relationship to tone value

Where elliptical half-tone dots are used, the first link up shall occur no lower than at 35 % tone value and the second linkup no higher than at 65 % tone value.

4.2.5 Image size tolerance

For a set of colour separation films in common environmental equilibrium, the lengths of the diagonals shall not differ by more than 0,02 %.

NOTE This tolerance includes image-setter repeatability and film stability.

4.2.6 Tone value sum

There is no restriction on the tone value sum.

NOTE Tone value sums between 300 % and 400 % may be used. However, in order to match products from other processes, a lower tone value sum may be appropriate.

STANDARD SIST ISO12647-5

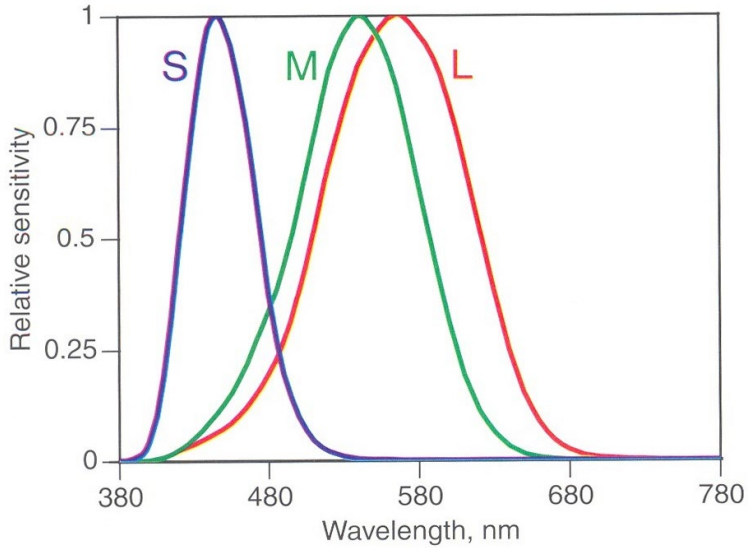
4.2.7 Grey balance

Grey balance, unless otherwise specified, should be given by the tone value combinations of Table 1.

Table 1 — Grey balance

Tone value	Cyan %	Magenta %	Yellow %
25 % tone	25	15	15
50 % tone	50	40	40
75 % tone	75	64	64

L : M : S = 40 : 20 : 1



STANDARD SIST ISO12647-5

4.3.1.1 Print substrate colour

For **the** three gamut classes defined in 4.3.1.3, the print substrate colour shall be white with the colorimetric properties shown in Table 2. The print substrate used for proofing should be identical to that used for the production. If that is not possible the print substrate used for proofing shall be a close match to that used for the production in terms of colour, gloss, type of surface (such as paper, plastic, board) and mass per area.

NOTE If the final product is to be surface finished, this may severely affect the substrate colour.

Table 2 — Print substrate colour restrictions

$100 \geq L^* \geq 90$
$-3 \leq a^* \leq 3$
$-5 \leq b^* \leq 5$

Določeni trije razredi barvnih območij – tiskovine z velikim, s srednjim in z majhnim barvnim območjem.

Vsi TM, ki so dovolj svetli so lahko ustrezni za sitotisk (Tabela 2).

STANDARD SIST ISO12647-5

Barvna območja

Table 3 — CIELAB coordinates of solid colours

Colour	Gamut class 1			2			3		
	L^{*a}	a^{*a}	b^{*a}	L^{*a}	a^{*a}	b^{*a}	L^{*a}	a^{*a}	b^{*a}
Cyan	59	-35	-43	52	-33	-51	46	-32	-54
Magenta	51	70	-15	47	74	-5	42	79	10
Yellow	90	-11	66	89	-9	83	88	-7	100
Black	24	0	0	18	0	0	8	0	0
Red [b]	50	59	42	47	67	50	44	66	47
Green [b]	55	-68	32	49	-65	30	43	-62	28
Blue [b]	28	27	-41	21	26	-40	16	29	-39

[a] Measured according to ISO 12647-1:1996. 5.6. [b] Colour sequence yellow, cyan, magenta.

NOTE 1 The provision of colour co-ordinates for three gamut classes in Table 3 reflect the wide range of products produced by graphic screen printing. Gamut class 1 is appropriate for low saturation applications. Gamut class 2 is appropriate for medium saturation applications such as when it is necessary to match other printing processes. Gamut class 3 is appropriate for high saturation applications such as point of sale.

STANDARD SIST ISO12647-5

Table 5 — Tone value ranges (on film) required to transfer

Screen ruling cm^{-1}	Solvent inks %	Air-dried water-based inks %	UV inks %	Water-based UV inks %
20	10 to 90	10 to 90	5 to 95	10 to 90
40	20 to 80	20 to 80	10 to 90	15 to 85

Table 6 — Tone value ranges (on film) recommended to transfer

Screen ruling cm^{-1}	Solvent inks %	Air-dried water-based inks %	UV inks %	Water-based UV inks %
20	6 to 95	6 to 95	3 to 96	5 to 94
40	10 to 90	10 to 90	8 to 92	10 to 90

NOTE In most graphic applications, particularly when printing onto paper, it is normally possible to achieve the wider tone value ranges shown in Table 6. The tone value range depends on the screen mesh used for printing. With a coarser mesh (with thicker threads) the tone value range is narrower. The tone value range narrows considerably as the screen ruling increases from 20 cm^{1} to 40 cm^{-1}. This is particularly true for solvent inks and air-dried water-based inks.

4.3.4 **Tone value** increase

The tone value increase (dot gain) aim values for proof and production printing shall be as specified in Table 7. The test method shall be as specified in clause 5. The values refer to a control strip as specified in 5.1, that is with a screen ruling of 30 cm^{-1} and circular half-tone dots. If one of the value sets specified in Table 7 is observed, the print characteristic curves of the subject matter will closely resemble the corresponding curve in Figure 3 or Figure 4.

At film tone values of 25 %, 50 % and 75 %, the deviation of the tone value of a proof or an OK print from the specified value shall not exceed 5 %.

The statistical standard deviation of the tone values of a production run should not exceed 4 % (68 % of production to be within 4 % of the OK print). The spread (variation of tone value increase between chromatic colours) of proof and production printing shall not exceed 5 %.

NOTE Differences in substrates may require minor press adjustments to produce identical curves for each substrate.

Table 7 — Tone value increase characteristic for production printing, measured at 30 cm^{-}

Type of UV	**Tone value increase on print [a], %**					
	Tone value on film					
	15	25	50	60	75	85
Water-based UV, conventional solvent	-5	-1	2	3	9	7
Conventional UV, water-based air-dried	3	7	13	14	12	8

[a] As measured with status E or T, with or without polarization.

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1 Scope

This part of ISO 12647 specifies the requirements for the screen printing of four-colour process-colour material used for display, signage, and graphics using flat bed or cylinder printing equipment. Both the size and resolution of the finished product are unrestricted. The process stages included are

— data preparation and delivery,

— proof production,

— printing forme preparation, and

— production printing.

4.1.2 Data resolution

Input data should be provided at a data spacing of twice the screen ruling to be used as determined by the scaling criteria, e.g.: 140 cm^{-1} pixels for a 70 cm^{-1} screen ruling.

4.2 Printing forme requirements

4.2.1 Resolution

Printed material produced by screen printing varies widely in both size and nominal viewing distance. For screen printing the reference acceptable image quality criteria shall be based on a 70 cm^{-1} screen ruling viewed at a distance of 42 cm (175 lpi at 16,5 inches). This relationship of distance and screen ruling defines when rosettes are no longer visible to a viewer with 20/20 vision (dot fusion).

This relationship should be scaled for other viewing distances or other screen rulings. For the same viewing quality at different distances, maintain the relationship of resolution to distance.

NOTE For a convenient approximation, divide either the desired distance in meters or the desired resolution in dots per centimetre into 30 to compute the other for that specific pair. This is sometimes referred to as the rule of 30.

The target resolution shall be based on an agreement between the printer and their customer. It should be in accordance with the following three criteria:

1) a minimum screen ruling with dots large enough to reproduce a tonal range from 1 % to 98 % using the mesh as configured, the imaging technique, the emulsion and the ink;

2) a minimum printed dot size that is not less than 1,5x the width of the thread diameter of the mesh;

3) a maximum screen ruling as recommended by the "rule of 30" for the intended viewing condition.

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4.2.2 Stencil production

The silver, thermal, or inkjet film used for imaging screens shall have sufficient UV density (>4,0) in printing areas and sufficient UV transparency (<0,1) in the non-printing areas to produce all dots required in 4.2.1. Direct to screen and computer to screen systems (CTS) shall have sufficient resolution be able to produce all dots required in 4.2.1.

NOTE Computer to screen systems (CTS) directly image the stencil and direct to screen systems (DTS) apply an image which is used to create the stencil.

4.2.3.1 Printing forme preparation

The angle of the screen mesh attached to the screen frame shall be at 0° and 90° ± 1° with respect to the frame. The angles of the image shall also be 0° and 90° ± 1° with respect to the frame.

4.2.3.2 Screen angles

For half-tone dots without a principal axis, the nominal difference between the screen angles for cyan, magenta, and black shall be 30°, with the screen angle of yellow separated at 15° from another colour.

For half-tone dots with a principal axis, the nominal difference between screen angles for cyan, magenta, and black shall be 60°, with the screen angle of yellow separated by 15° from another colour.

In all cases, no colour should align within 7,5° of the mesh (frame). If flesh tones are present, the yellow should not be referenced to magenta.

NOTE 1 This is to prevent moiré in flesh tones and to ensure that no row of dots lines up with the mesh, which would destabilize the small dot structure. It is poor practice to use and rotate offset films to produce the forme.

NOTE 2 It is common practice to use frequency modulated screening for the yellow separation with approximately the same size as the dots in the 10 % area of the conventional separations and a different tonal compensation curve.

4.2.4 Image size tolerance

For film based systems, the set of supplied films under common environmental equilibrium shall not differ by more than 0,02 % in the lengths of their diagonals.

4.3 Print production requirements

4.3.1 Visual characteristics of image components

4.3.1.1 Visual appearance of the supplied proof

Supplied proofs shall be prepared in accordance with either ISO 12647-7 or ISO 12647-8 except where indicated below and shall use the same characterization data set chosen for production. The tristimulus correction factor shall be used to adjust for the substrate colour when the production stock is not available. Proofs shall have the proper colour but may have a different size than the intended product. Proof resolution may be finer than the intended product. In this case the rule of 30 shall be followed within the constraints of the proofing equipment assuming the proof to be viewed at 42 cm.

4.3.1.2 Print substrate colour

For the best colour reproduction, the print substrate colour should be restricted as shown in Table 1. All colour measurement shall be made in accordance with ISO 13655:2009, white backing, M1.

Table 1 — Print substrate colour restrictions

$90 \leq L^* \leq 100$
$-3 \leq a^* \leq 3$
$-5 \leq b^* \leq 5$

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Table 2 — CIELAB ΔE_{ab} tolerances for the solids of the process colours[1]

Type of tolerance	Black		Cyan		Magenta		Yellow	
	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]	ΔE_{ab}	ΔE_{00}[b]
Deviation tolerance	4,0	2,8	5,0	3,5	6,0	4,2	6,0	4,2
Variation tolerance[a]	1,5	1,1	2,0	1,4	3,0	2,1	3,0	2,1

[a] The distribution of CIELAB colour differences is not Gaussian but skewed. For reasons of consistency, the variation tolerance is defined here as the upper limit for 68 % of the production copies. This is analogous to a Gaussian distribution where 68 % are within plus or minus one standard deviation of the mean.

[b] Tolerance values for DE2000 are given for information only.

[1] Measured in accordance with ISO 13655:2009, M1 with white backing.

5 Test method and reporting: Control strip

For process control a multi-colour control strip shall be used. This control strip shall be printed along with the subject on all proofs and should be printed on all production jobs. It shall contain well-defined control patches with accurate tone value designations and meet the quality and resolution requirements of the accompanying image. The screen print colour bar shall include Solid; C, M, Y, K patches; Tonal percentages of C, M, Y, K of 5 %, 10 %, 25 %, 50 %, 75 %, and 90 %; RGB overprints a white patch; and neutral grey C,M,Y patches for 10 %, 25 %, 50 %, 75 %, and 90 % (see Annex A).

The control patches on the stencil, together with the subject matter, should be inspected to ensure that the intended tone values have been achieved. In addition, for information purposes, or the checking of stencil and flooding problems, half-tone control patches may be printed along with the control strip that contain the same half-tone screen values as used in the image area of the print.

NOTE The effective measurement aperture diameters of the densitometers on the print need to be large enough to accommodate and include the required quantity of half-tone dots in each measurement as specified in the documentation of the densitometers' manufacturer. In addition, for measurement with apertures of less than 5 mm diameters the typical practice is to average five readings of every control patch.

For line screens 18 dots per centimeter or less it is recommended that an average of five or more readings

Figure A.1 — Example IDEAlliance Screen control strip

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Table C.1 — CIELAB colour values for solid tones of the primary and secondary colours for screen printing

	Small gamut option			Medium gamut option[b]			Large gamut option		
	L^*	a^*	b^*	L^*	a^*	b^*	L^*	a^*	b^*
Black (K)	24	0	0	18	0	0	8	0	0
Cyan (C)	59	−35	−43	52	−33	−51	46	−32	−54
Magenta (M)	51	70	−15	47	74	−5	42	79	10
Yellow (Y)	90	−11	66	89	−9	83	88	−7	100
Red[a] (M + Y)	50	59	42	47	67	50	44	66	47
Green[a] (C + Y)	55	−68	32	49	−65	30	43	−62	28
Blue[a] (C + M)	28	27	−41	21	26	−40	16	29	−39

[a] Colour sequence Yellow, Cyan, Magenta.

[b] According approximately to offset PC1.