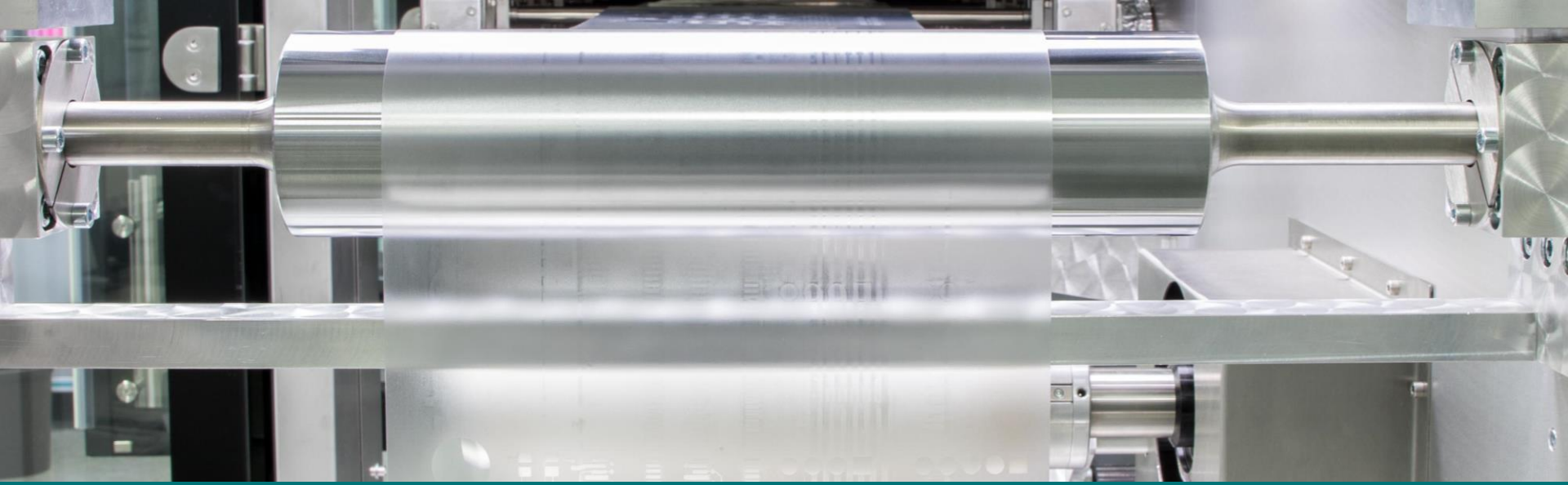


# Flexography technology

19/08/25

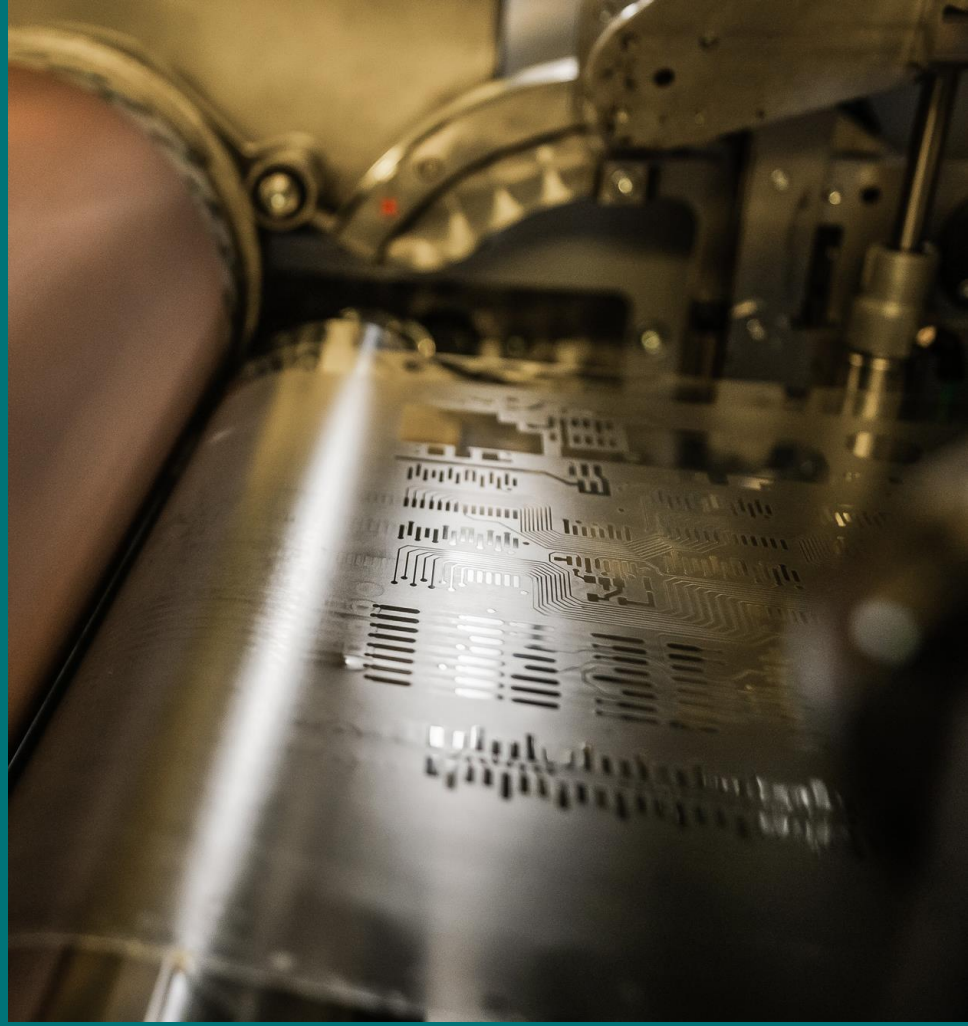
MEMBER OF ATH

# Agenda

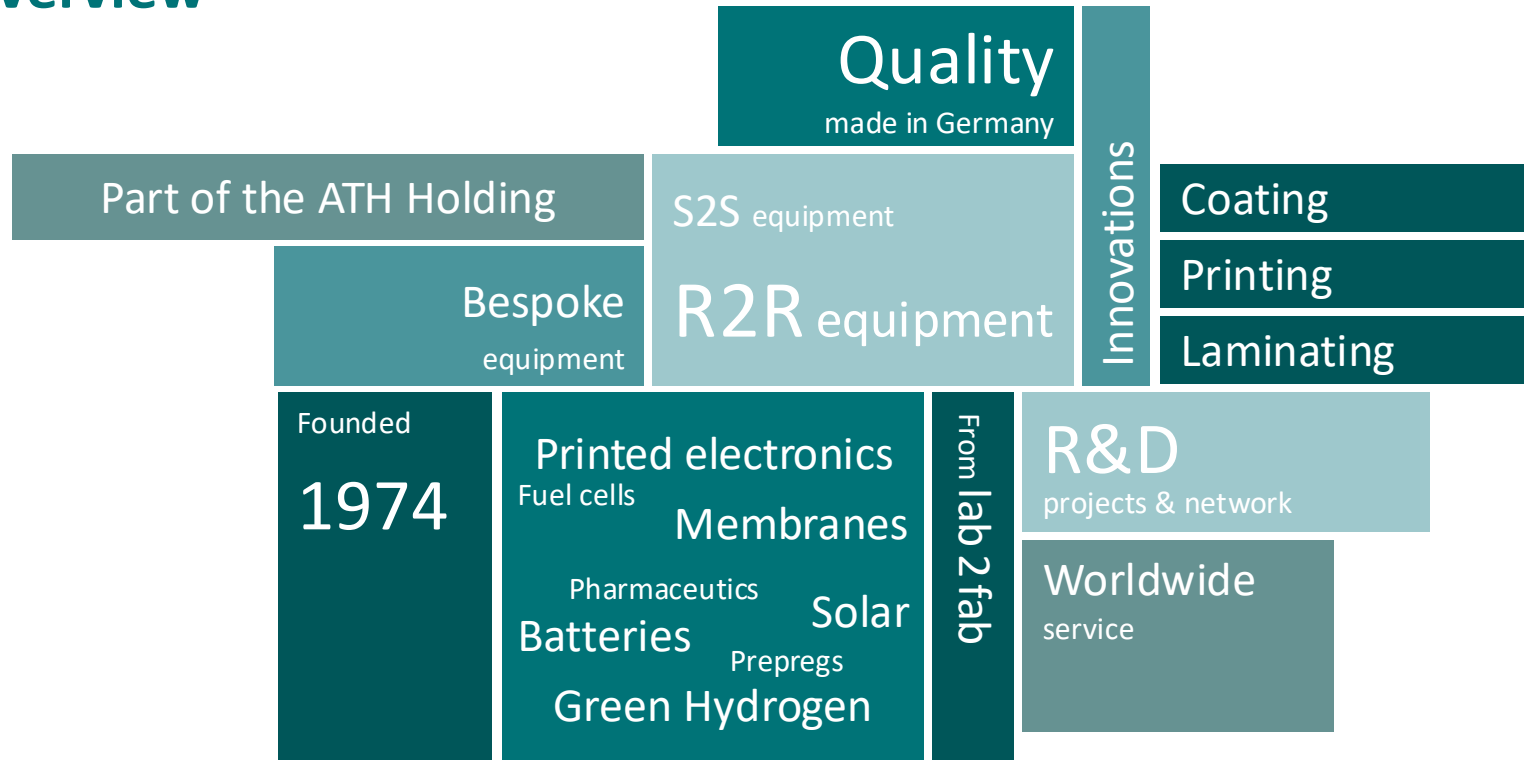
1. Introduction
2. Motivation
3. Flexography printing
4. Components
5. Summary

# 1.

## Introduction



# Overview


Quality
made in Germany
Innovations
Part of the ATH Holding
S2S equipment
R2R equipment
Coating
Printing
Laminating
Bespoke
equipment
Founded
1974
Printed electronics
Fuel cells
Membranes
Pharmaceutics
Solar
Batteries
Prepregs
Green Hydrogen
From lab 2 fab
R&D
projects & network
Worldwide
service

# Group of companies

ALTONAER
TECHNOLOGIE
HOLDING

KROENERT

- ✓ Founded 1903
- ✓ Approx. 200 employees
- ✓ Located in Hamburg

DRYTEC

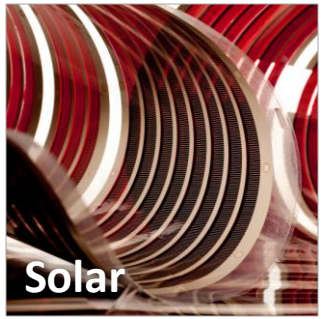
- ✓ Founded 1995
- ✓ Approx. 50 employees
- ✓ Located in Norderstedt

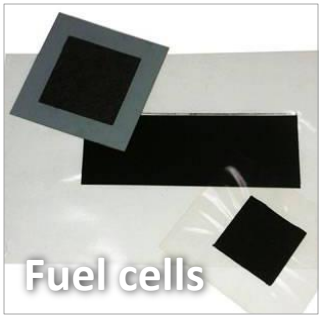
Coatema®
Coating Machinery GmbH

- ✓ Founded 1974
- ✓ Approx. 50 employees
- ✓ Located in Dormagen

# Represented worldwide

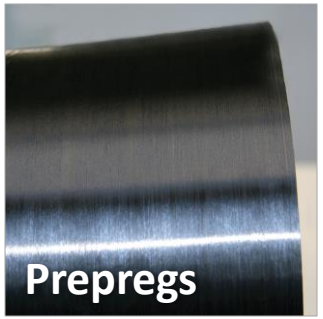
# Our markets

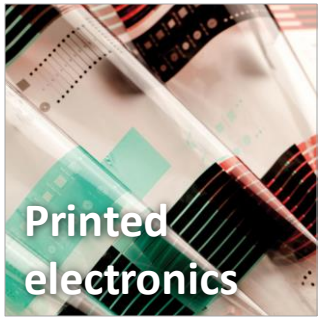


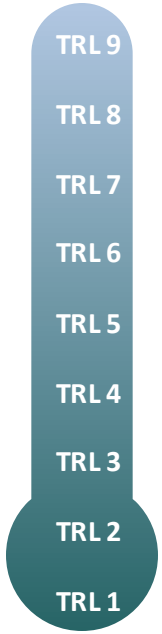





Actual system proven in operational environment



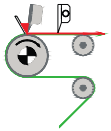

Basic principles observed

# Coatema focus areas

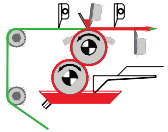
- Green hydrogen
- Fuel cells
- Batteries
- Solar

- Sustainability
- Digital fabrication
- Printed electronics
- The next thing

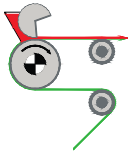
# Coating systems



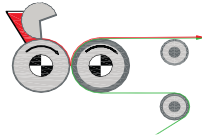
Knife system



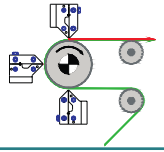
Double side coating system



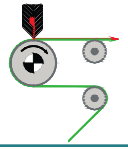
Commabar system



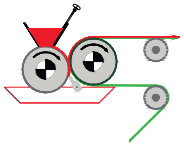
Reverse commabar system



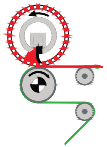
Slot die system



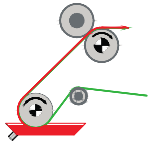
Curtain coating system



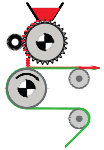
Case knife system



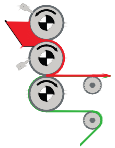
Rotary screen system



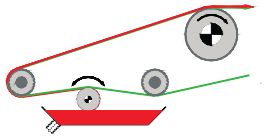
Dipping system (Foulard)



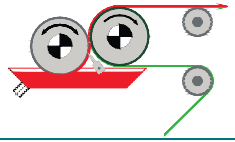
Powder scattering system



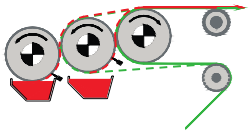
Reverse roll coating system



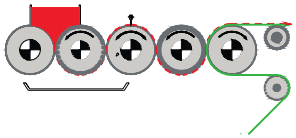
Micro roller coating system



2-roller coating system

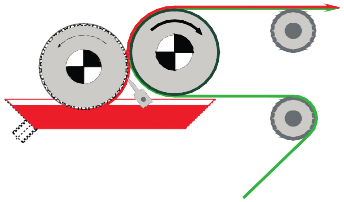


3-roller combi coating system

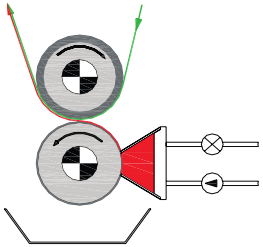


5-roller coating system

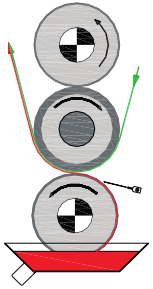
# Printing systems



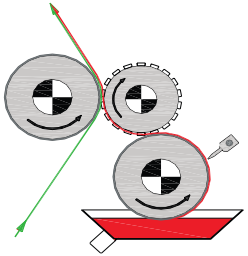
Engraved roller system



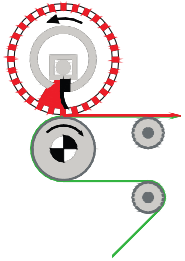
Gravure roller system



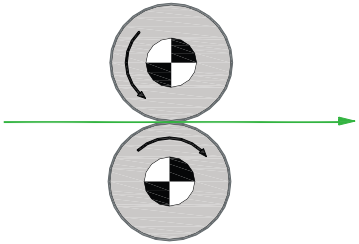
Gravure indirect system



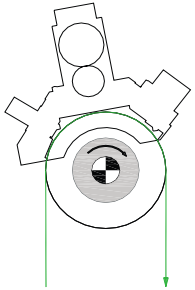
Flexography system



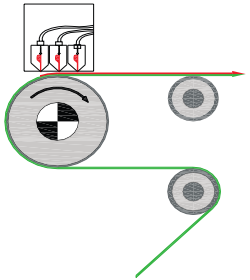
Rotary screen system



Hot embossing system



Nanoimprint system



Inkjet system

# Our work in associations – global networking

oe-a

NMWP.NRW
Cluster NanoMikroWerkstoffePhotonik

HOPE-A
Hellenic Organic & Printed Electronics Association

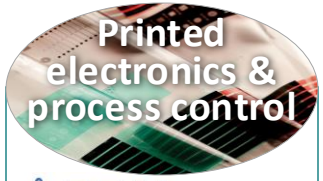
Board Member:
OE-A

Advisory Board:
Fraunhofer ITA

# Coatema customers

# R&D customers

# R&D projects overview 2022 – 2025




REAL NANO

In-line and real-time digital nano-characterization for flexible organic electronics

NOUVEAU

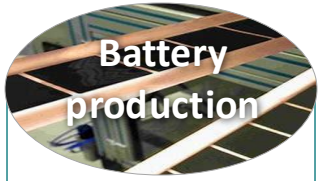
The NOUVEAU project will develop solid oxide cells (SOCs) with innovative La- and PMG-free electrode materials


FLEX2ENERGY
AUTOMATED MANUFACTURING PRODUCTION LINE FOR IPVS

R2R production line for OPV solar with integrated backend

FLEX-G 4.0

Upscaling and development of EC based switchable films to decrease energy use in buildings




IDEEL

Implementation of laser drying processes for lithium-ion battery production

SOLiD

R2R process optimization for solid state batteries


pepLAT

Plasmonically enhanced photocatalysis for wastewater treatment

ROLL 2 SOL

R2R nanostructuring of functional films


WATER PROOF

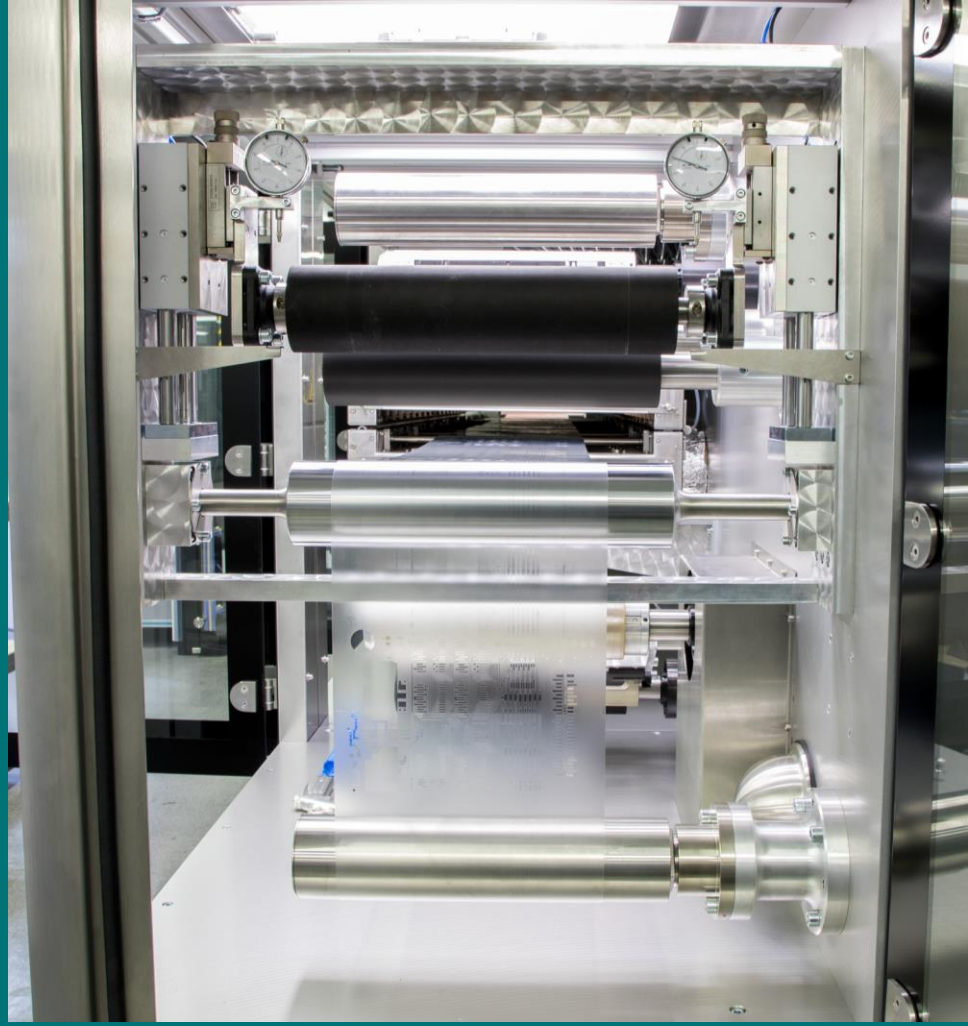
The WaterProof project aims at developing an electrochemical process that converts $CO_2$ emission

FLEX FUNCTION 2 SUSTAIN

Creating an open-innovation testbed for sustainable packaging

# 2.

## Motivation



# Definition & origin of flexography

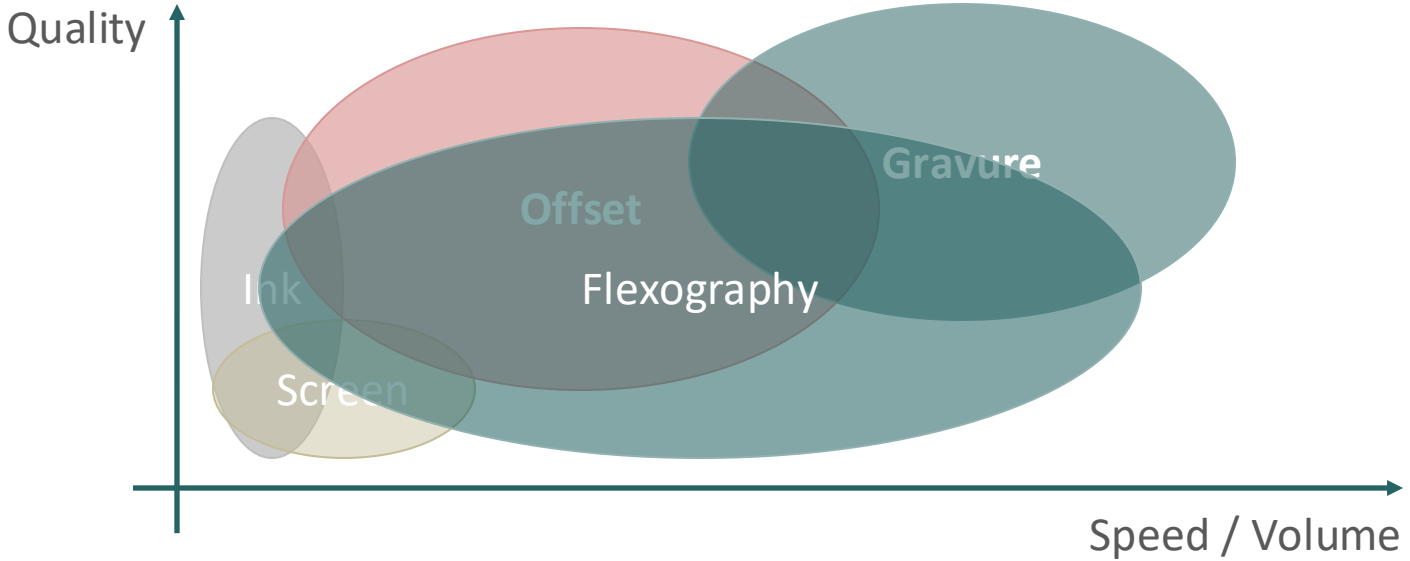
- ✓ Flexography creates an image through relief printing, using flexible plates to form a raised negative of the image, which is inked and then transferred onto the substrate using pressure.
- ✓ Johannes Gutenberg developed the **letterpress** in 1440
  - ✓ A raised hard surface plate is inked and pressed against a sheet of paper
  - ✓ Movable and reusable lead metal types

# History of flexography

- ✓ Original name of this letterpress process is „aniline printing“
  - ✓ Use of aniline dyes diluted in alcohol in the mid 19th century
- ✓ 1950s: New name
  - ✓ Flexographic process
- ✓ Until 1970:
  - ✓ Exclusively rubber printing plates
  - ✓ Printing of wrapping papers

# Printing parameters

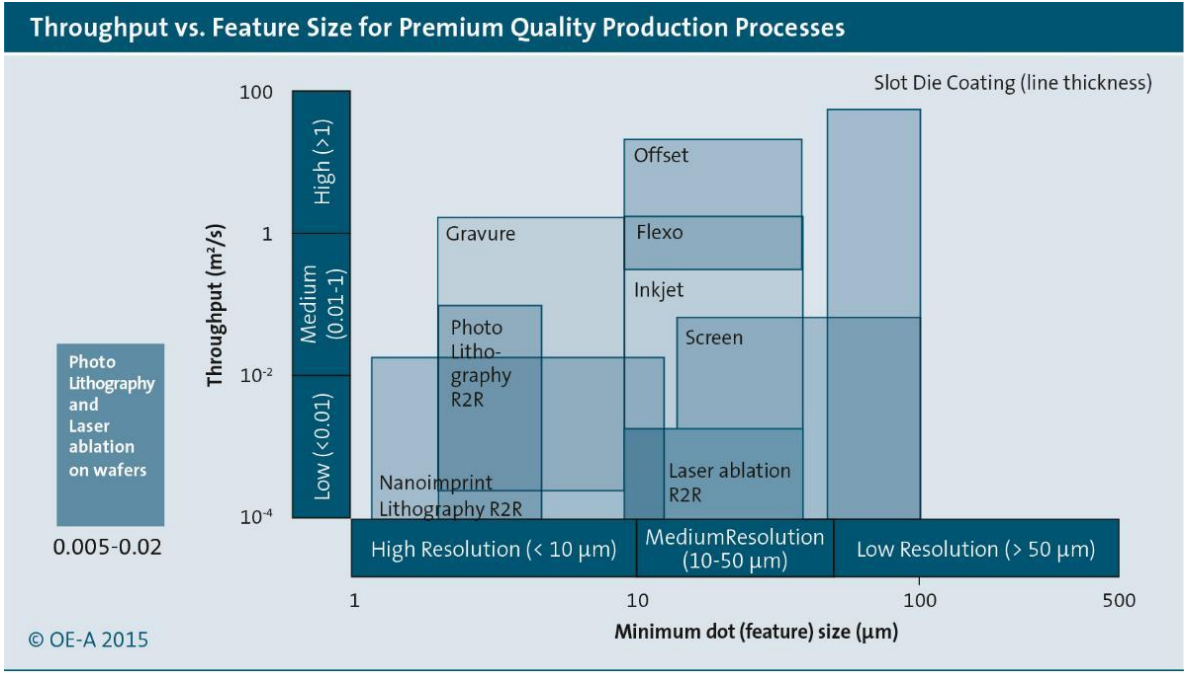
Compared to other techniques flexography offers a large window of quality and speed.



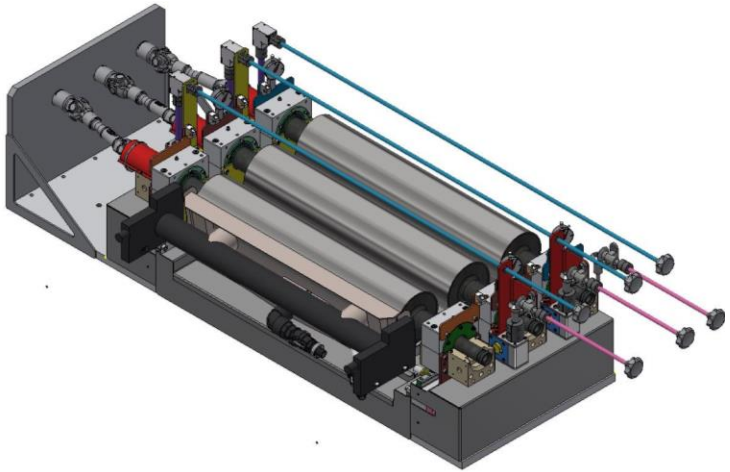
# Printing parameters

| Printing method | Printing speed (m/s) | Nip pressure (MPa) | Ink viscosity (Pa·s) | Layer thickness (µm) | Feature size (µm) | Regis-tration (µm) |
|---|---|---|---|---|---|---|
| Flexography | 3 – 10 | 0.1 – 0.5 | 0.01 – 0.5 | 0.04 – 8 | 40 – 80 | 20 – 200 |
| Gravure | 10 – 16 | 1.5 – 5 | 0.01 – 0.2 | 0.1 – 12 | 20 – 75 | >10 |
| Offset | 8 – 15 | 0.8 – 2 | 1 – 100 | 0.5 – 3 | 25 – 50 | >10 |
| Screen printing | 2 | - | 0.1 – 50 | 3 – 100 | 75 – 100 | >25 |
| Inkjet | 1 – 5 | - | 0.001 – 0.03 | 0.01 – 0.5, 20 (UV) | 10 – 50 | <10 |

# Printing parameters



# Printing systems

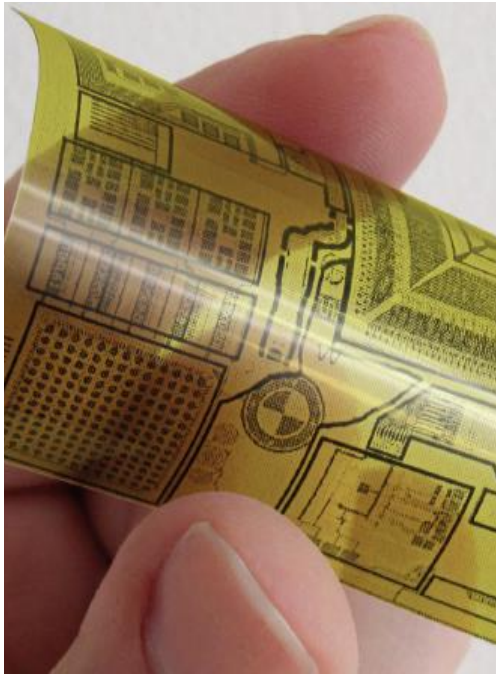


# 3.

## Flexography printing

# Ongoing improvements

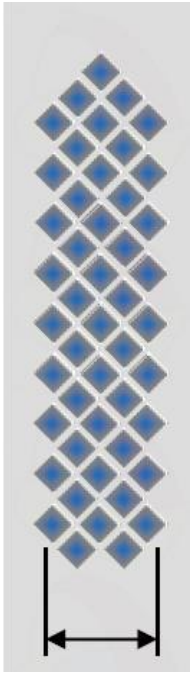
- ✓ Evolution of letterpress
- ✓ Image on a soft plate
- ✓ Graphic applications
  - ✓ Packaging
  - ✓ Publications like magazines
- ✓ Improved quality over last 25 years
  - ✓ Press
  - ✓ Plate
  - ✓ Anilox

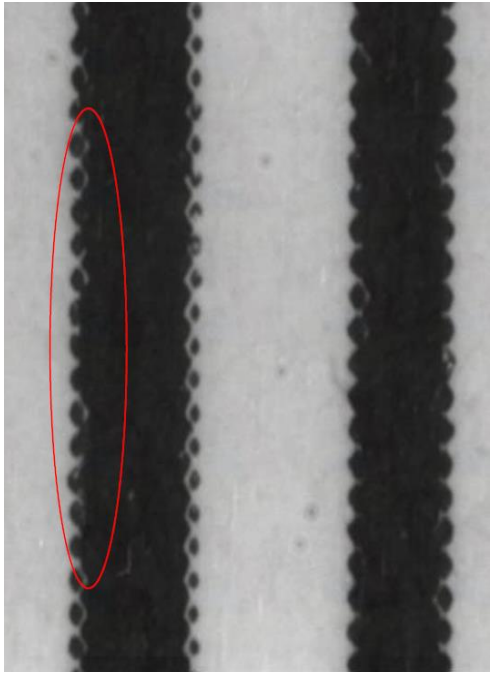


# Printing technologies

- ✓ Inkjet, screen printing and conventional rotogravure
  - ✓ Lines are generated by combination of printed dots
  - ✓ Limits in line resolution

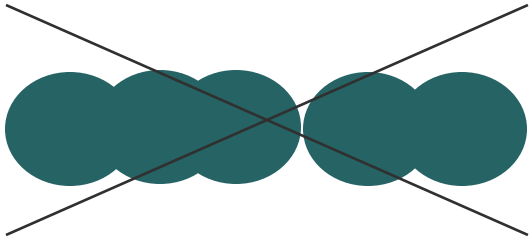
→ Flexography as solution

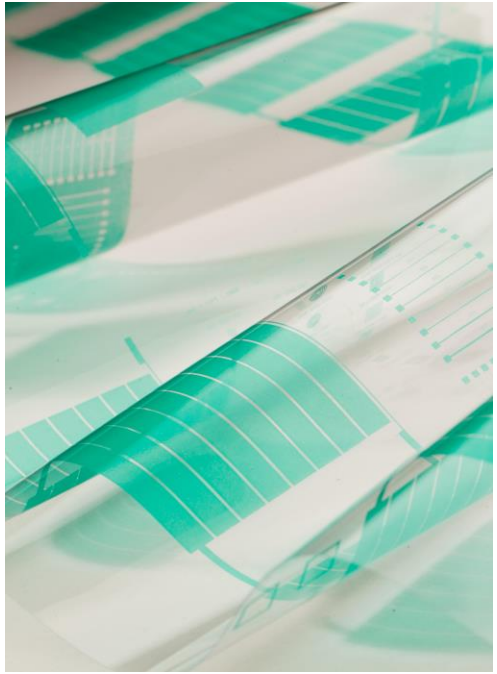




# Printing continuous lines

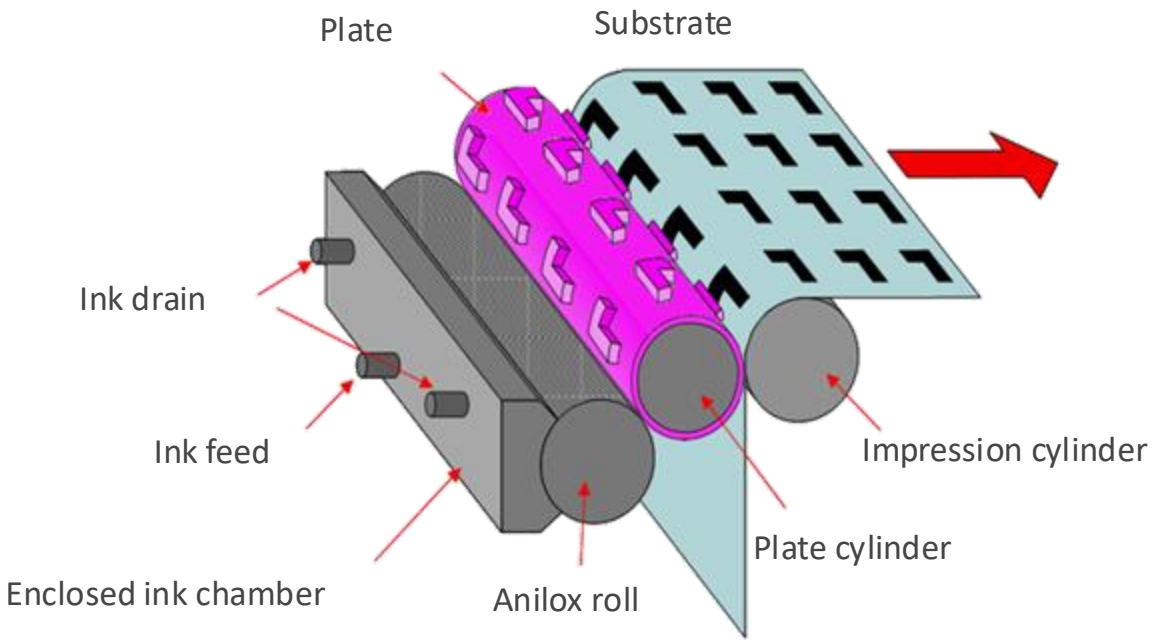
- ✓ Relief plate allows the deposition of ink as continuous lines instead of a series of joining dots (e.g. inkjet)





# The process

Raised image on polymer plate pick up the ink from an engraved cylinder (anilox) and deposit it over the substrate.



# Flexographic press

- ✓ Industrial press offers mechanical stability and controls for acurate printing
  - ✓ Stack presses, in-line systems, central impressions machines
- ✓ Medium-high initial capital cost:
  a limit to research

# Advantages and limitations

## Advantages

- ✓ High resolution
- ✓ Excellent accuracy
- ✓ Good deposition rate with a smooth texture
- ✓ No limit to the substrate
  - ✓ Paper, board or unsupported films
- ✓ Fast & cheap process for long-term applications
- ✓ Ideal R2R patterning for functional materials

## Limitations

- ✓ Limited thickness of layers (wet 5 – 30 µm)
- ✓ Not ideal for short print runs
  - ✓ High initial cost for printing plates
  - ✓ Plate changing → time consuming
- ✓ New techniques offer bolder colours, more highly defined images and complicated designs

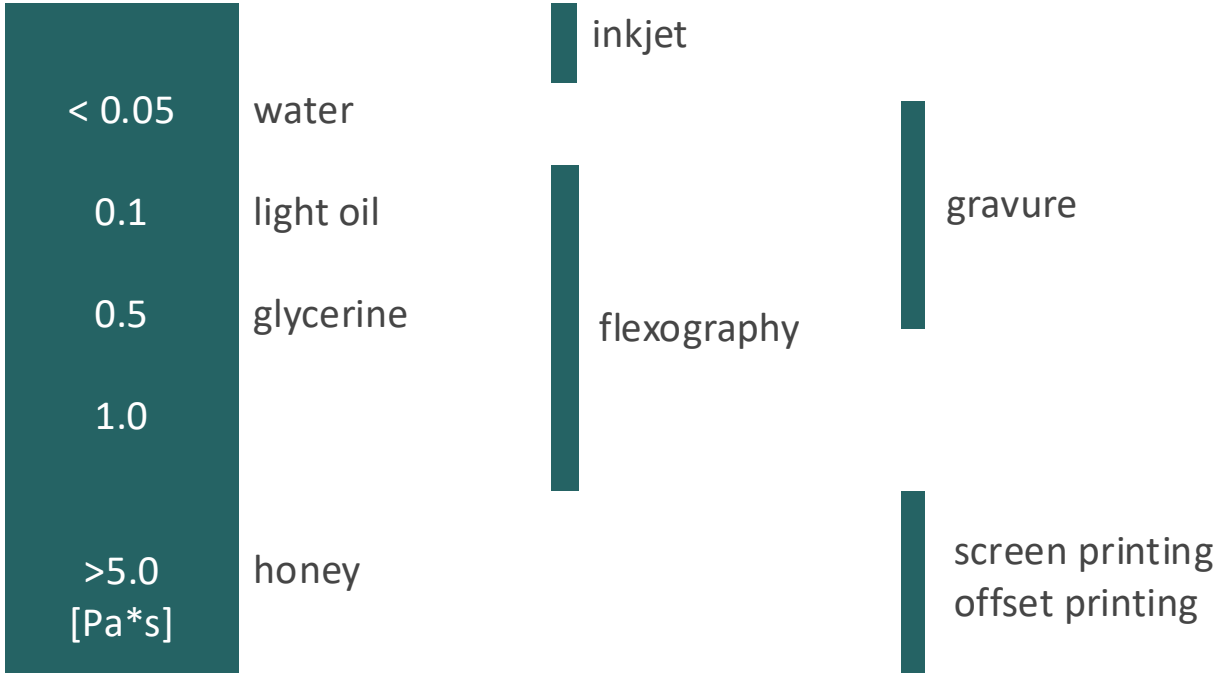
# 4.

## Components

# Flexographic inks

- ✓ Flexible formulation similar in composition to inks used in gravure package printing
  - ✓ Colorants (dyes or pigments)
  - ✓ Binding agents (resins or plastics)
  - ✓ Solvent or solvent blend
- ✓ Wide viscosity range (0.05 – 3 Pas)
- ✓ Processing big particles up to 10 – 20 µm
- ✓ High deposition rate
  - ✓ R2R speed up to 500 – 800 m/min

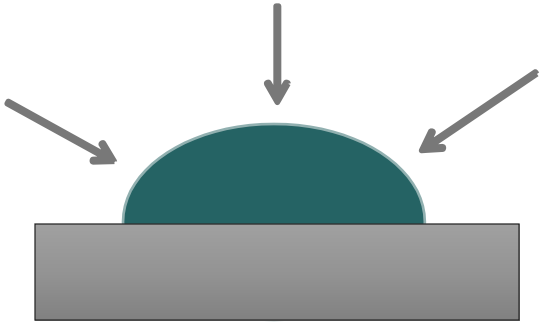
# Viscosity of inks for flexographic printing



# Ink behaviour

- ✓ Surface tension (hypothesis)
  - ✓ Lines <200 µm range
  - ✓ Surface tension is the dominant force
  - ✓ Due to quality of starting deposit line structure is kept avoiding inconsistencies

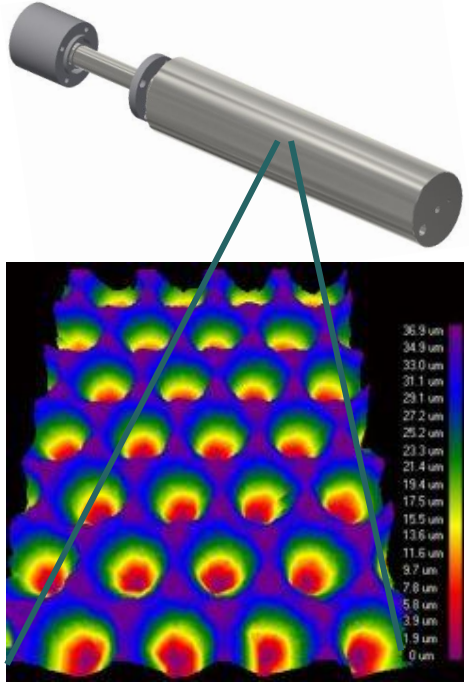
- ✓ Too high pressure
  → squeezing the ink out
  - ✓ Printing defects
  - ✓ Blank or semi-blank spaces in middle

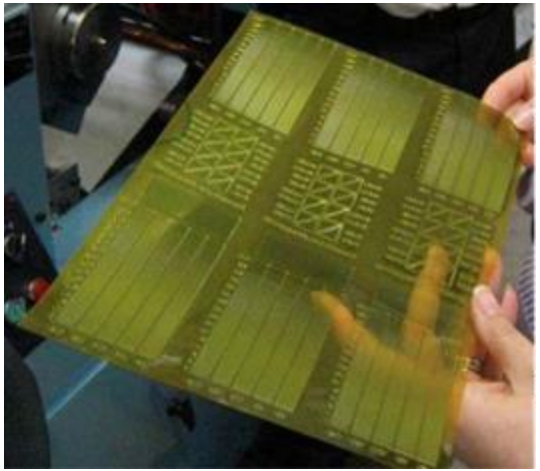


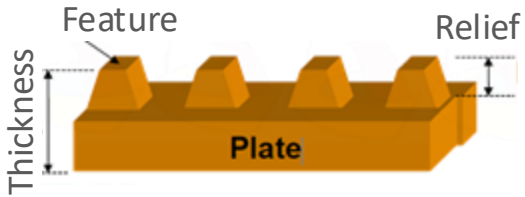
Soucre: blog.luminite.com/blog/flexo-printing-defects-doughnuts

# The components

- ✓ The anilox
- ✓ Metering system
- ✓ Ceramic cylinder
- ✓ 100 & engraved
- ✓ The plate
- ✓ Image carrier
- ✓ Soft photopolymer
- ✓ UV exposure created a raised surface for printing from it
- ✓ Taped around cylinder
- ✓ Improvements in plate resolution






Soucre: www.zecher.com/rasterwalzen/keramikrasterwalzen

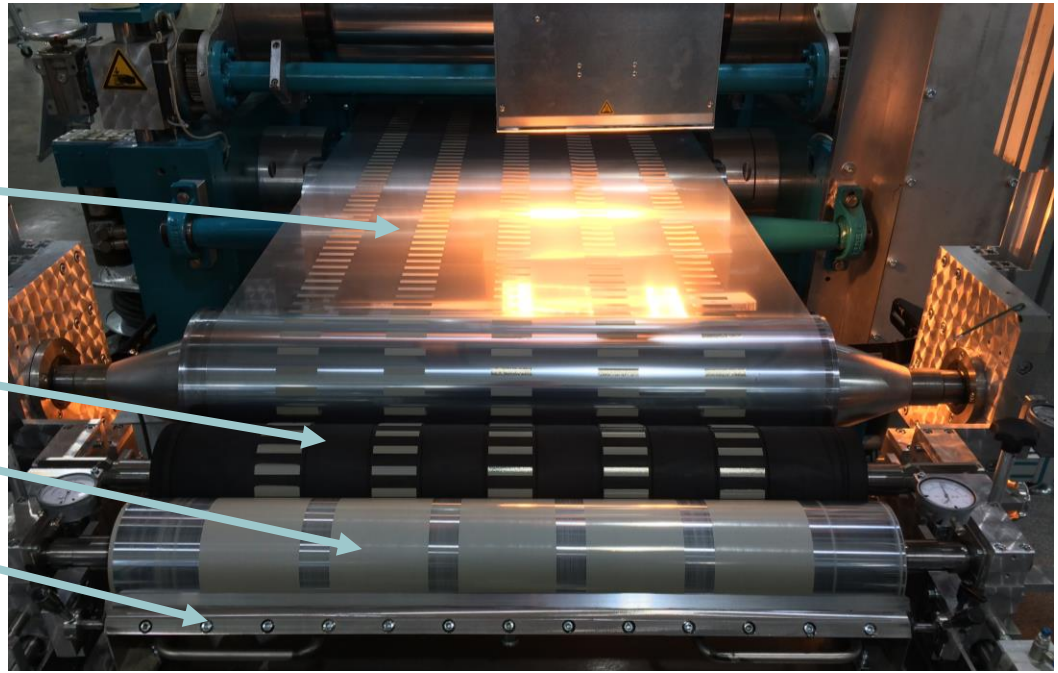
# The components

Substrate

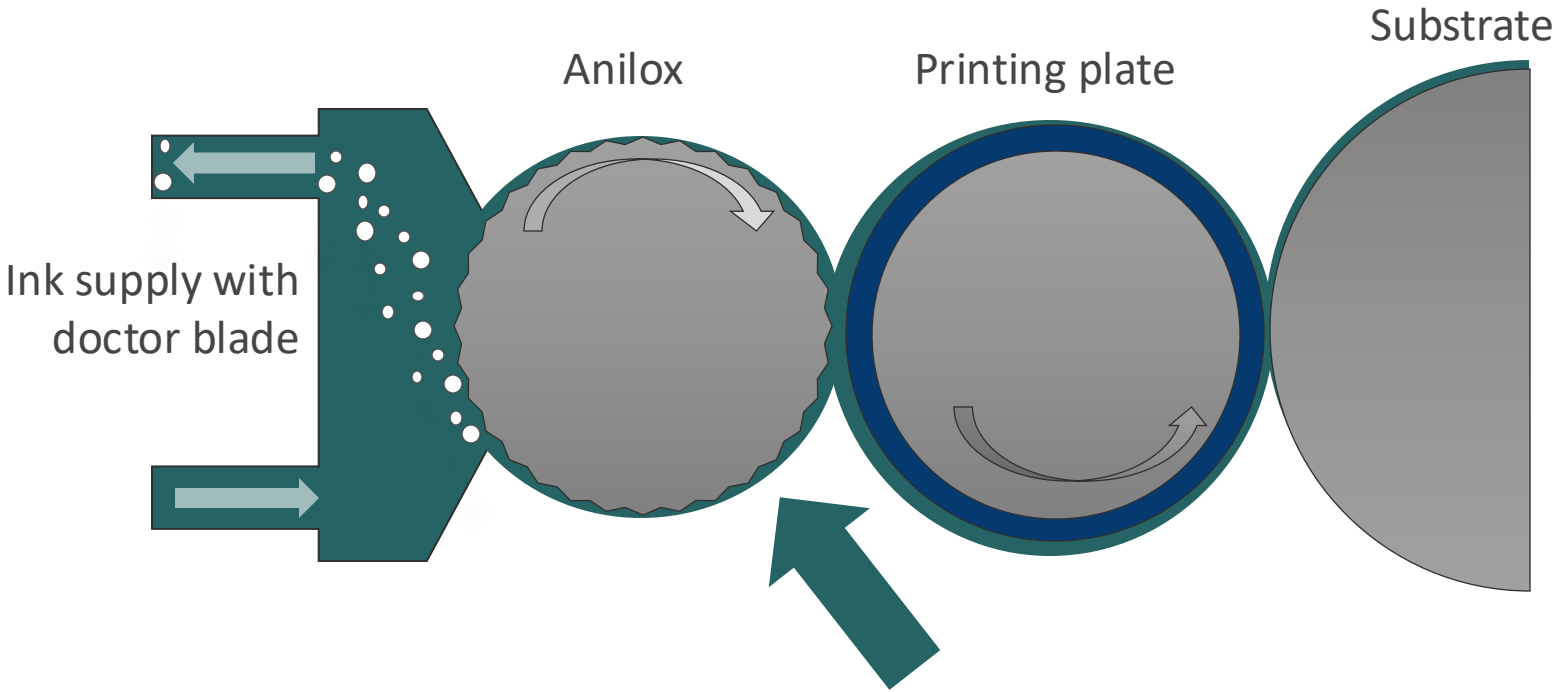
Printing plate

Anilox

Inks supply

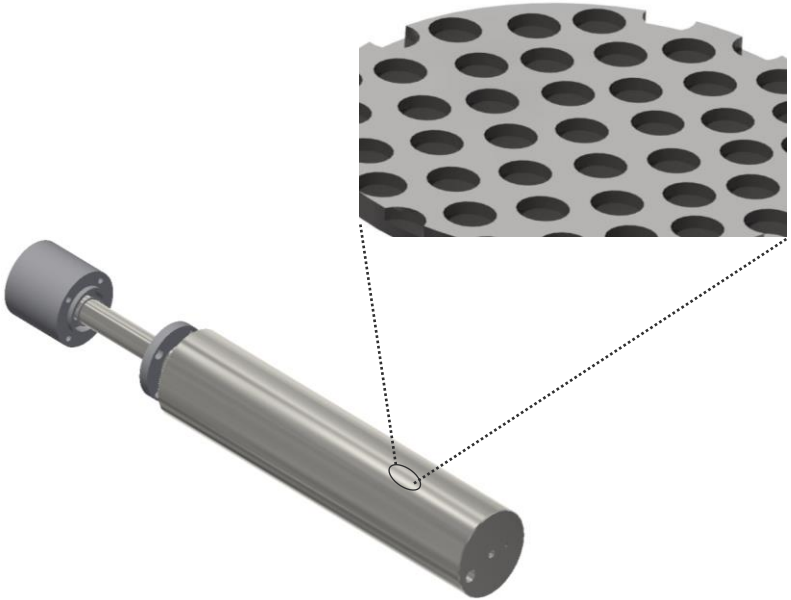


# Anilox

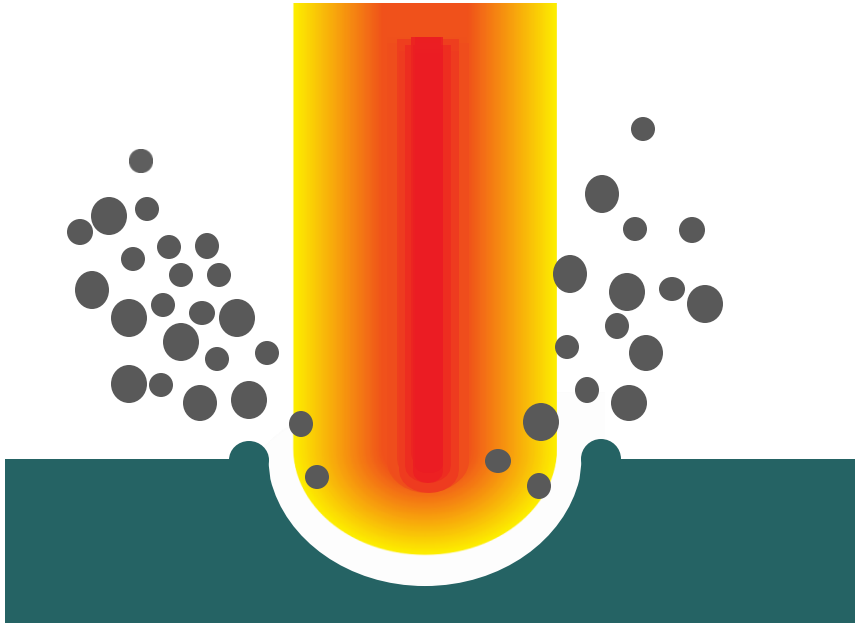

Substrate
Anilox
Printing plate
Ink supply with
doctor blade

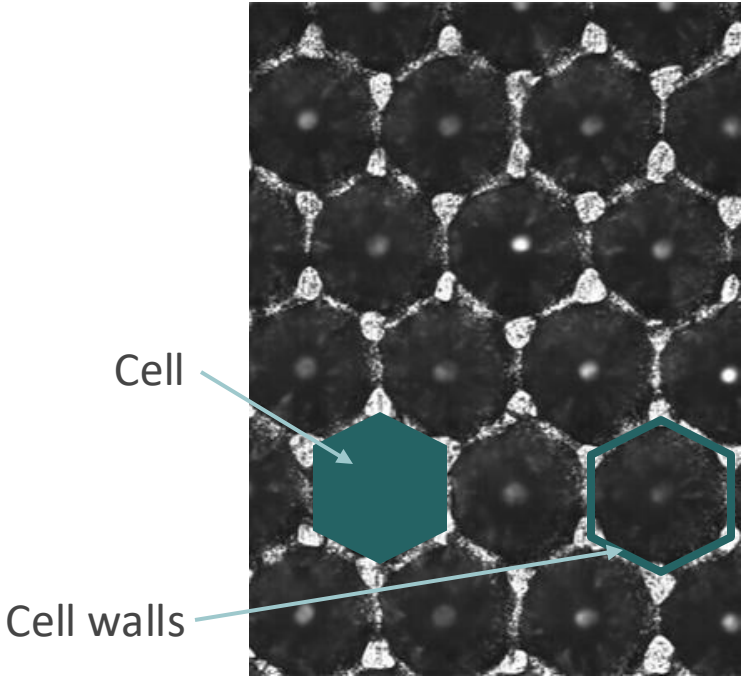
# Anilox

- ✓ The heart of the flexo printing system
- ✓ Most critial component to be optimized
- ✓ The most sophisticated component in the printing group
- ✓ The only component determining the quantitiy of ink transferred onto the printing plate
- ✓ Usual laser engraved ceramic cylinder



# Manufacturing the anilox



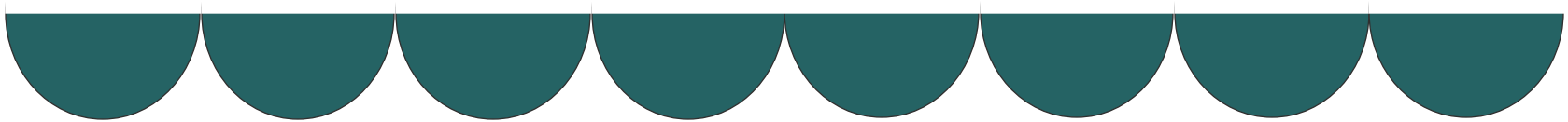



Soucre: www.zecher.com/rasterwalzen/keramikrasterwalzen/

# Line count

- ✓ Number of cells per linear measure
- ✓ Lines per centimetre [l/cm, lpi]

250 lines



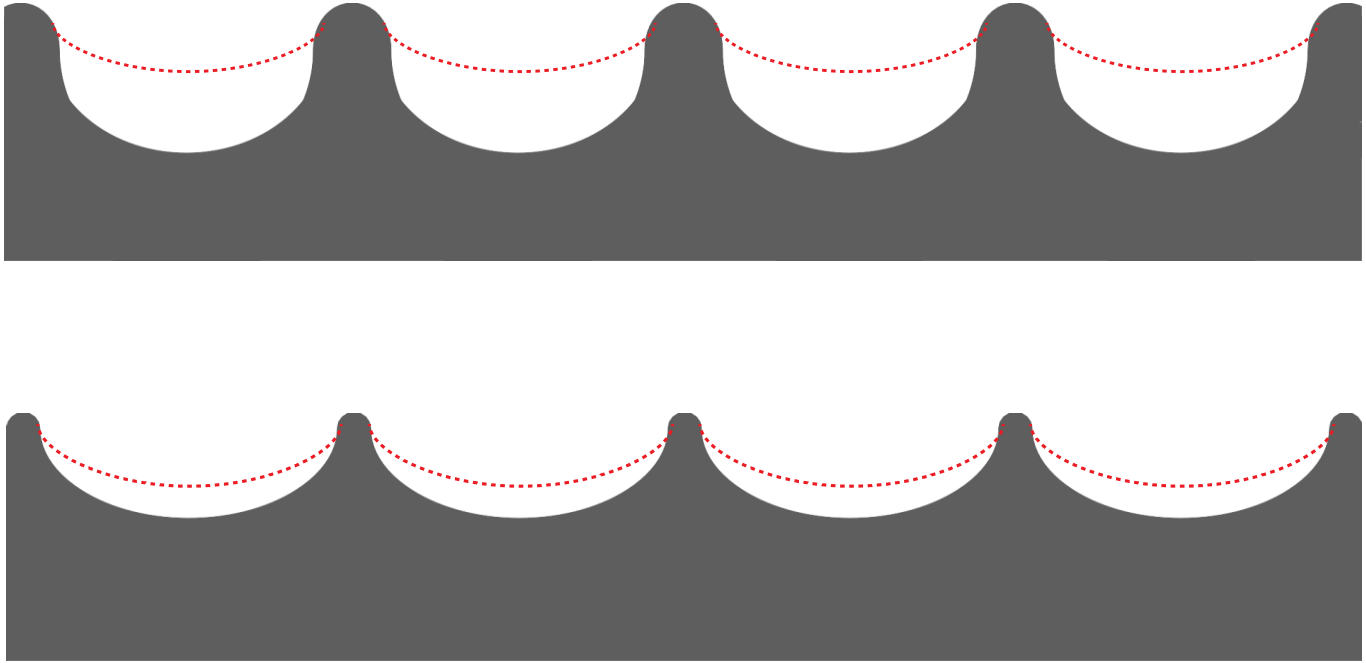
150 lines

# Anilox dipping – 5 to 1 ratio

✓ Correct anilox and image resolution

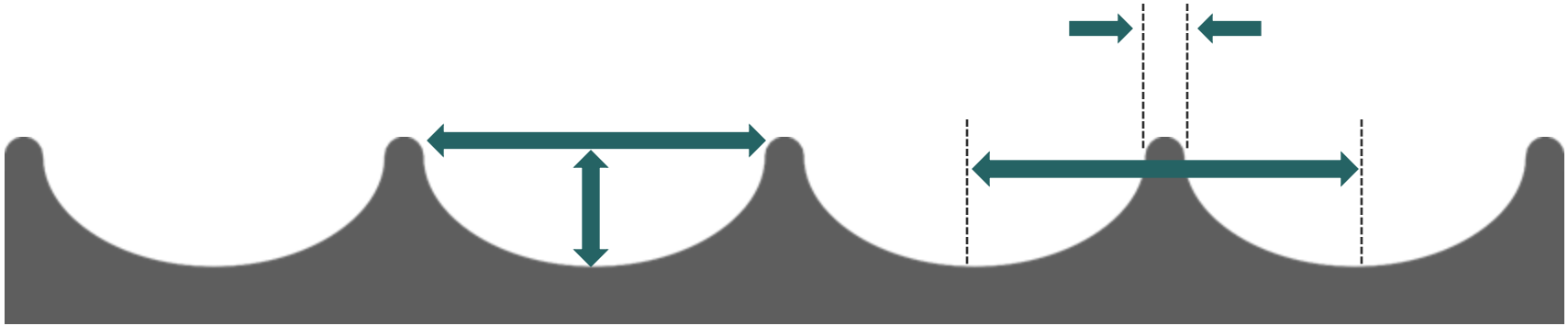

✓ Coarse anilox and image resolution → dipping

# Too deep cell transfer less ink



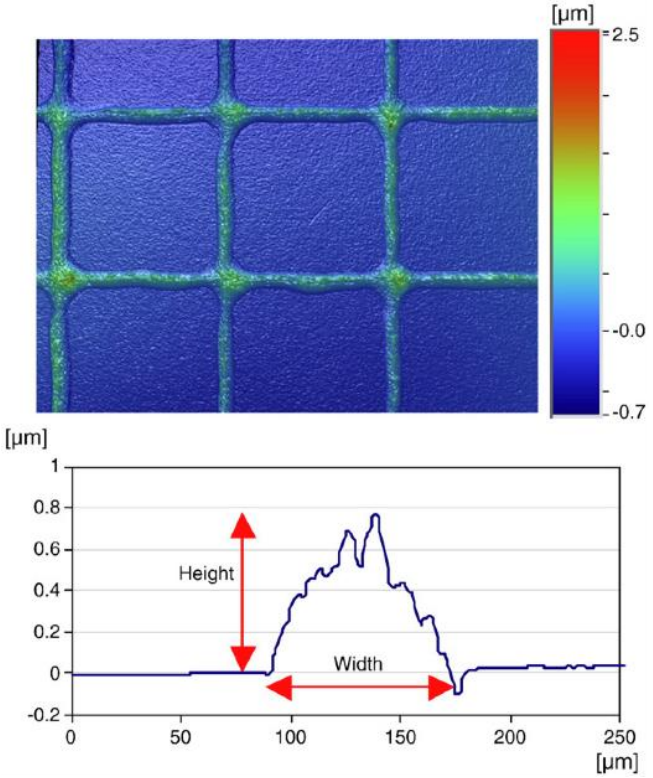
# Ideal dimension

- ✓ Depth: Opening ~ 1:3
- ✓ Wall: Cell ~ 1:10
- ✓ Parameters may change according to anilox manufacturer



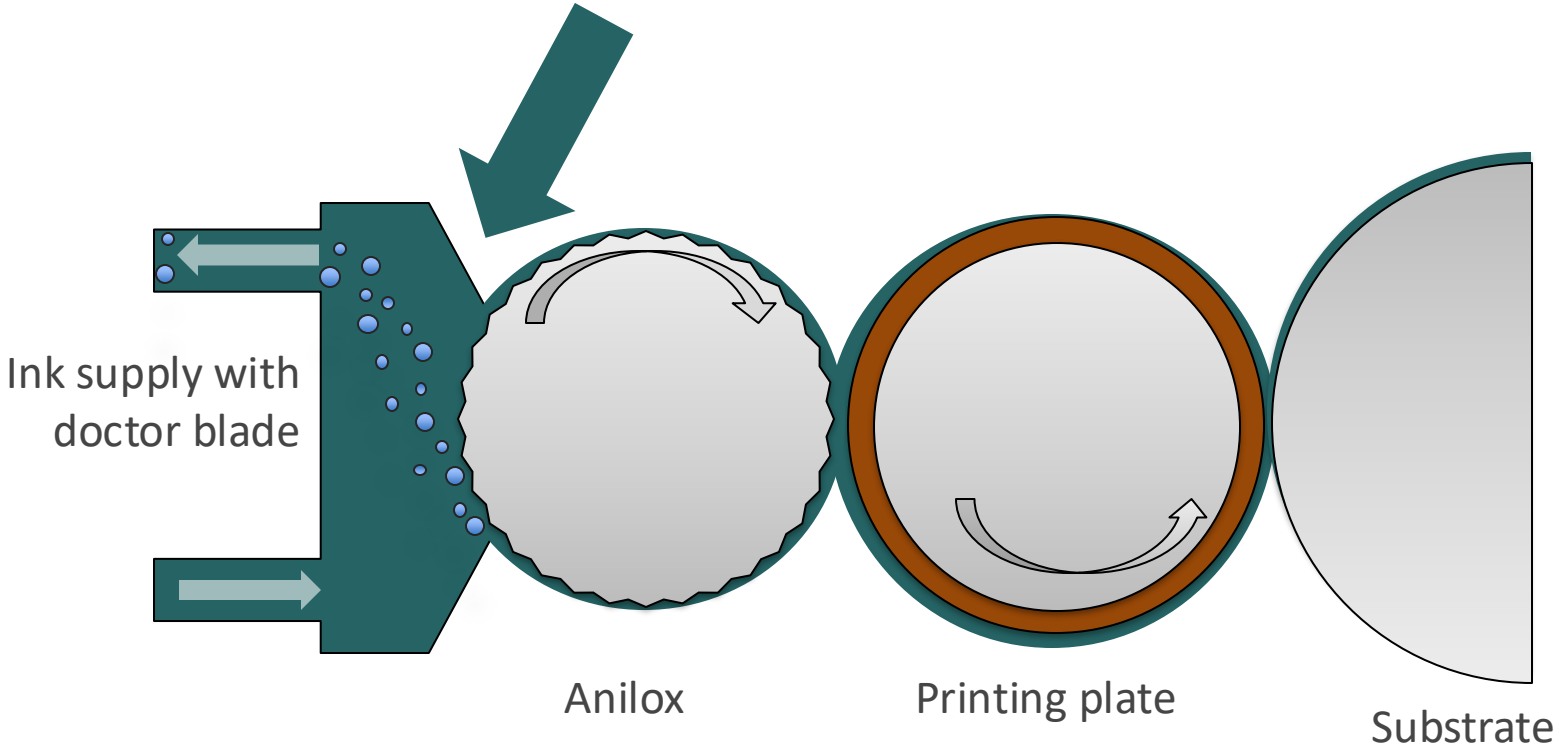
# Controlling the thickness

- ✓ Flexibility in control of deposit thickness
  - ✓ The anilox roll is the metering system, independent from plate image
  - ✓ Increasing anilox volume



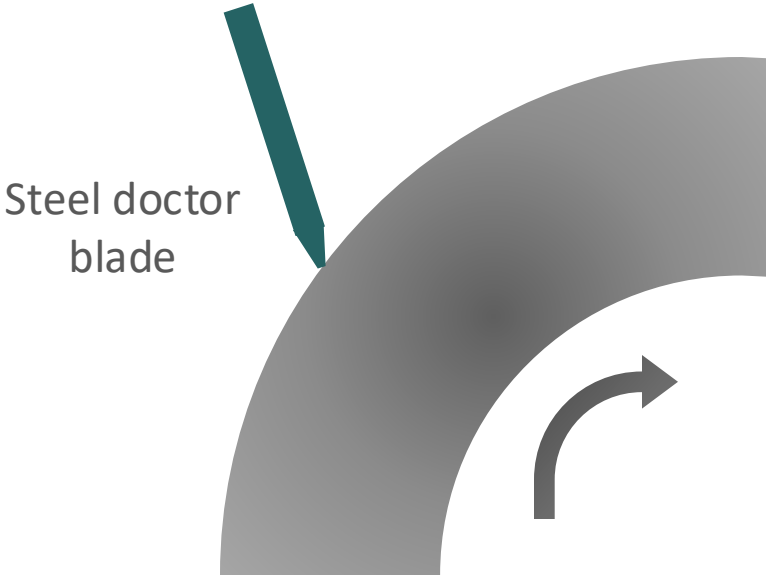

Soucre: Thin Solid Films 518 (2010) 6113–6116

# Doctor blade

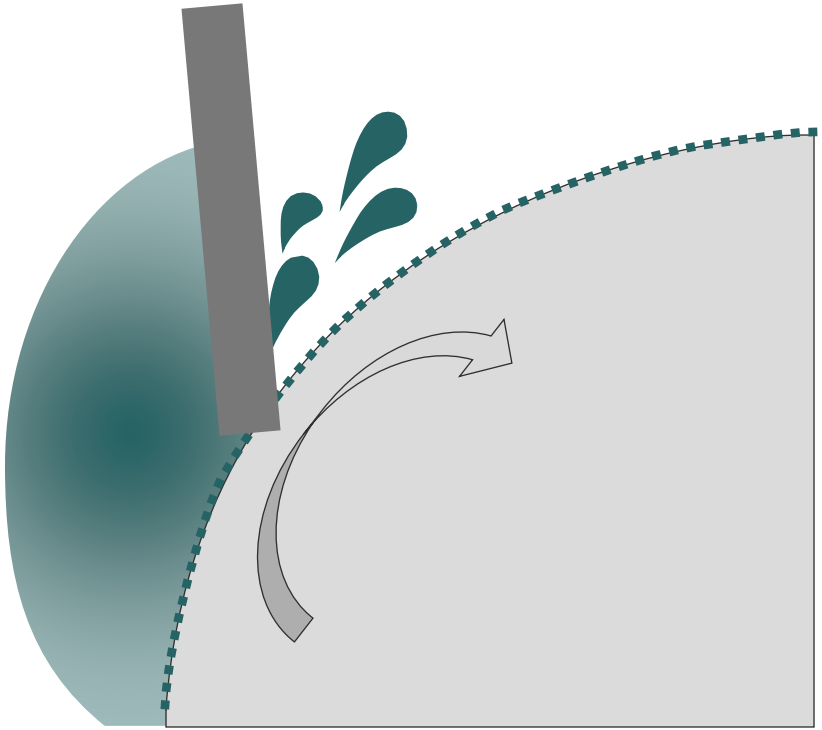


# Doctor blade

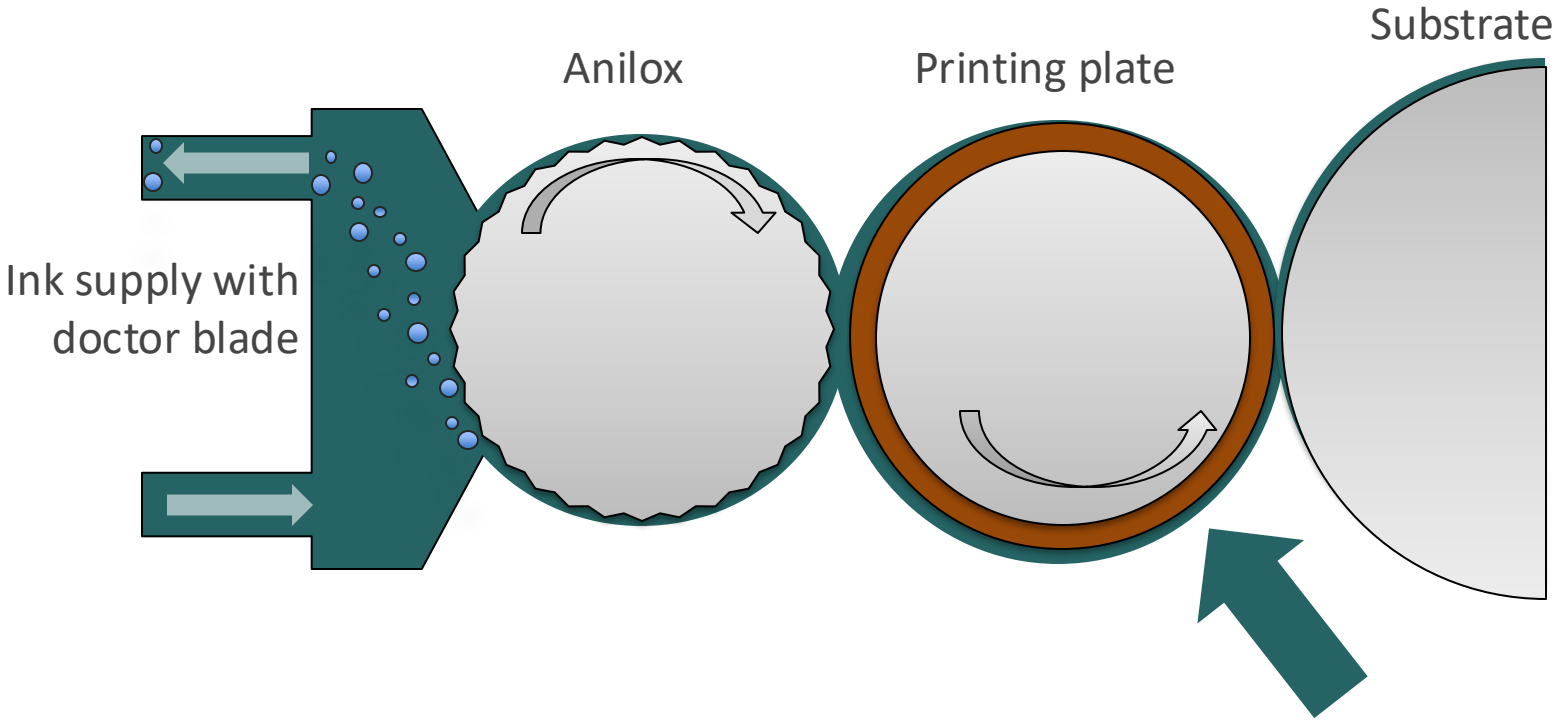
- ✓ Ensures the ink is transferred only by engraved arrears different designs
- ✓ The only system ensuring repeatable and predictable results



# Doctor blade in detail



# Printing plate



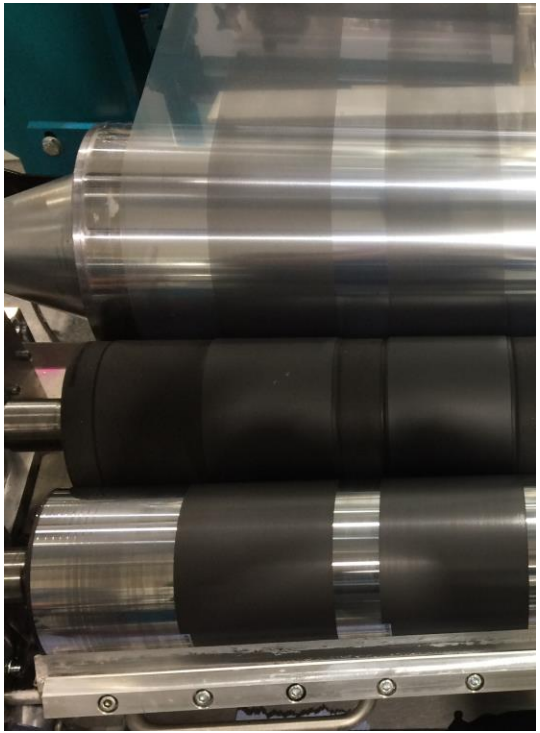
# Printing plate

# Printing plate

- ✓ Image carrier
- ✓ Soft photopolymer
- ✓ UV exposure creates a raised surface
- ✓ Taped around cylinder/sleeve

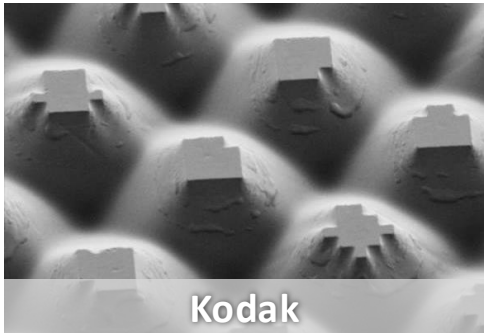
**Key improvements**

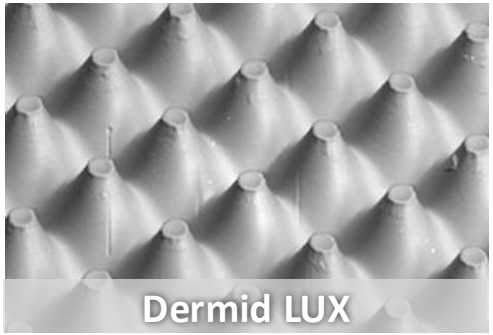
- ✓ Improvements in plate resolution
  - ✓ Various laser masking approaches
- ✓ Direct „in-the-round“ exposure
- ✓ Direct laser engraving of plate
- ✓ Improved materials
  - ✓ Elastomers, chemical resistant photopolymers

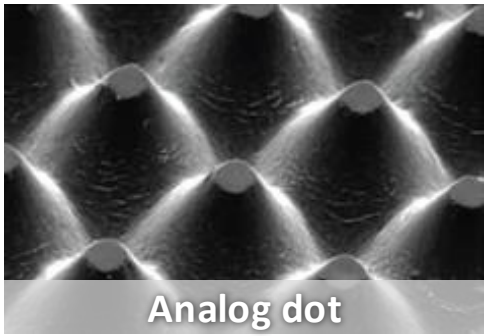


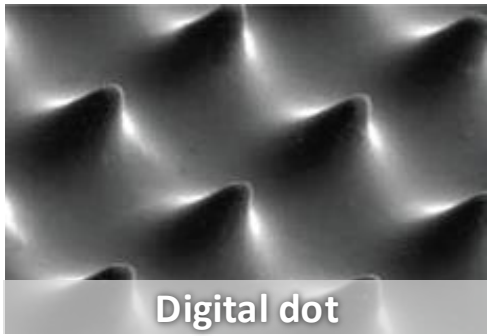
# Printing plate designs

Plate design can vary from the manufacturer



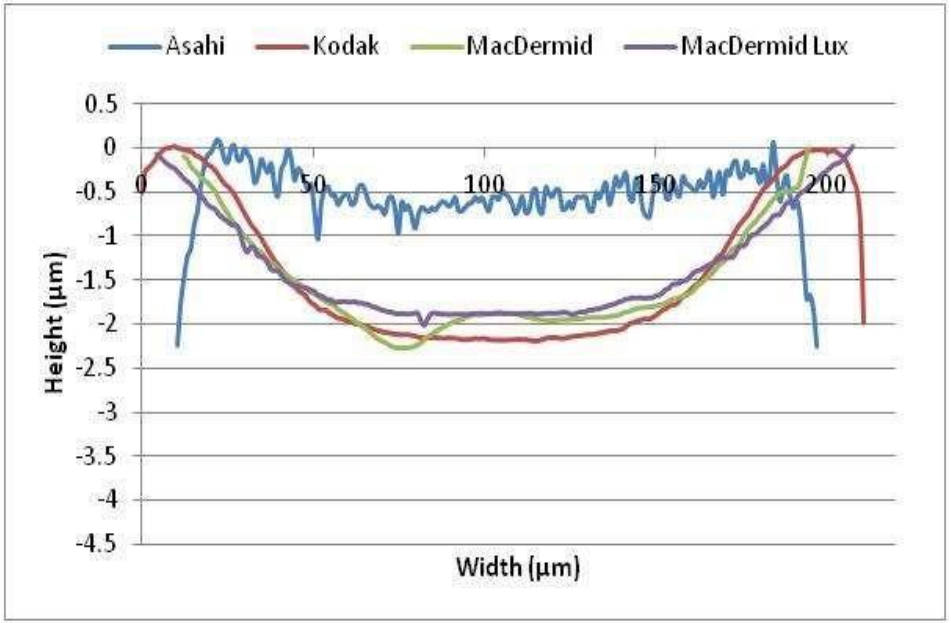



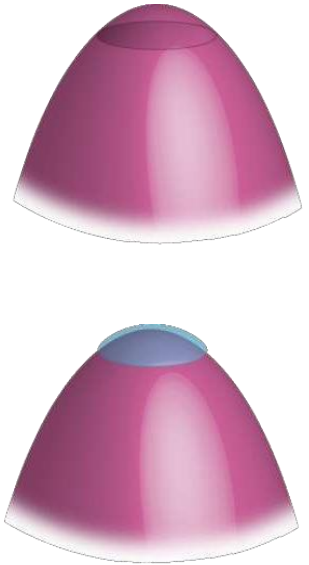




Soucre: 1) 1_www.printweek.in/features/kodak-flexo-plate-technology-spotlight-41227 2) www.flexotechmag.com/key-articles/20525/high-tech-technology-that-s-flexo-plates-today/ 3) www.quintco.com/digital-photopolymer-dots/

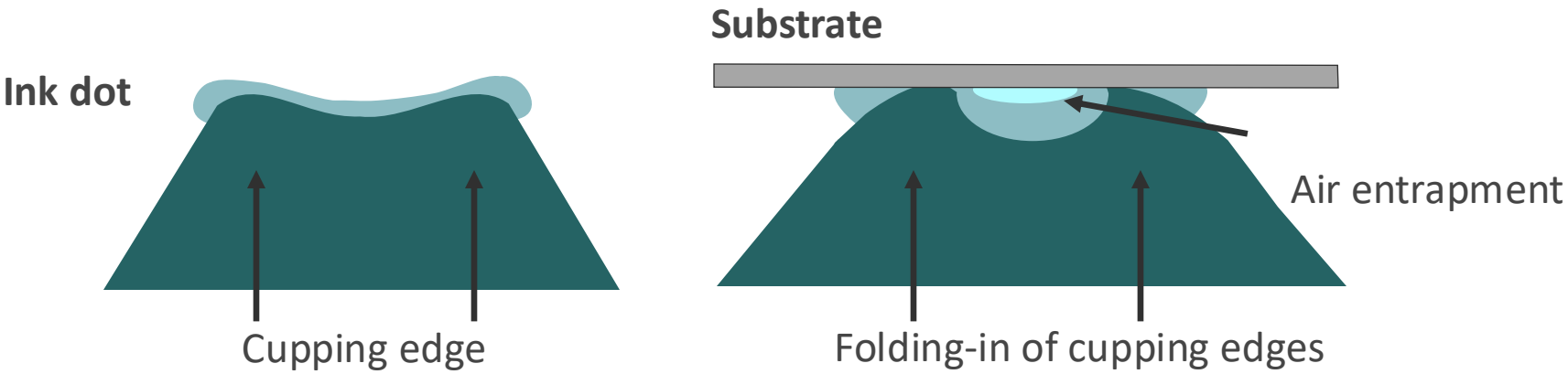
# Printing plate designs



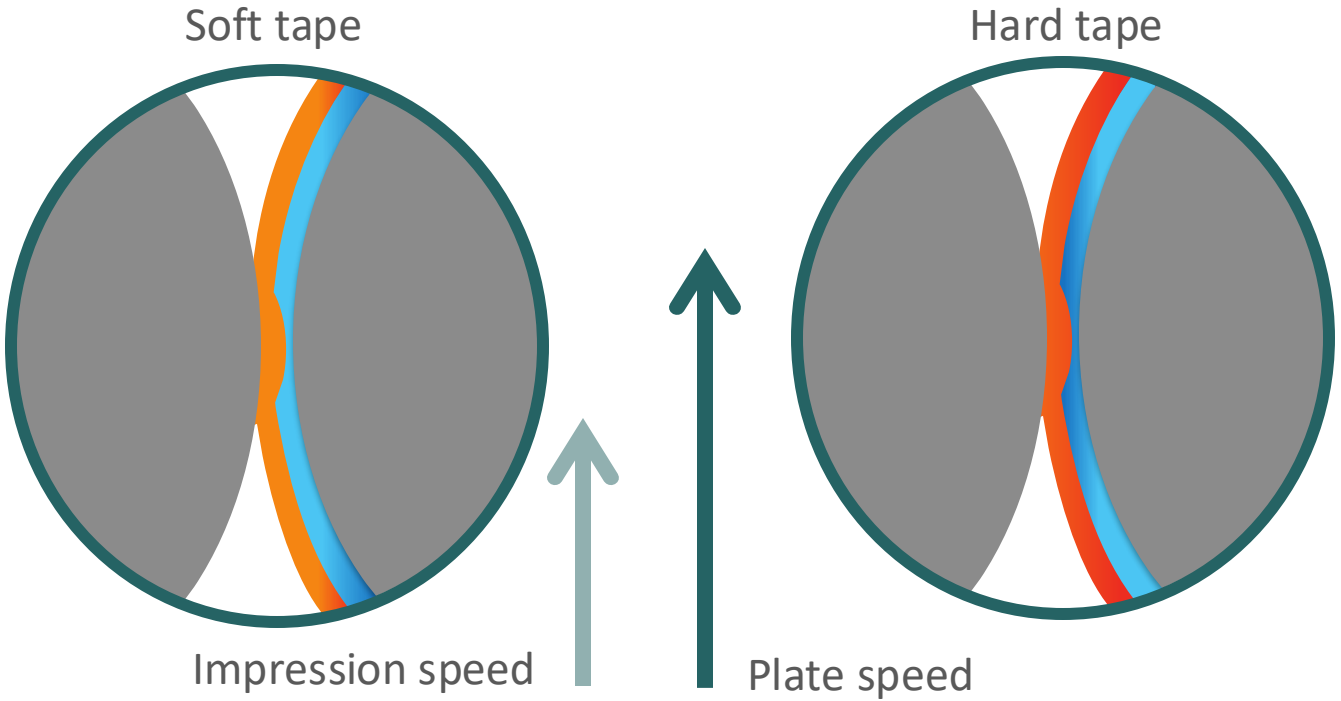



Dot profiles at 50% nominal area coverage and 100 lpi line ruling

# Contact area for printing plate



# Mounting tape and impression contact

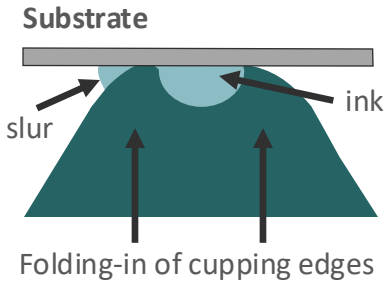


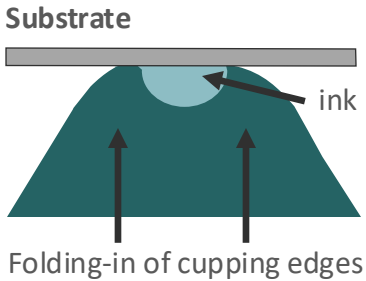
# Surface slurring

Smearing of the printed image
- ✓ Dots are distorted in printed direction
- ✓ Enlogated
- ✓ Oval shape
- ✓ Halo of ink

Caused by
- ✓ Impression/slippage between printing plate and substrate
- ✓ Or between anilox and printing plate

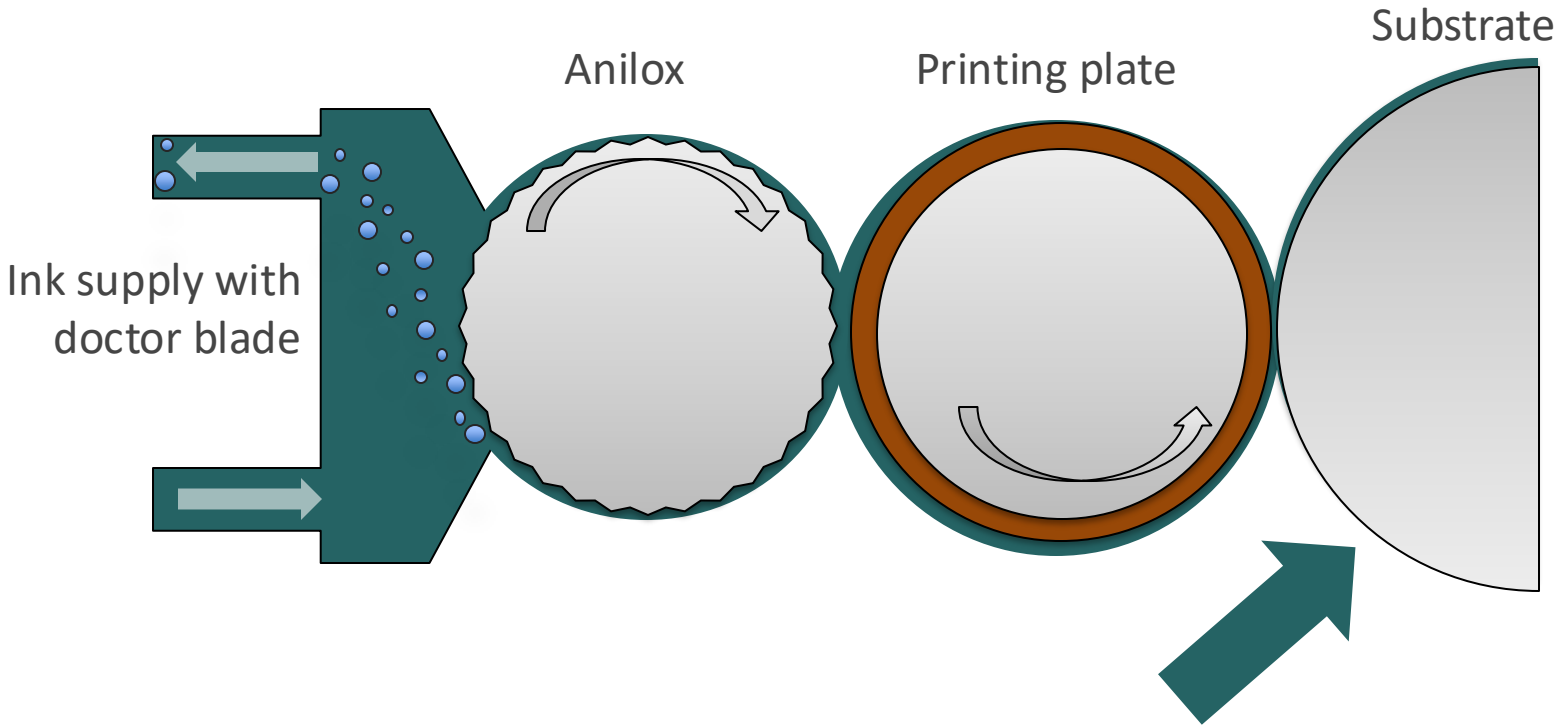
Impression can cause further defects
- ✓ Misregistration
- ✓ Bridging/filling-in



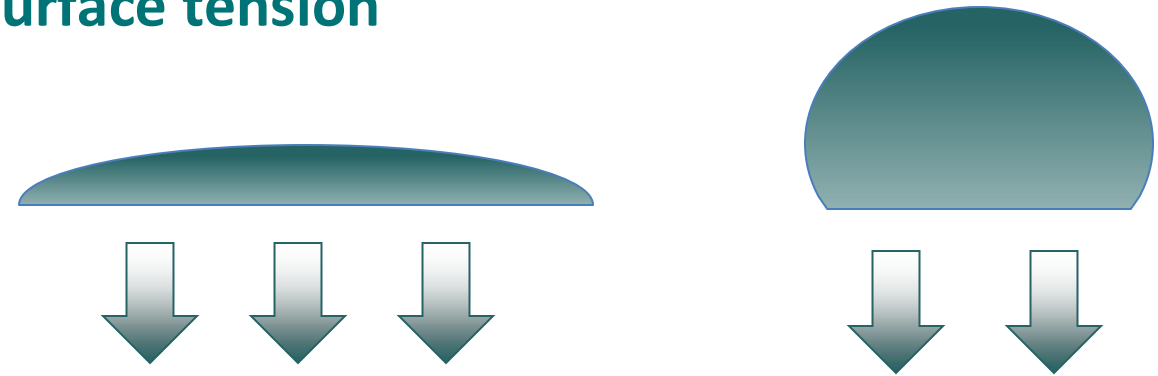




Soucre: www.flexo.expert/slur-the-sneaky-enemy-of-print-quality/#iLightbox[gallery2722]

# Substrate

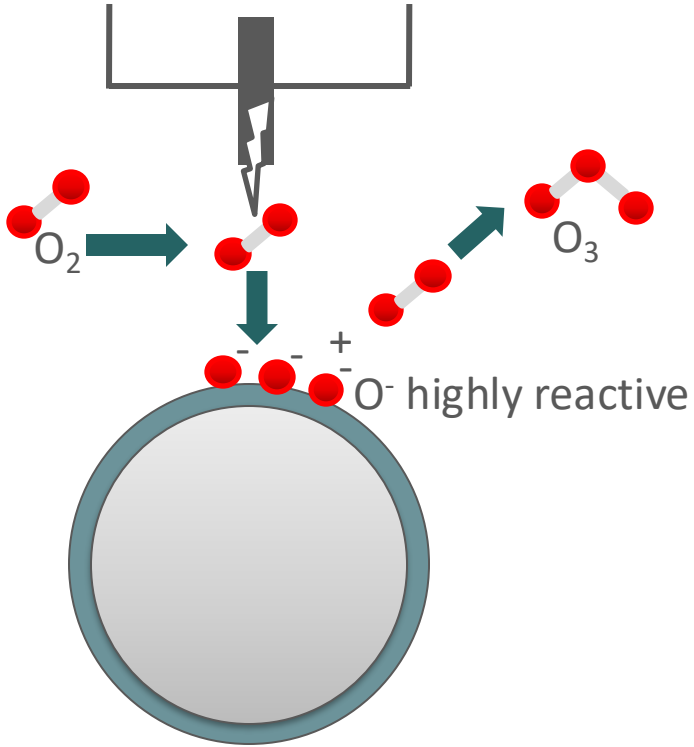

Substrate
Anilox
Printing plate
Ink supply with
doctor blade

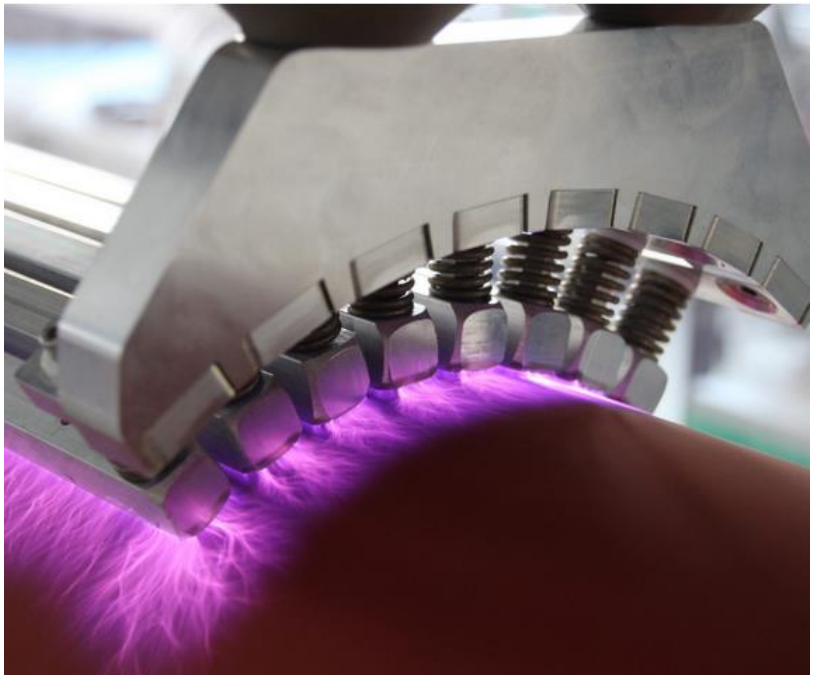
# Impact surface tension




Soucre: www.enerconind.com/web-treating/lab-trials.aspx

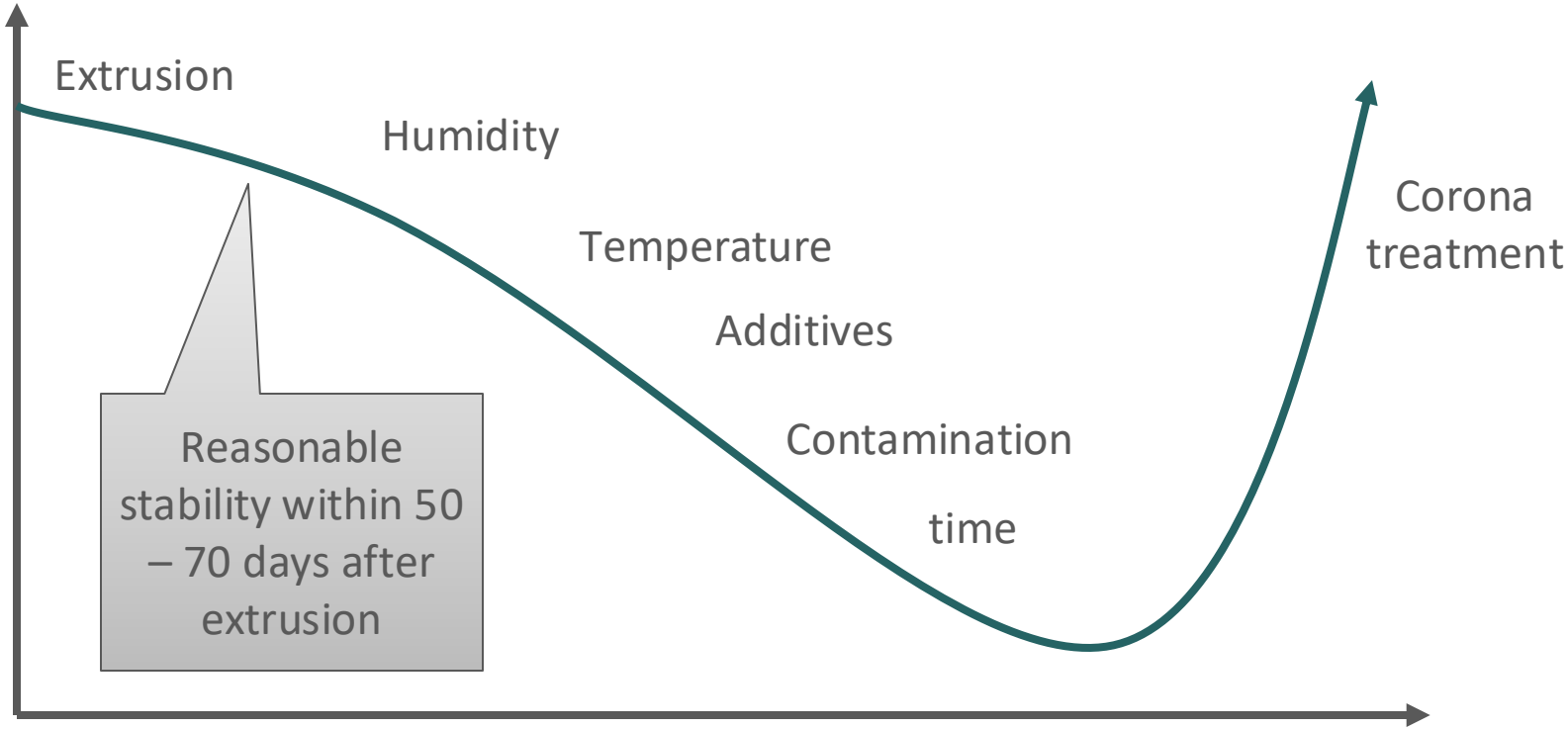
# Increasing surface energy by corona treatment



Soucre: www.vetaphone.com/our-offering/corona-treatment/

# Decay of surface energy



# 5.

## Summary

# Flexography

- ✓ Ideal R2R patterning for functional materials
- ✓ High resolution
- ✓ Excellent accuracy
- ✓ Good deposition rate and smooth texture
- ✓ Fast & cheap process for high amounts

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