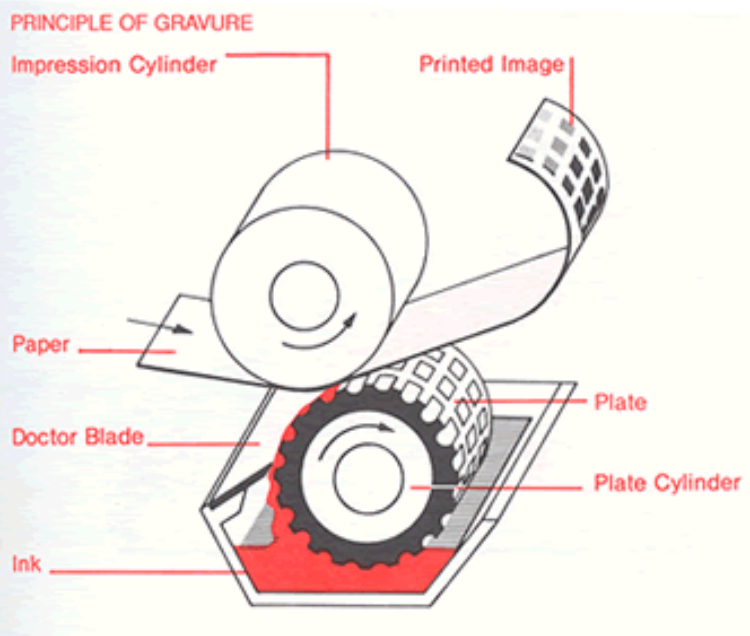
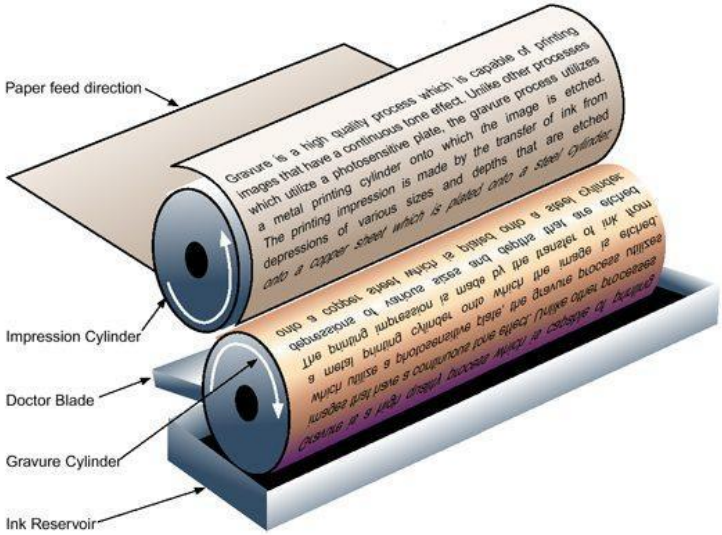
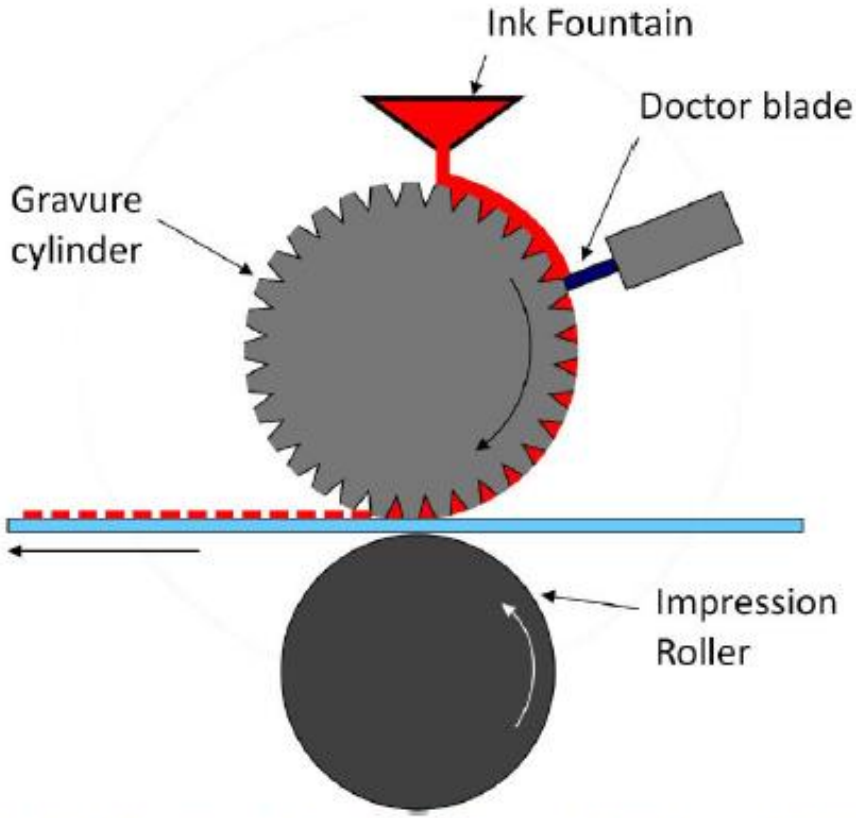
Gravure Printing

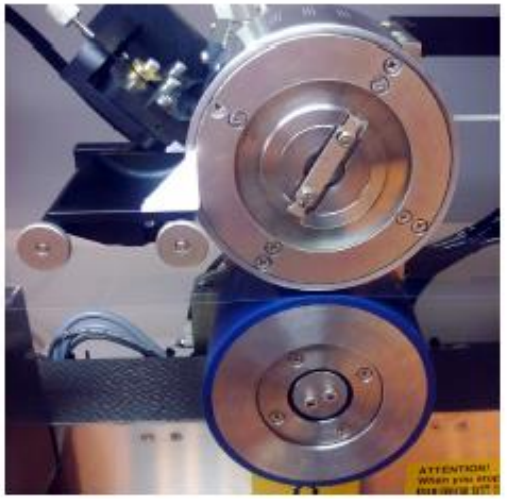
- Traditional printing method used in packaging industry
- Basic principle is to transfer an image to the substrate with engraved gravure cylinder
- Cells are typically 25-30 µm deep with 60-100 cells / cm
- Doctor blade is used for wipe excess ink off





Gravure Printing





Alejandro De la Fuente Vornbrock "Roll Printed Electronics: Development and Scaling of Gravure Printing Techniques"

Operation

- Image transferring elements (cells) are engraved to the surface of the printing cylinder. Non-image areas are on the surface level.
- The printing cylinder rotates in an ink fountain as a result of which the entire printing cylinder (cells and surface) is flooded with ink.
- Excess ink is wiped off of the surface with a doctor blade so that ink remains only on the engraved cells.
- Ink is then transferred directly onto the substrate in a printing nip under pressure.
- The ink transfer can be improved by creating an electric field across the nip. This field lifts ink out of the cells into contact with the substrate, thus improving the ink transfer. This is called ESA (Electrostatic assist) system.

  http://www.youtube.com/watch?v=xialgxiIpNk

Gravure, Printing Parameters

- Ambient temp 20 - 25 °C
- Printing cylinder temp as close as possible to the ambient temp
- Substrate (printing) speed 1 – 20 m/min (4 – 12)
- Printing cylinder speed 1:1 with substrate
- Cylinder (nip) pressure 0.2 – 0.6 Mpa (depending on the machine)
- Example of gravure printing compressive forces (“Sampo” SOM-100)

Cylinder pressure	**Nip force**
0.2 Mpa	40 kg
0.3 Mpa	60 kg
0.4 Mpa	80 kg
0.5 Mpa	100 kg
0.6 Mpa	120 kg

Gravure Printing, Pros and Cons

Advantages

- Simple operation – only a couple of components for ink transfer
- Simple machinery
- Fast manufacturing
- Enables big manufacturing volumes
- Good resolution
- Durable printing plates/cylinders -> different inks (solvents) can be used

Disadvantages

- Expensive printing plates/cylinders (~600 € ->), requires expertise
- High quality demands for substrate
- Finding proper process parameters

Printing Cylinders

– Steel cylinder plated with copper and after engraving chromed to increase its durability and improve the filling and emptying of the cells

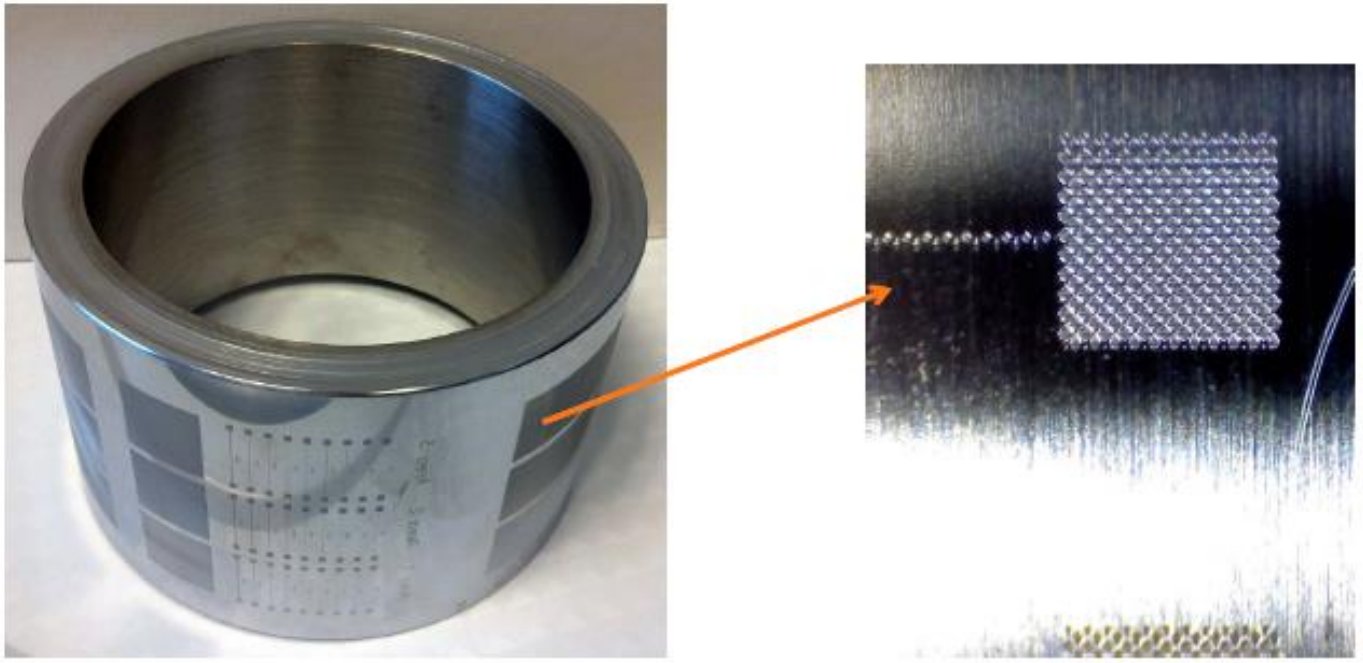
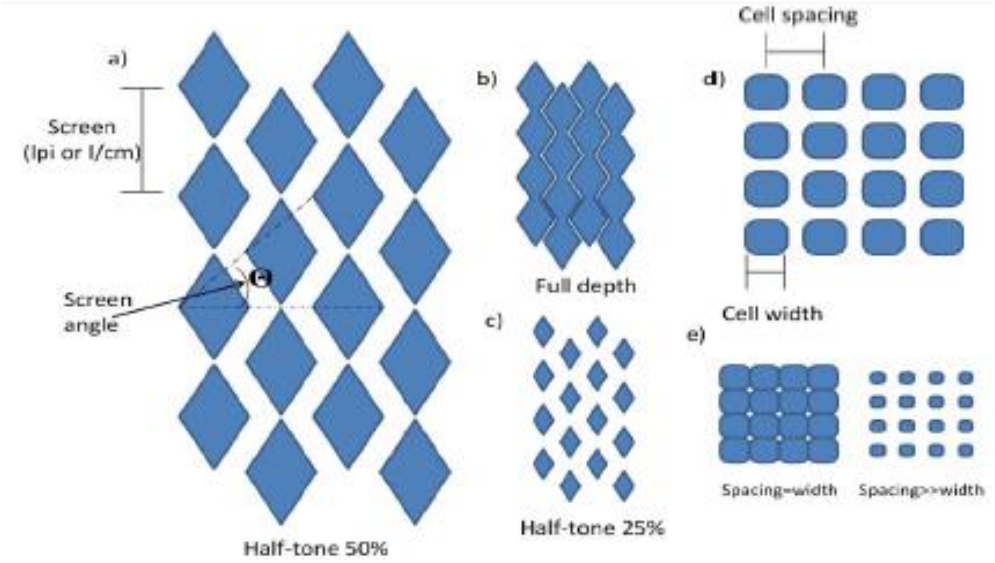


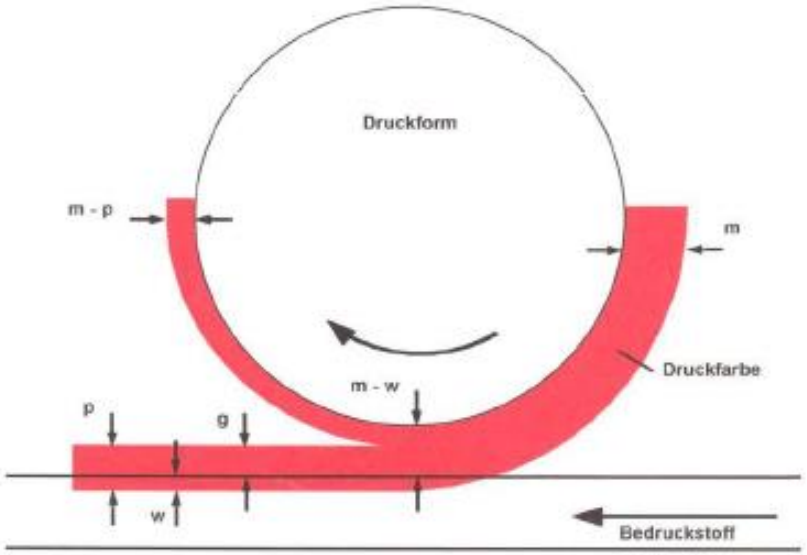
Image Forming

- Images are formed by single cells. Cell shape, depth, wall thickness and resolution can be freely adjusted.
- Cell volume defines the amount of ink transferred to substrate.
- Resolution typically 40 – 140 lines/cm.
- Right parameters have to be found to each different ink to be able to get accurate and proper thickness layer.
- Cylinder can include several different parameter cells.



Gravure Inks

- Gravure inks have very low viscosity (20 - 200 mPa•s) since they have to be able to flow in and out of the engraved cells at high speeds
- Printed layer is thin, usually from hundreds of nms to a couple of µms
- When printing large solid areas cell wall thickness is very thin -> ink spreads on the surface forming a uniform layer
- Only about 50 % of ink is transferred from printing plate to substrate



Factors Related to Printing Quality

- Ink viscosity, surface tension and type
- Printing speed
- Cell geometry
- Resolution (lines/cm)
- Blade geometry, wiping parameters
- Nip pressure
- ESA (Electrostatic Printing Assist) level
- Cylinder properties – material, plating
- Substrate roughness, pore structure and compressibility