

# Inkjet Printing

- Digital printing method
- Operation is similar than in normal inkjet printer, but materials printed are suitable for electronics

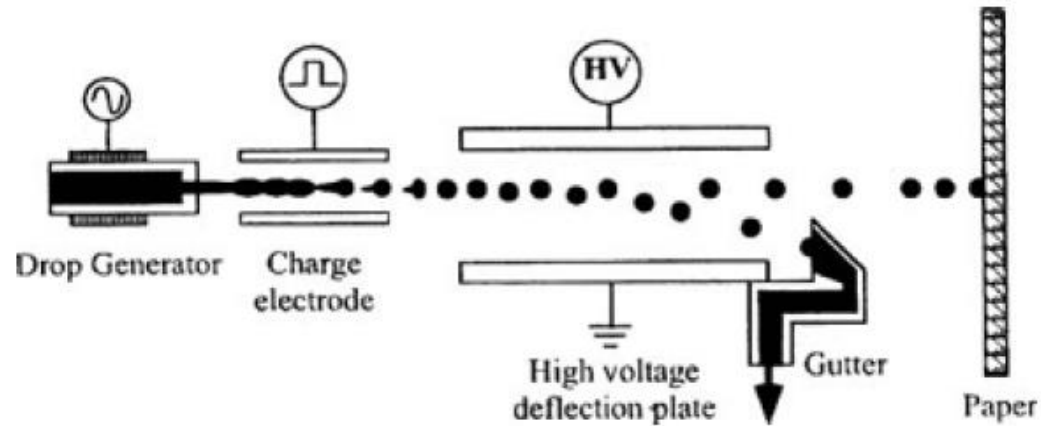
[http://www.youtube.com/watch?v=p5H5Hxw\\_ACE](http://www.youtube.com/watch?v=p5H5Hxw_ACE)

[http://www.youtube.com/watch?v=F035jDS\\_pU8](http://www.youtube.com/watch?v=F035jDS_pU8)

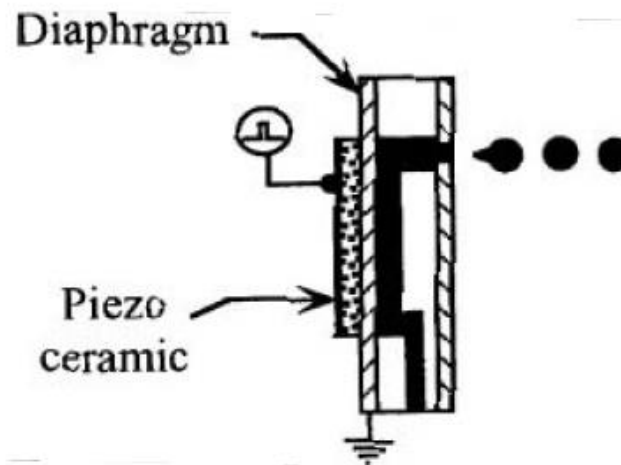
<http://www.youtube.com/watch?v=tagP1XhWPI8>

<http://www.youtube.com/watch?v=CFuNd3Lqslc>

# Inkjet Printing



Progress and Trends in Ink-jet Printing Technology, Hue P. Le, Le Technologies, Inc., Beaverton, Oregon



# Inkjet Printing

## **Continuous printing**

- binary deflection
- multiple deflection

## **On demand printing**

- thermal (bubble jet)
- piezo
- acoustic
- electrostatic

# Quality Factors

## **Ink composition**

- Functional materials
- Solvent
- Additives

## **Ink parameters**

- Viscosity                      2 – 30 mPas
- surface tension            40 – 80 mN/m
- particle size                ink particles max. 1/100 of nozzle diameter

# Print Settings

- Print head
  - nozzle size
  - heating
  - clogging
- Waveforms
- Nozzle's distance from substrate
- Surface temperature
- Substrate properties
  - surface energy
  - Hydrophobic or hydrophilic

# Droplet formation

- Pressure difference which makes the droplet is produced by motion of the piezo. Piezoelements are controlled by specific waveform. Waveform affects the droplet formation, firing frequency, and other droplet properties.
- Droplet properties during flight are:
  - size
  - velocity
  - formation time and distance
  - deviation of direction
- Typical waveform in the image



# More about Droplets

- Optimal pulse width= $L/c$ , where
  - $L$  = fluid channel length
  - $C$  = sound velocity in fluid
- Amplitude is proportional to velocity of droplet. Width affects the droplet size, which affects the speed also.
- Print head temperature has to be taken into account also. Lower viscosity means easier jetting -> amplitude has to be changed.
- Viscosity of fluid has also other effects to jetting. Low viscosity can lead to air being mixed to ink which is one cause of satellite droplets.
- High viscosity ink needs higher voltages, which can cause vibration in ink.

# Drop Placement Accuracy

- Drop placement accuracy on substrate is affected by several things those factors can be divided into three groups:
  - droplet jetting
  - mechanical features of the machine
  - material properties
- Jetting related errors are usually caused by nozzle function differences which lead to variation in flying speed (time) and direction.
- In inkjet printing surface moves with certain speed related to print head and there is some distance between head and surface. Mechanical features include also print head/surface positioning and repeatability geometric, thermal and dynamic properties.
- Print head channel and nozzle dimensional stability, accuracy and uniformity has a great effect on printing frequency, volume and speed -> printing



# Print Head Maintenance

- Typical cleaning method is purge routine – forced flow of ink through the nozzles
- Wiping with lint-free fabric
- Capping
- Solvent flushing

# Inkjet Printing, Pros and Cons

## **Advantages**

- NIP – suitable also for varying surfaces
- Accurate droplet size and ink transfer to substrate →
- Less material waste
- Fast changes
- Additive method-→ material layering

## **Disadvantages**

- Slow
- Expensive print heads (piezo)
- Nozzle clogging
- Low repeatability in long runs