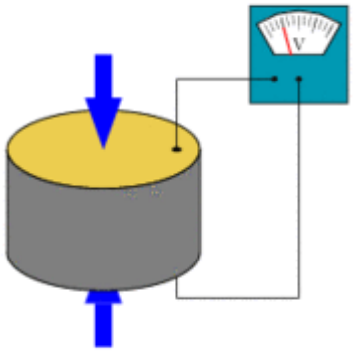
4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Piezoelectric effect is defined as the electromechanical relation that appears between stress and electrical charge in a material:

Materials that present piezoelectric effect include some crystals, ceramics, bones, DNA and proteins



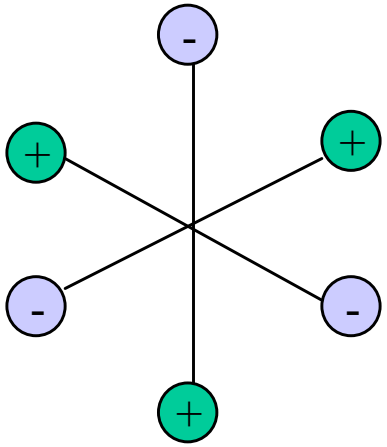
A piezoelectric disk generates a voltage when deformed (change in shape is greatly exaggerated) by courtesy of Mael Guennou – Titzeff (CC)

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

How it works

The unit cell of crystal silicon dioxide

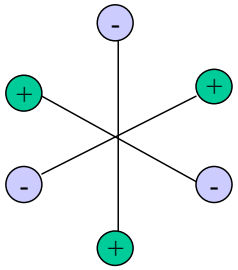


4. Applications with organic, inorganic and hybrid materials

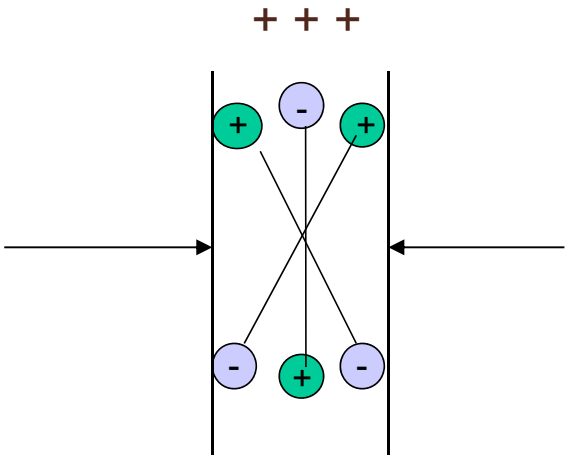
4.6 Piezoelectrics

How it works

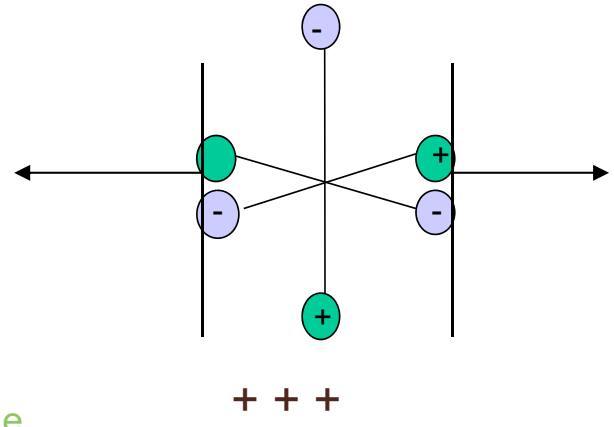
Unit Cell at Rest
SiO_2 (Quartz)



Unit Cell Under Mechanical Compression ("pushing" force):
Electrical polarity as shown



Unit Cell Under mechanical
Tension ("pulling" force):
Electrical polarity reverses.



http://www.ndt-ed.org/EducationResources/CommunityCollege/Ultrasonics/EquipmentTrans/piezotransducers.htm

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Most commonly used piezoelectric materials:

- Barium titanate, $BaTiO_3$
- Lead Zirconium- Titanates, $Pb(Zr_xTi_{1-x})O_3$ (or PZT)
- Sodium potassium niobate, $(Na,K)NbO_3$ (or also NKN)
- Polyvinylidene fluoride (PVDF)
- Diphenylalanine peptide nanotubes (PNTs)

https://www.youtube.com/watch?v=F1PzYi8jmuo

Advanced Functional Materials, 2011, ***21, 2251.***

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Applications:

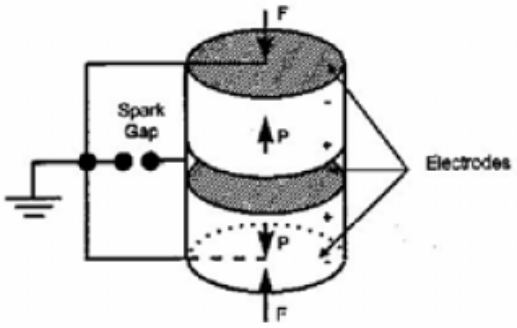
- Generation and detection of sound (mainly ultrasound)
- Drive an ultrasonic nozzle
- Inkjet nozzles
- Generation of high voltages (lighters, ignitors)
- Electronic frequency generation.
- Ultrafine focusing of optical assemblies (lasers, interferometers)
- Drivers of equipment such STEM, AFM….
- Microbalances

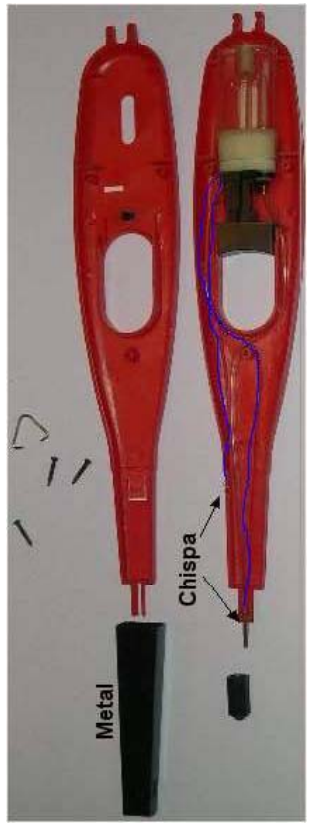
4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Examples

lighter





4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

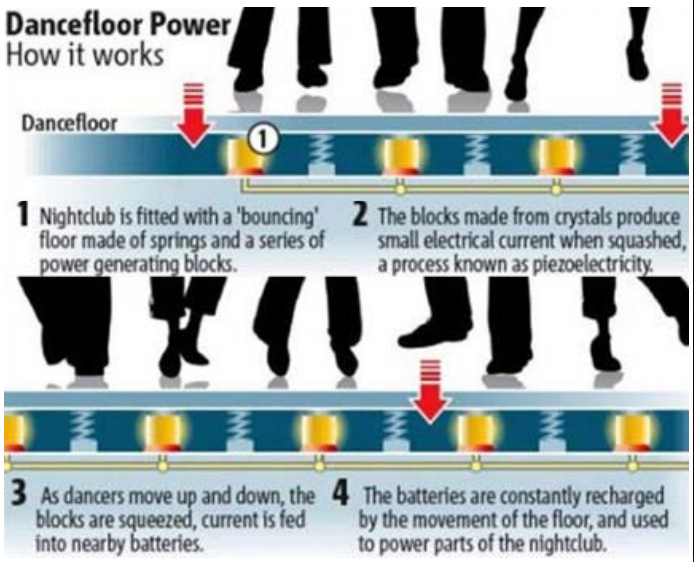
Examples

Fun

https://www.youtube.com/watch?v=K3G2QM5a-9U
https://www.youtube.com/watch?v=pLrqkAj2RtU
https://www.youtube.com/watch?v=R7zjfaPKMSE

Diesel injector

https://www.youtube.com/watch?v=ftchx1TDNJo



4. Applications with organic, inorganic and hybrid materials

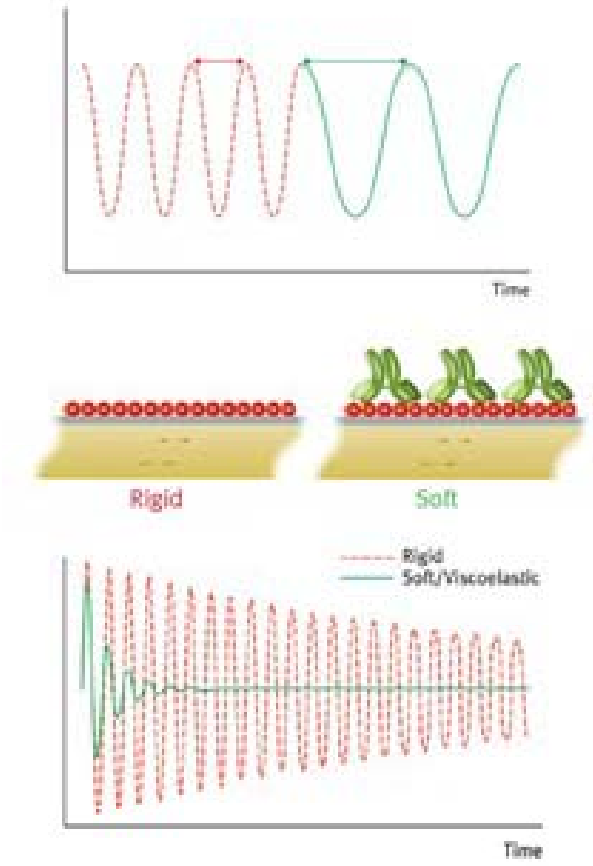
4.6 Piezoelectrics

Quartz microbalance

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$\Delta m \approx \frac{C}{n}\Delta f$$

n , overtone number
C, multiplier (17.7 ng Hz^{-1} cm^{-2} for a 5 MHz quartz crystal)



http://www.q-sense.com/

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Pumps for microfluidics

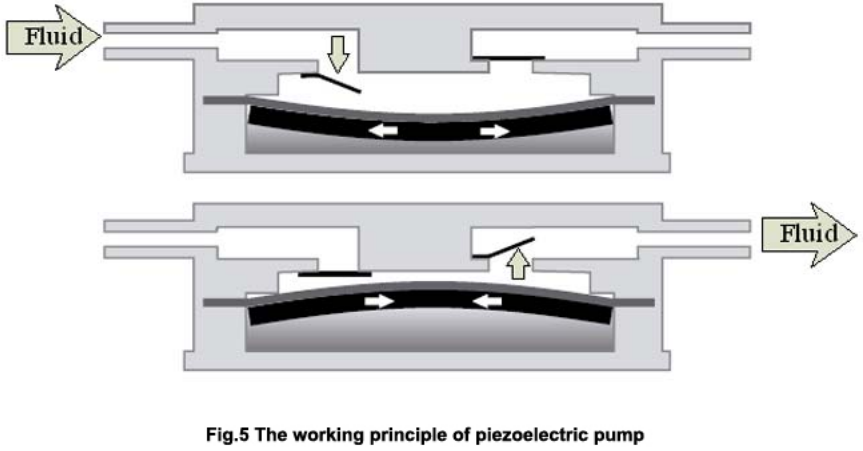
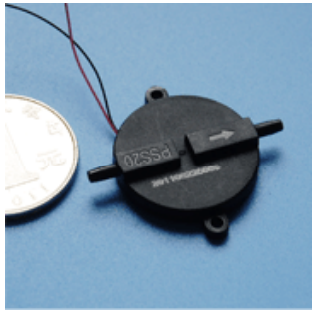
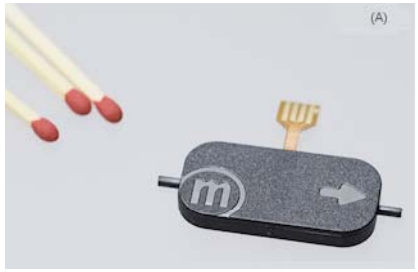
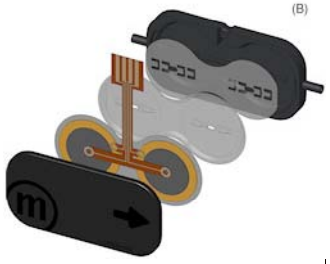
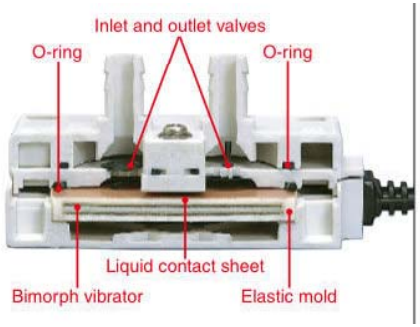


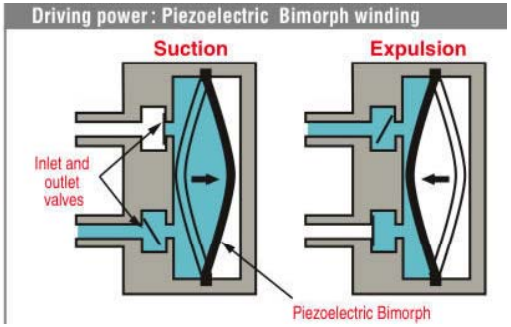
Fig.5 The working principle of piezoelectric pump











http://www.piezochina.com/Piezoelectric-Pump.html

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

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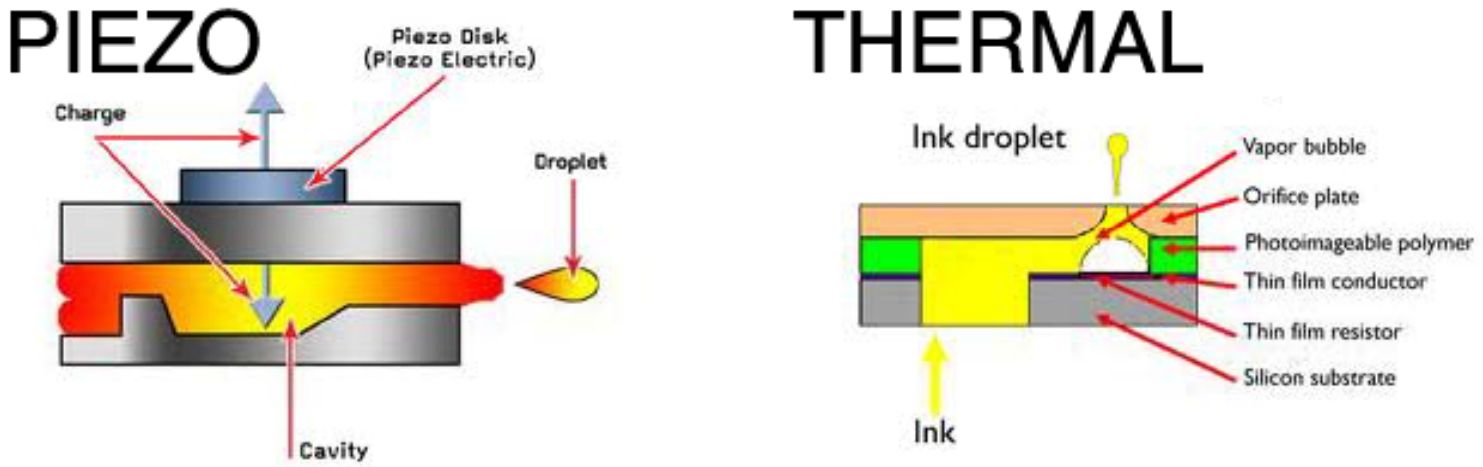
Inkjet



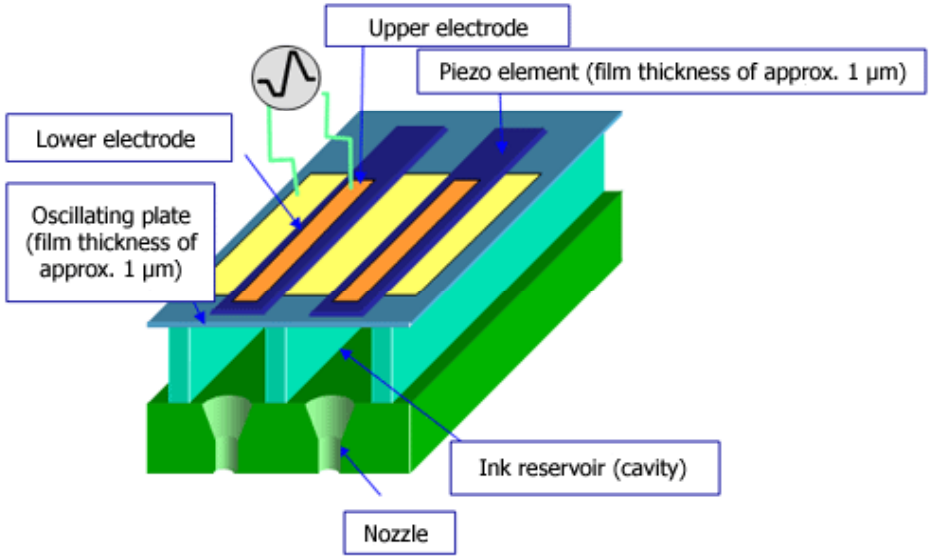
Operation of an inkjet nozzle

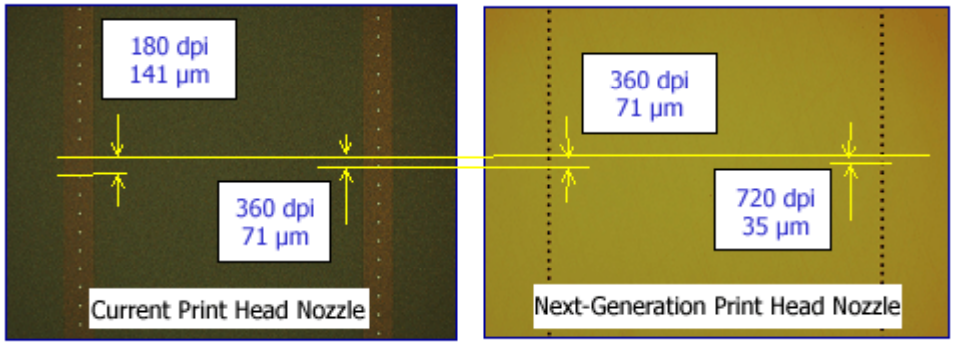
http://www.theimagecollective.org/inkjet-technologies/

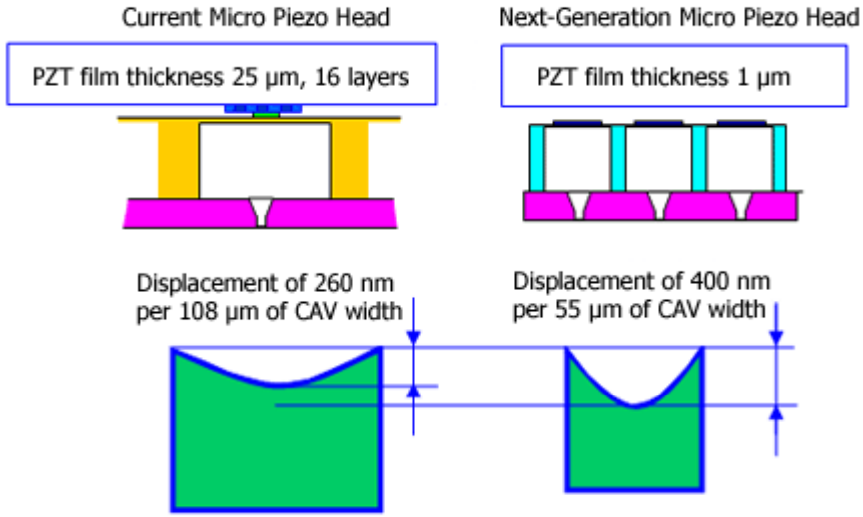
4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Inkjet (paper)







http://dpnow.com/3762.html

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

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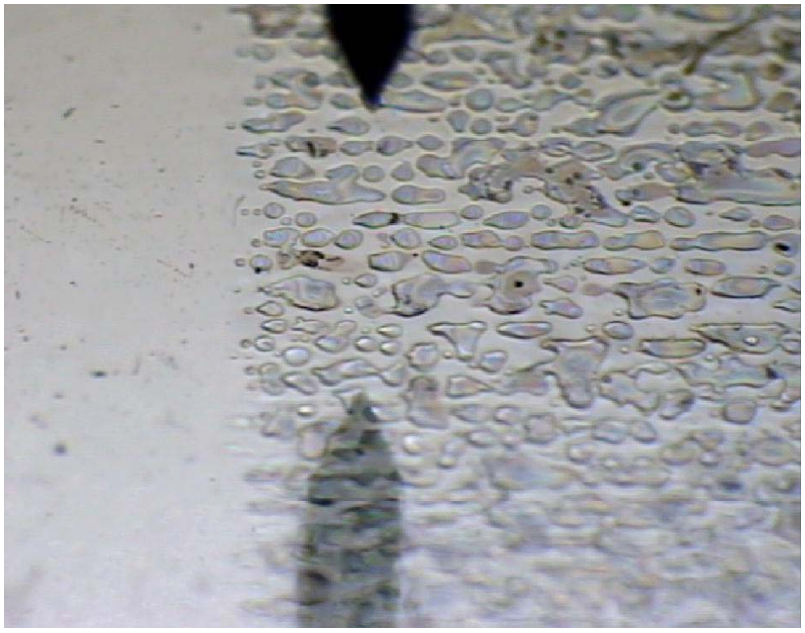
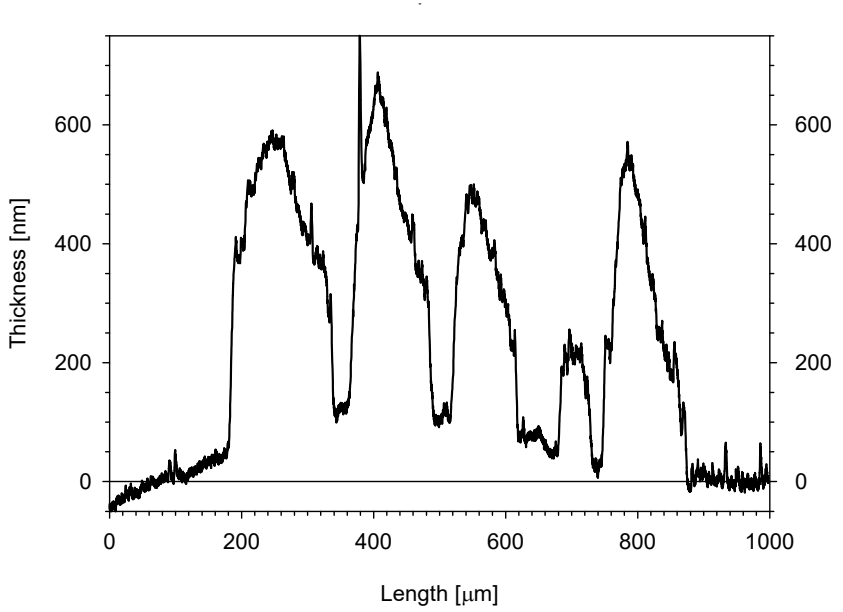
Inkjet





Heads from μL to pL

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

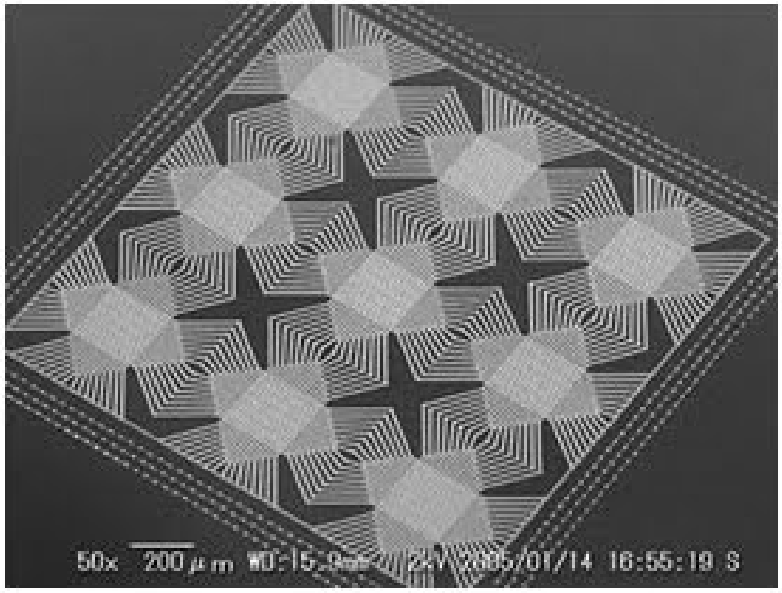
Inkjet (tiles)

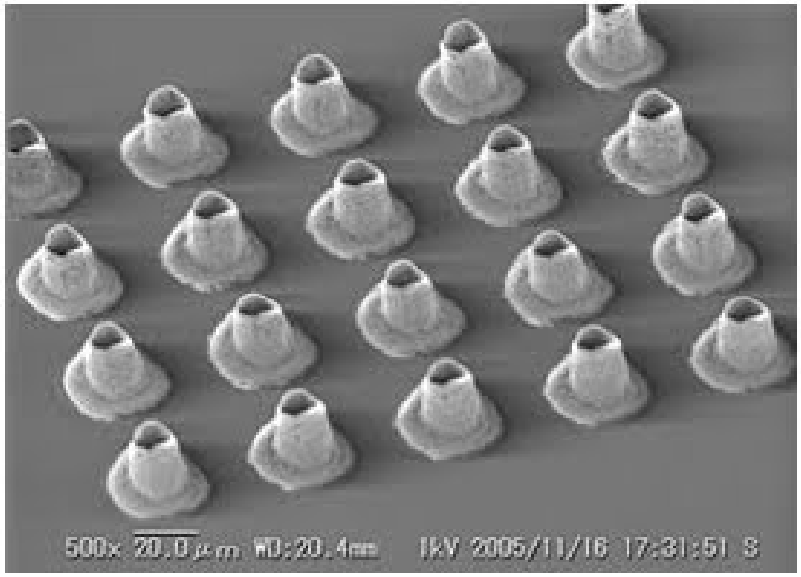
https://www.youtube.com/watch?v=4vhWllj2NCA
https://www.youtube.com/watch?v=v6ccvKE2SZc

4. Applications with organic, inorganic and hybrid materials

4.6 Piezoelectrics

Inkjet (nanotech)





http://www.ineffableisland.com/2009/11/palm-sized-superfine-inkjet-prints.html