

Micro and nano fabrication processes for Energy Harvesting

Professor Robert Dorey
Chair in Nanomaterials

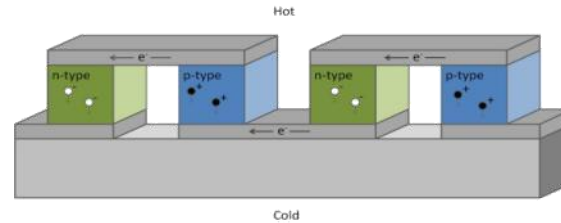
Energy Harvesting Network
MEMS/NEMS Energy Harvesting – 3rd December 2011

- Potential Energy Harvesting Structures
- Realising micro and nano structures
- Subtractive
- Additive
- Future potentials

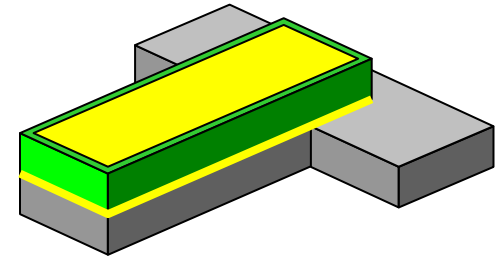


Energy Harvesting Structures

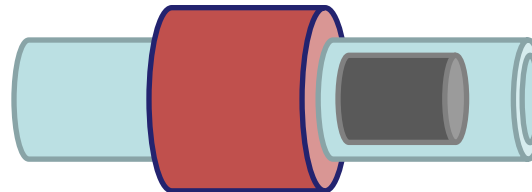
- Piezoelectric
- Pyroelectric
- Thermoelectric
- Induction



Thermoelectric: paired p and n type semiconductors



Piezoelectric: vibrating structures



Induction: magnet-coil interaction

Energy Harvesting Structures

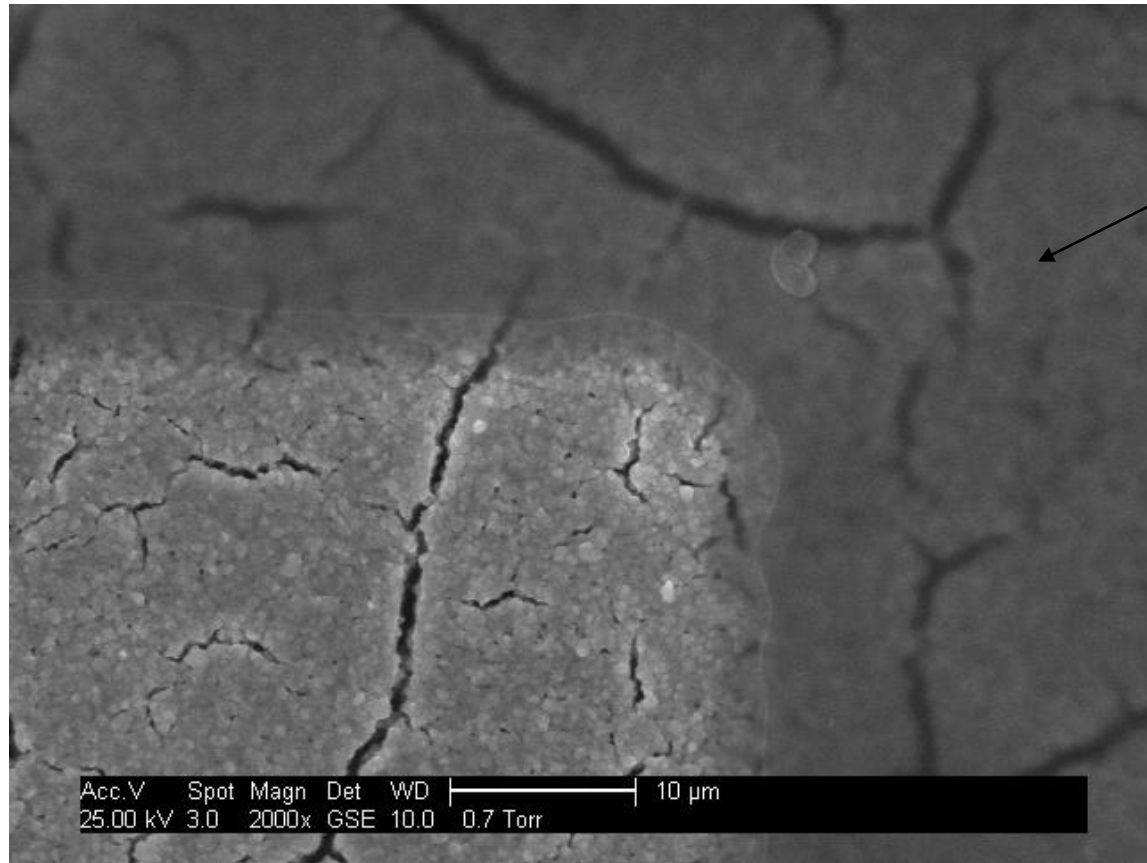


Moving beyond pick and place of discrete elements

Surface structured devices



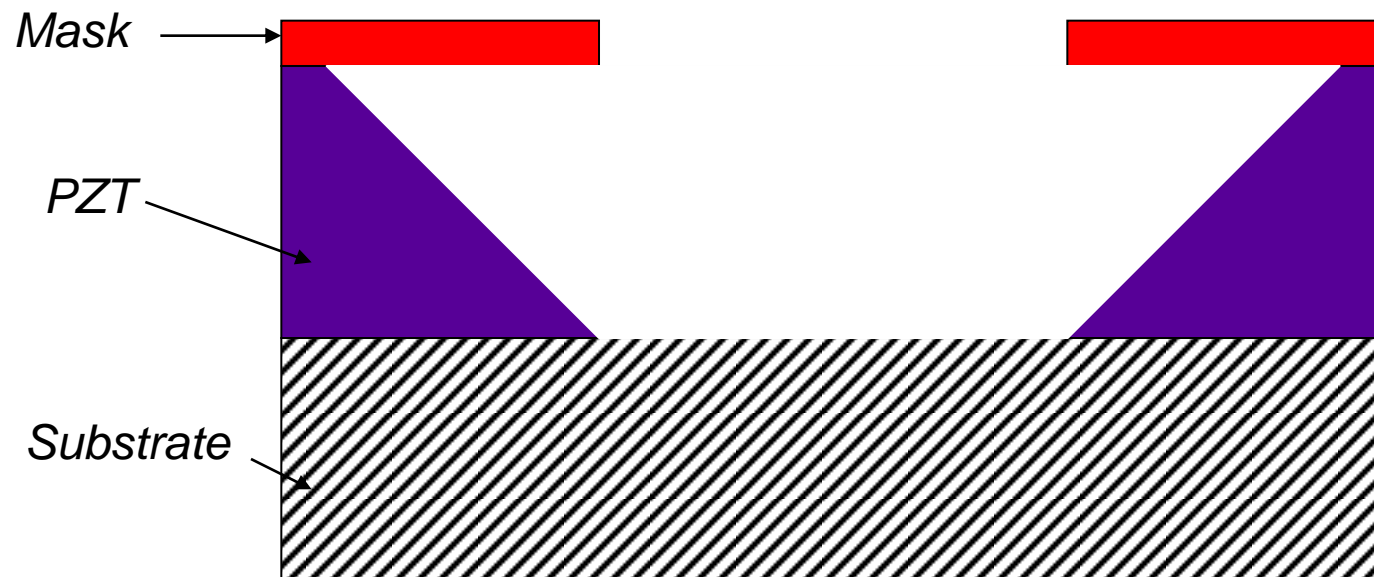
Structuring Etching



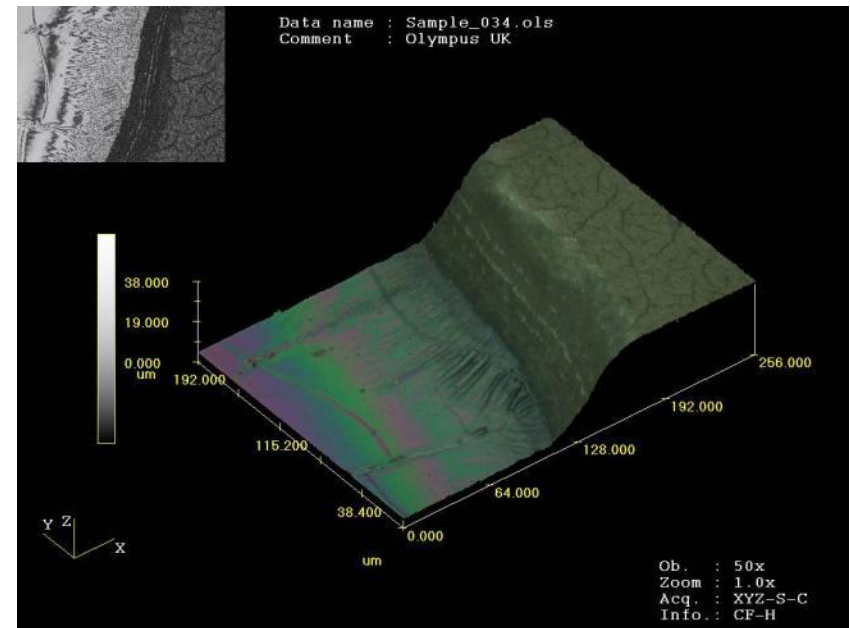
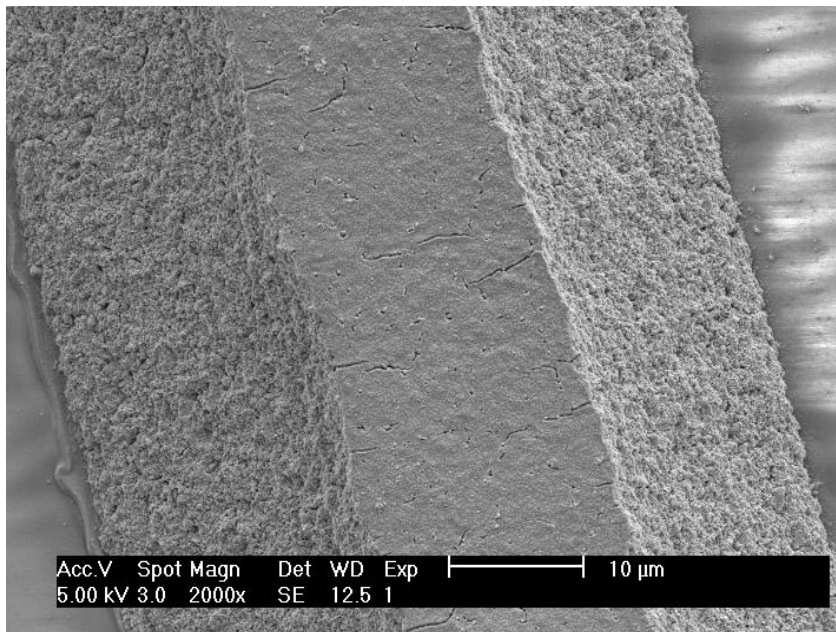
PZT wet etchant

HF (0.5 vol%) , HCl (4.5 vol%), H₂O (95 vol%) at 60°C

Structuring Etching



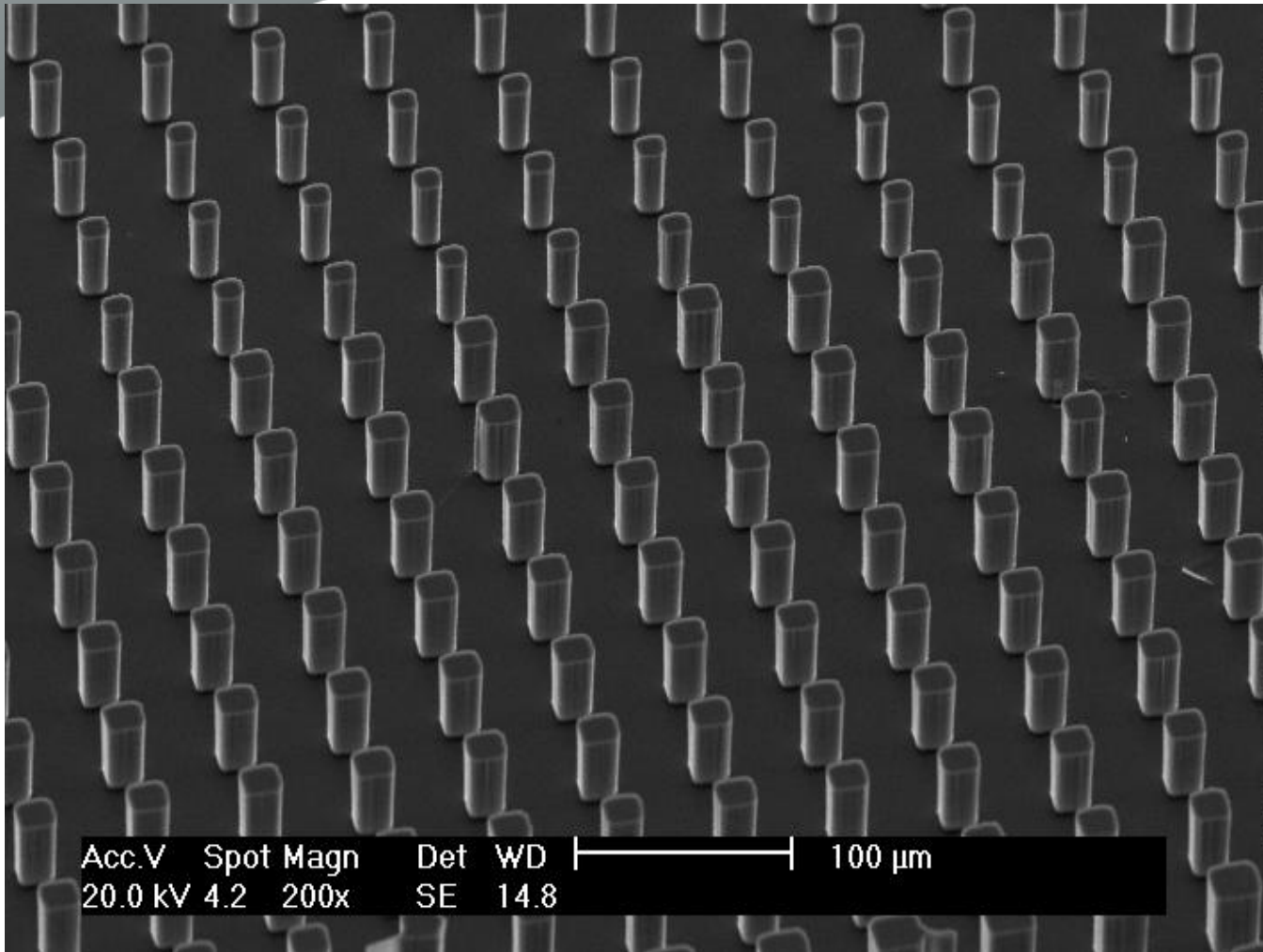
Structuring Etching



22μm thick PZT film

Wet etching of PZT thick films
(4.5 vol% HCl: 0.5 vol% HF: 95 vol% H₂O)

Surface structured Thermoelectric

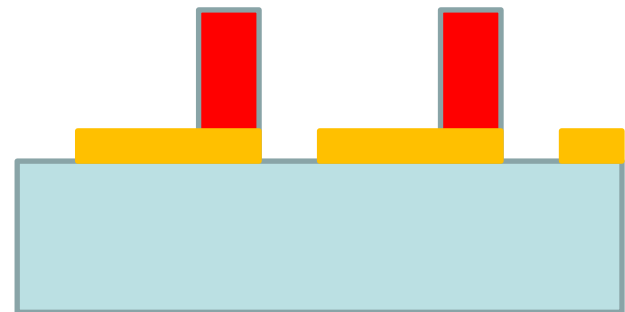
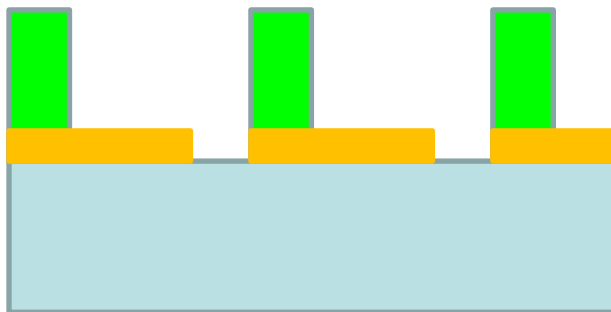
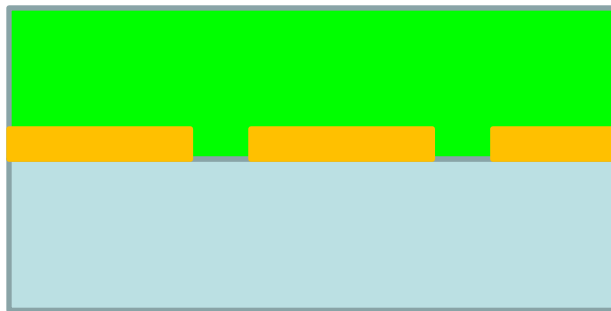


Increase thermopile density → increase voltage

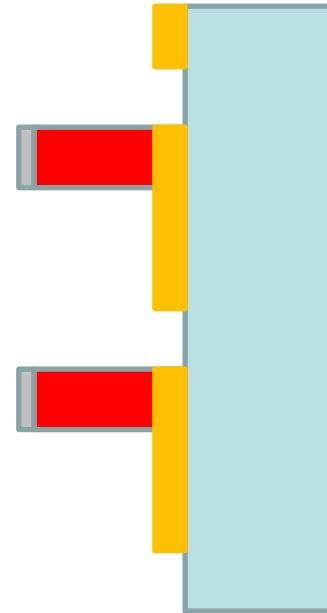
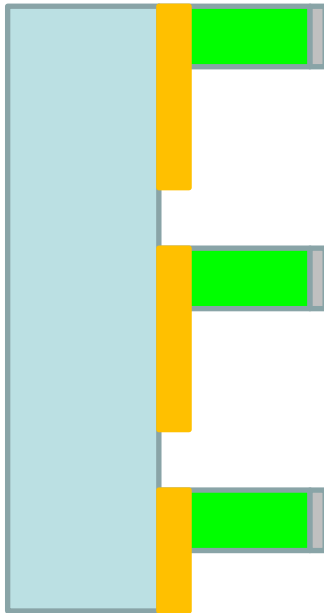
Surface structured Thermoelectric



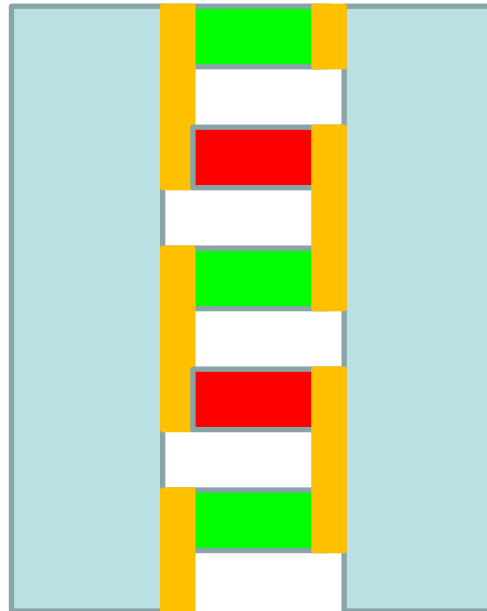
Surface structured Thermoelectric



Surface structured Thermoelectric



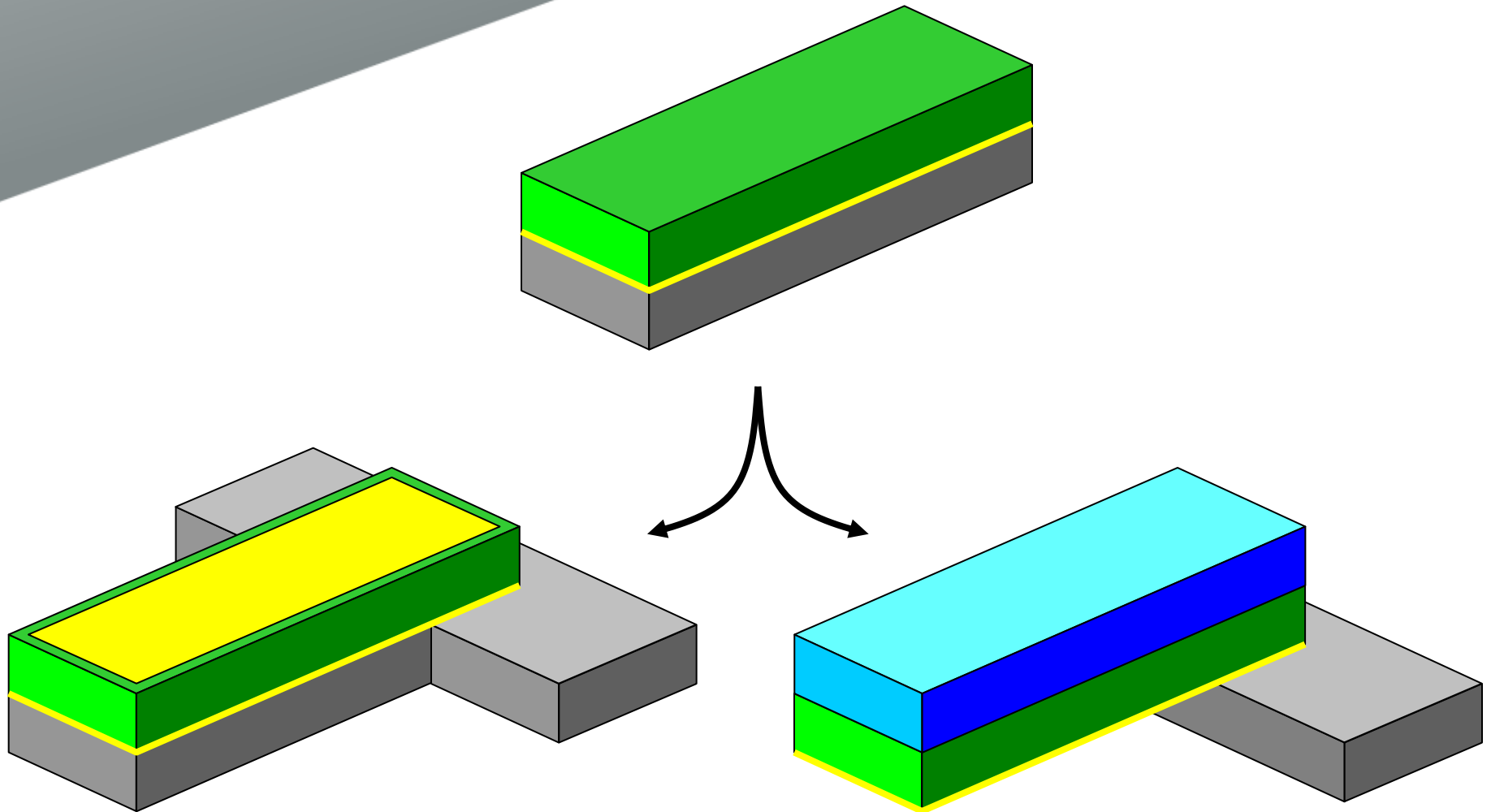
Surface structured Thermoelectric



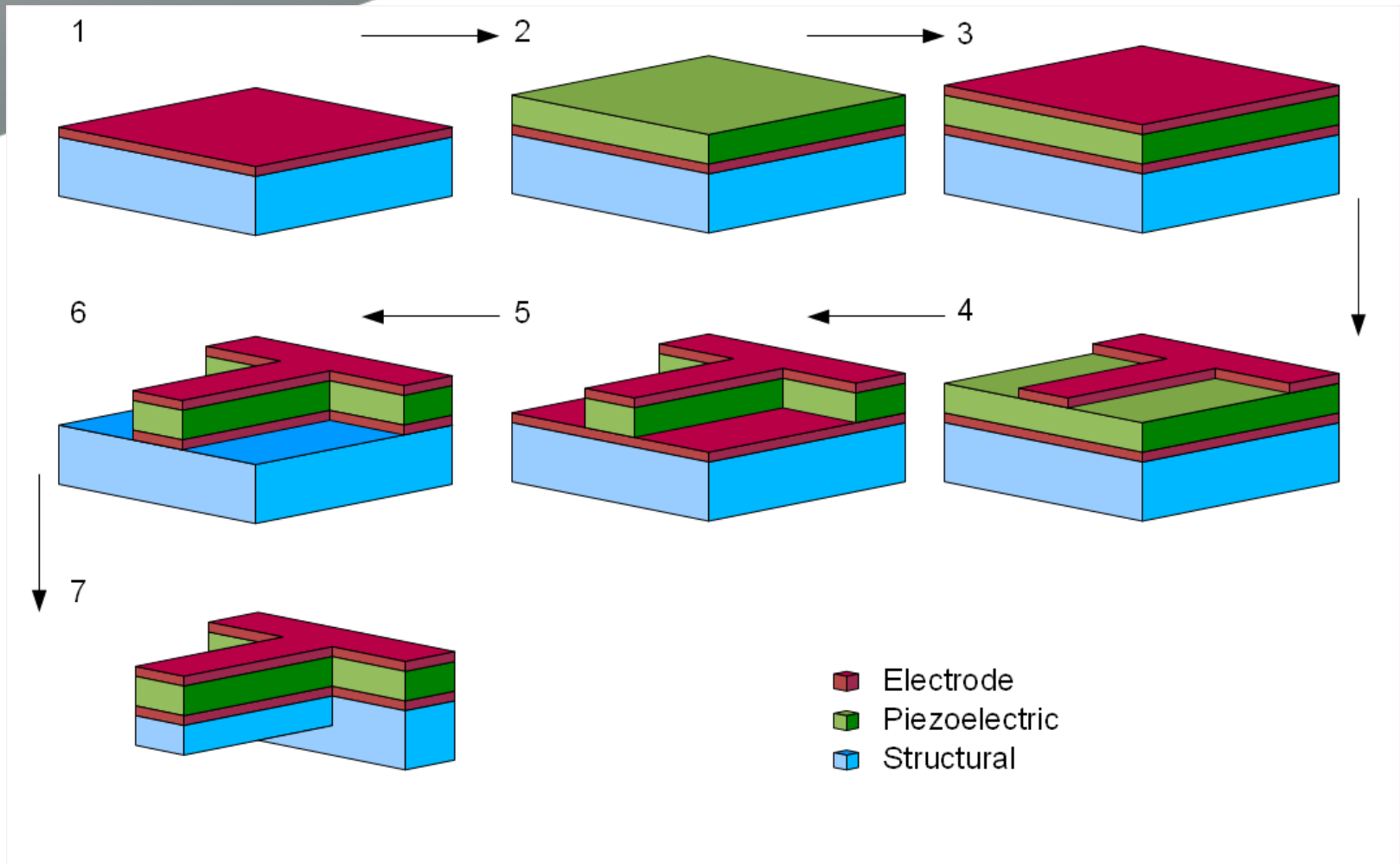
Suspended structures



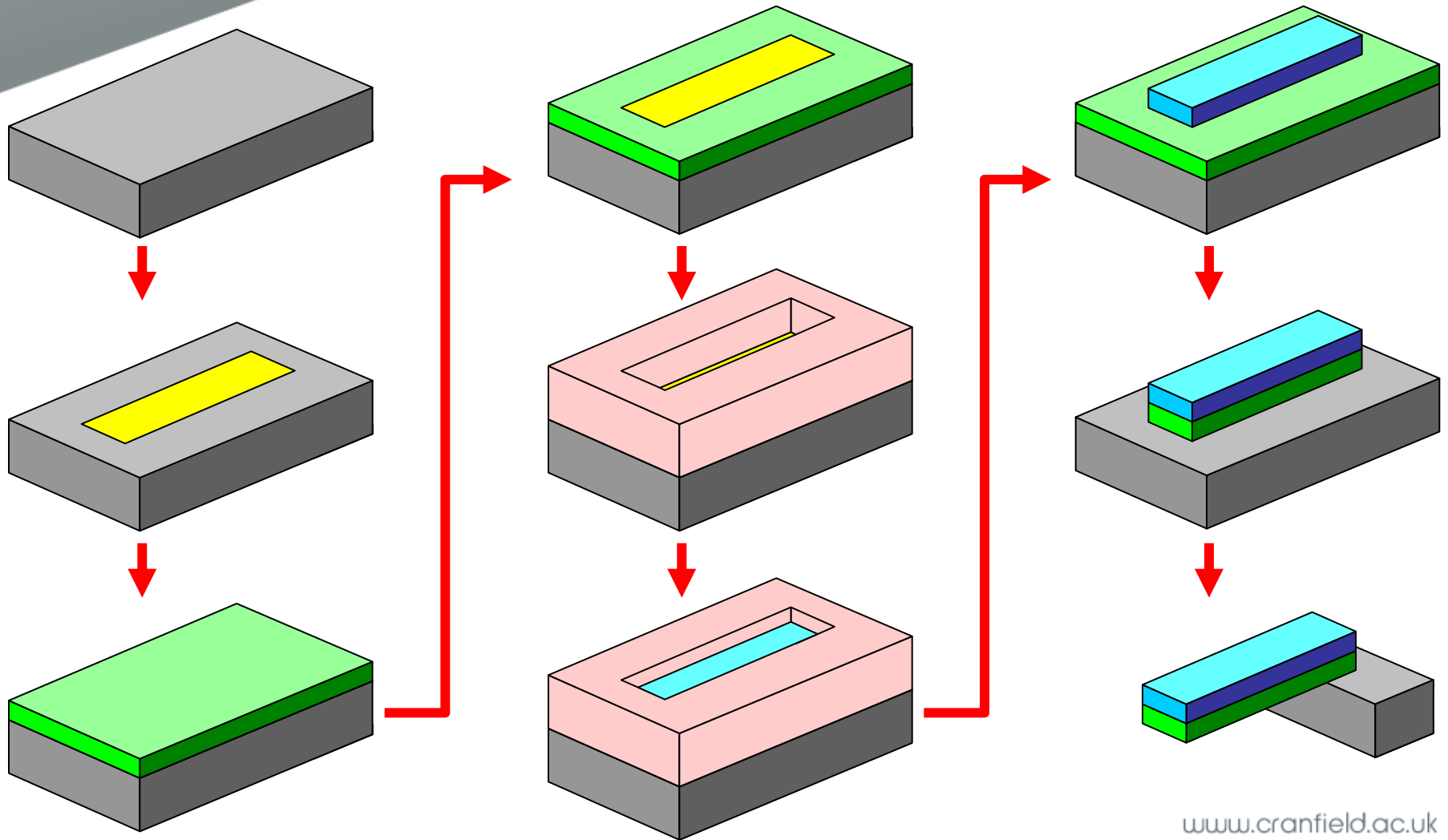
Suspended structures



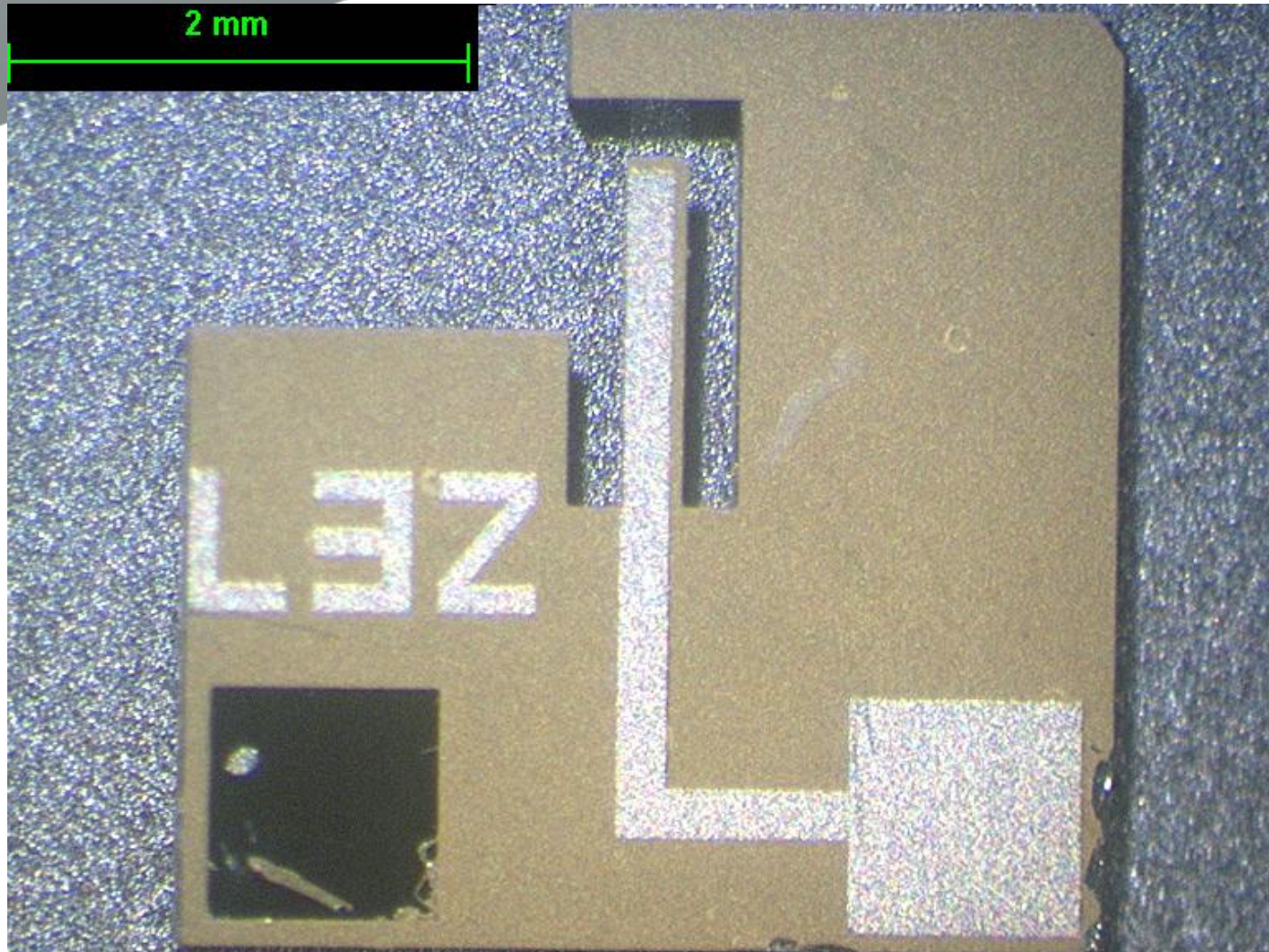
Suspended structures



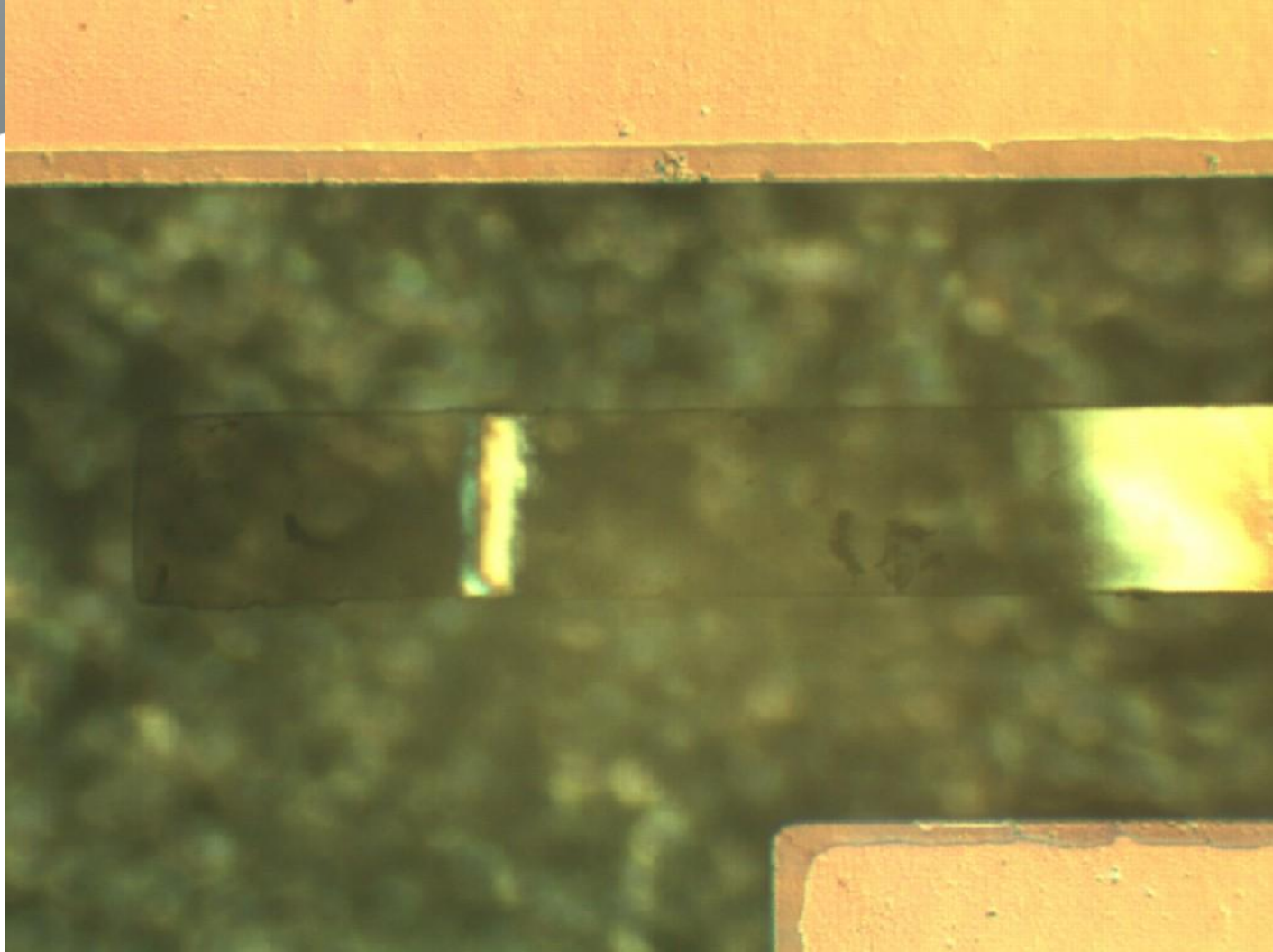
Suspended structures



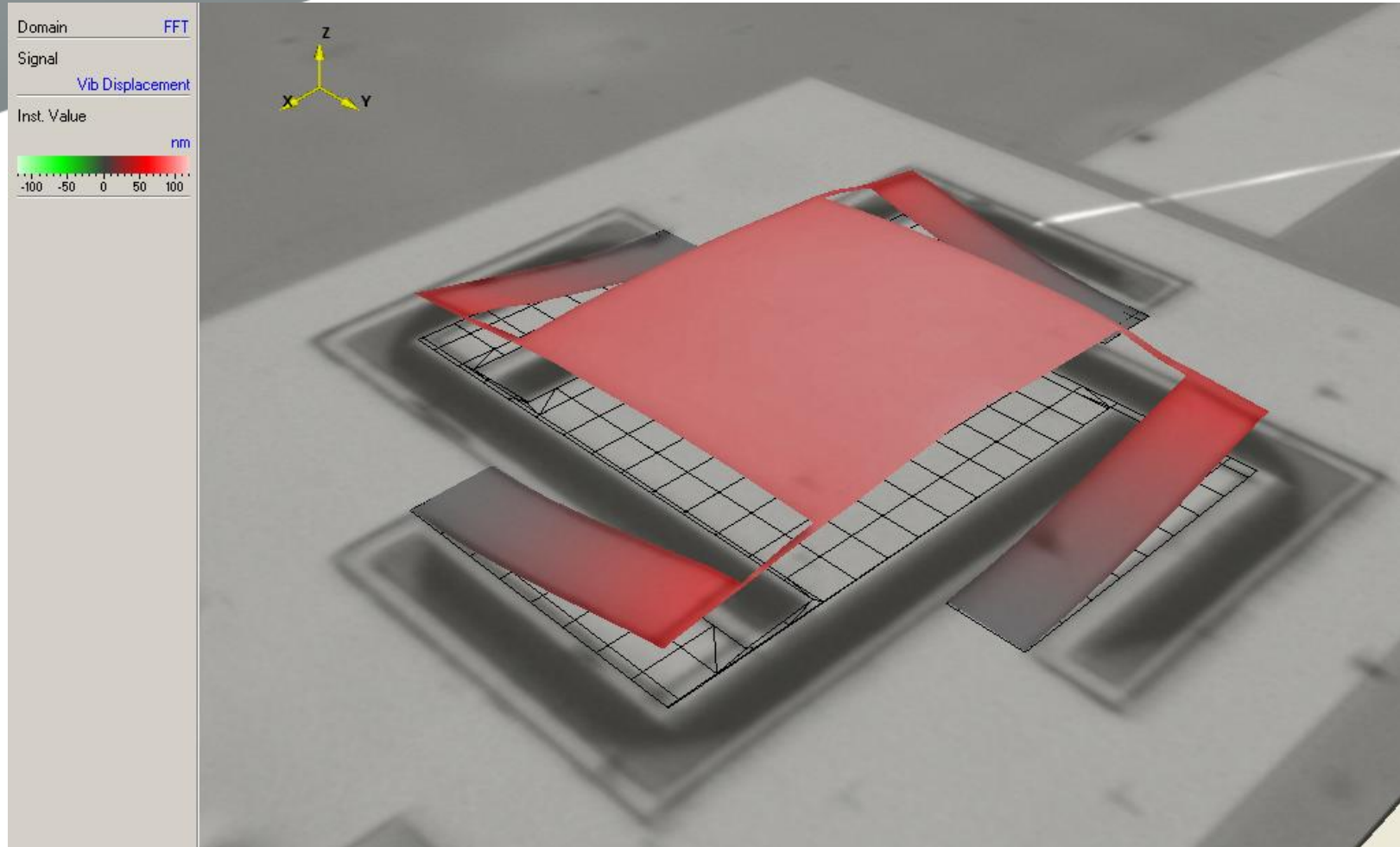
Micro-cantilever structure Piezoelectric



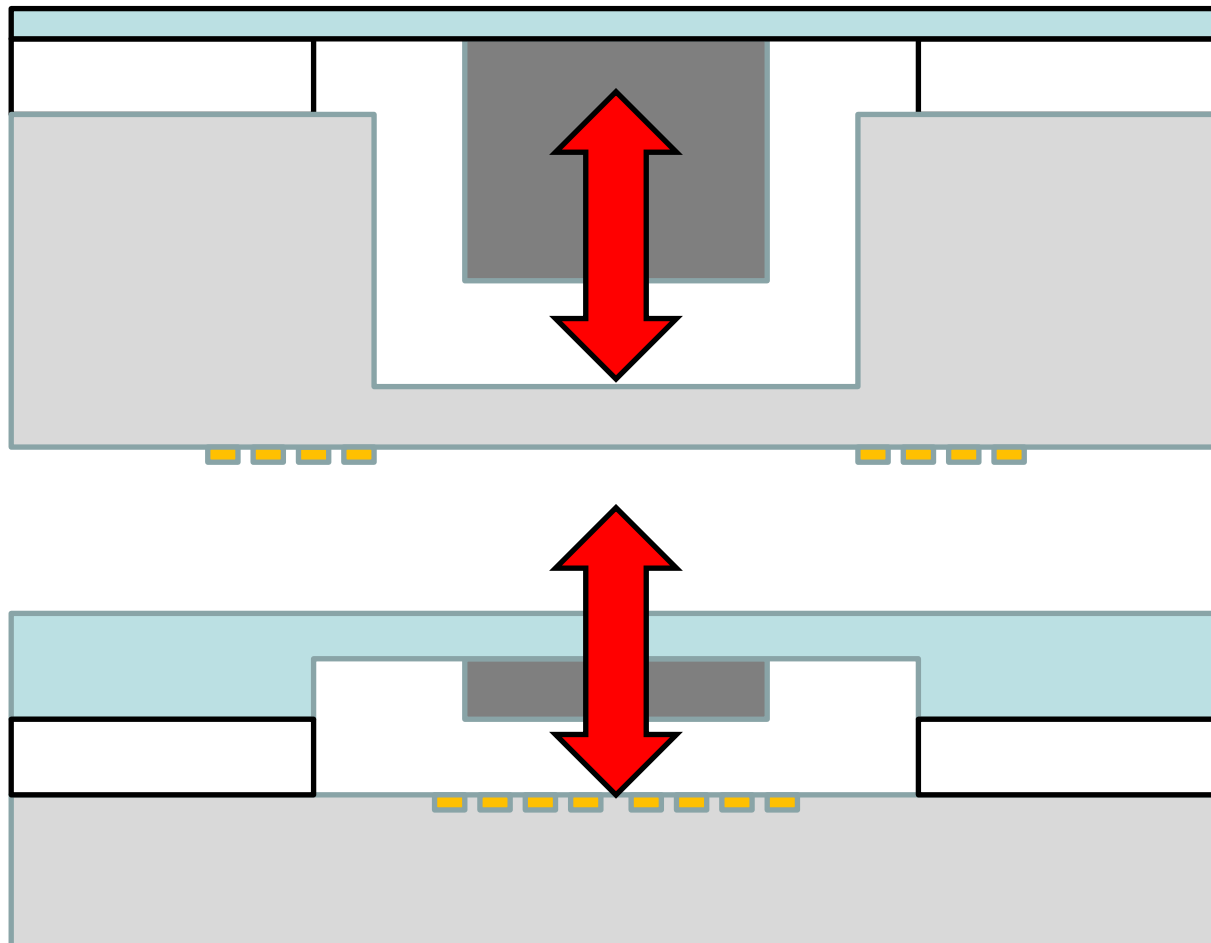
Micro-cantilever structure Piezoelectric



Micro-cantilever structure Piezoelectric



Micro-cantilever structure Induction



Energy Harvesting Structures



Moving beyond pick and place of discrete elements

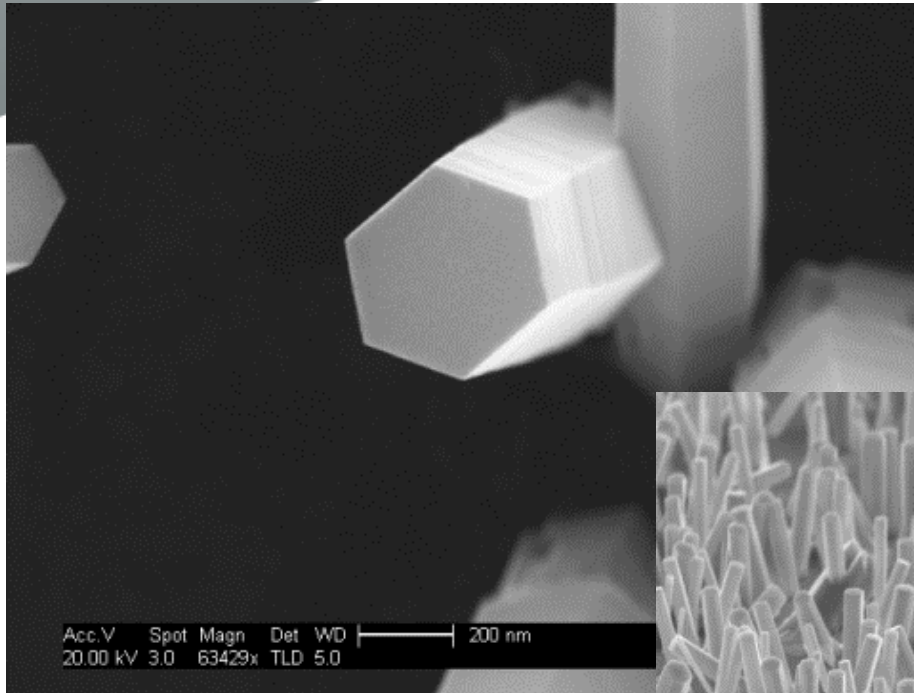
Energy Harvesting Structures



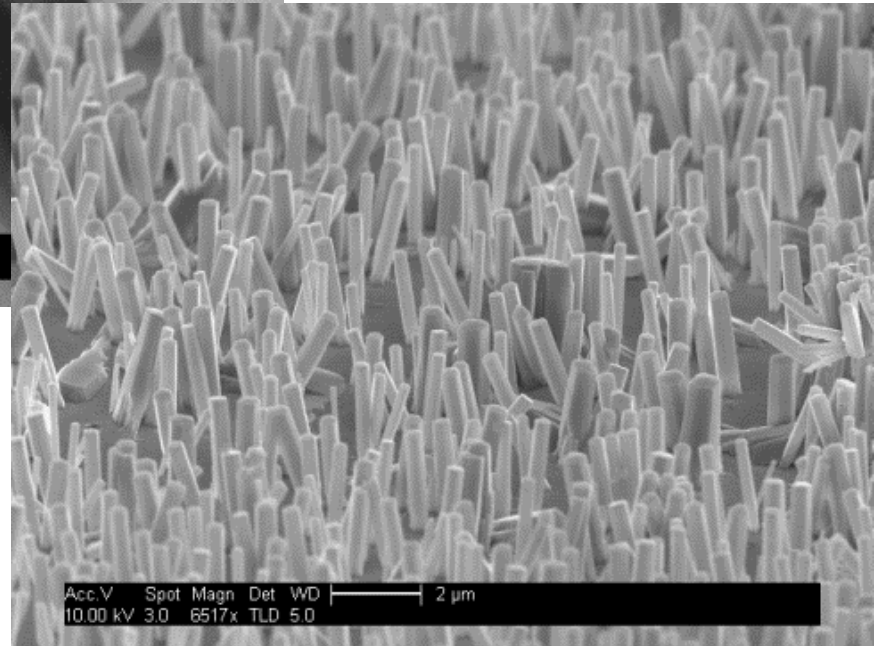
Moving **towards** pick and place of discrete elements

Structures

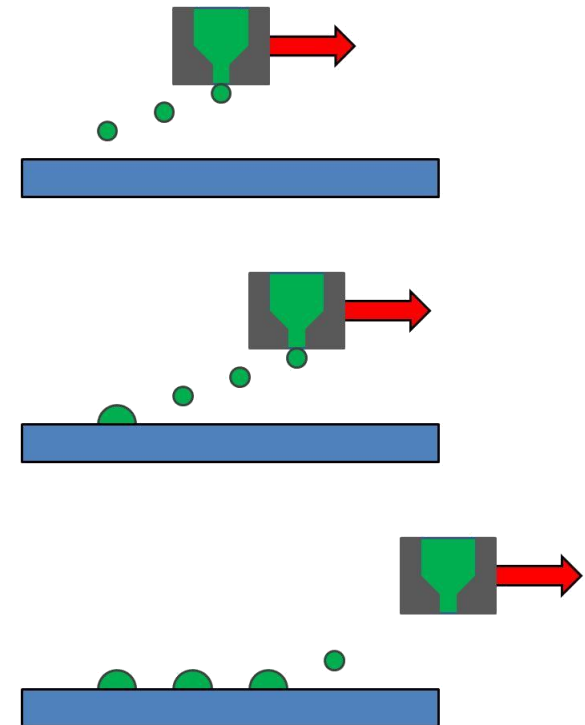
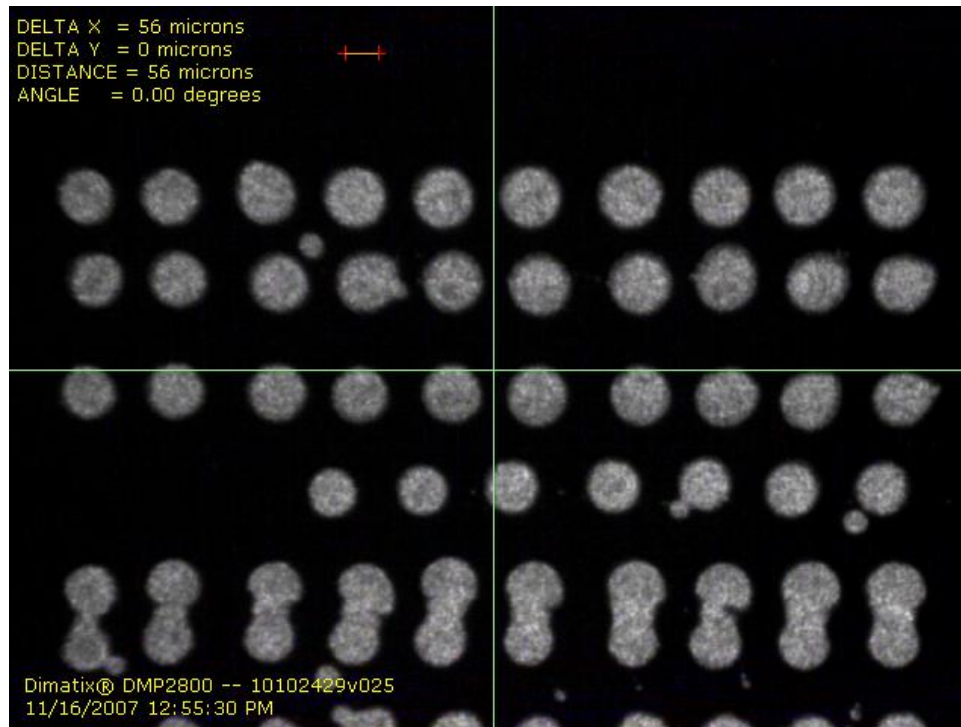
Direct growth



ZnO nanorods

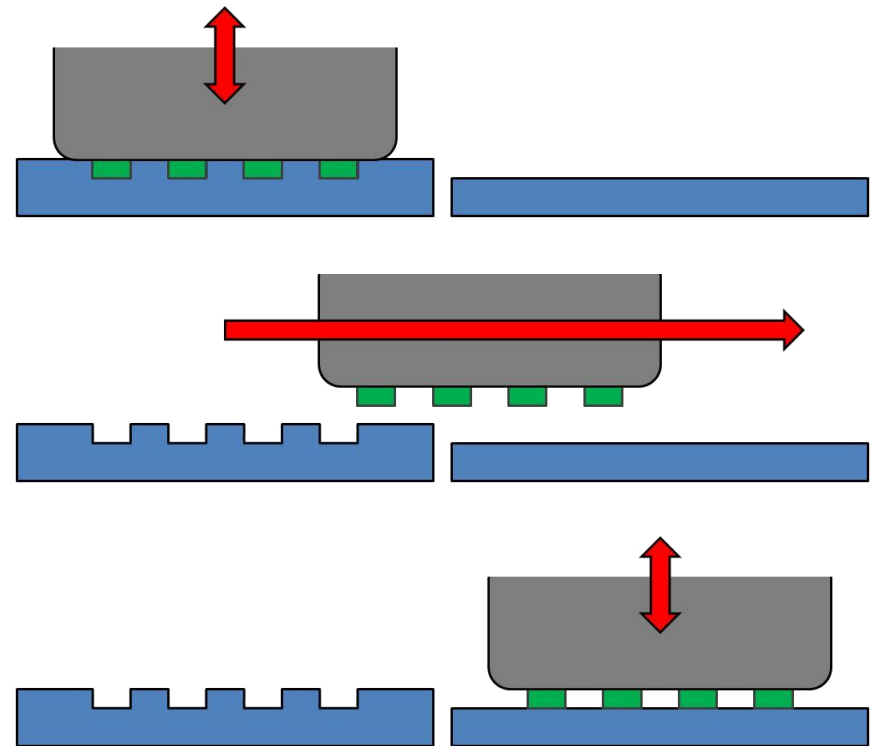


Structures Ink Jet



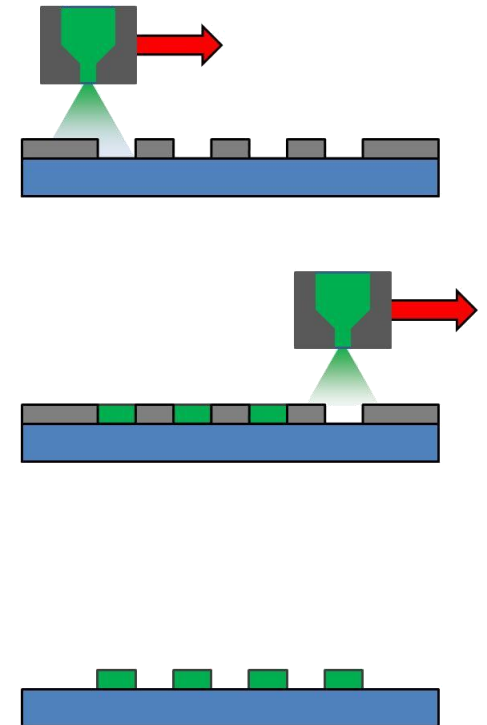
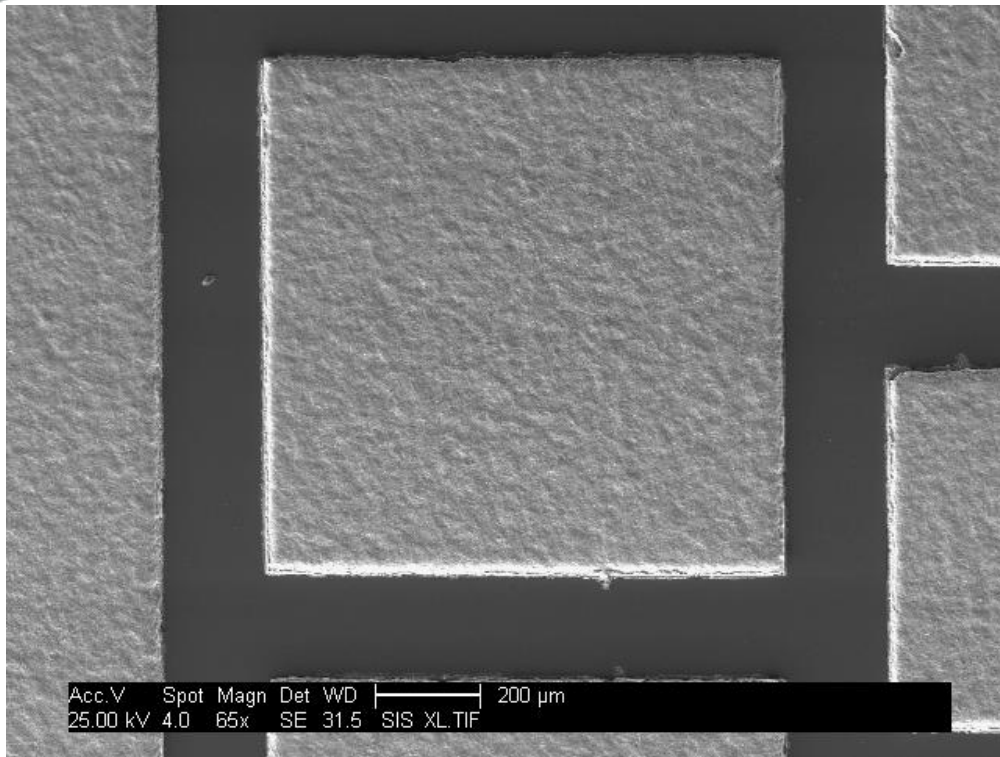
Structures

Pad printing



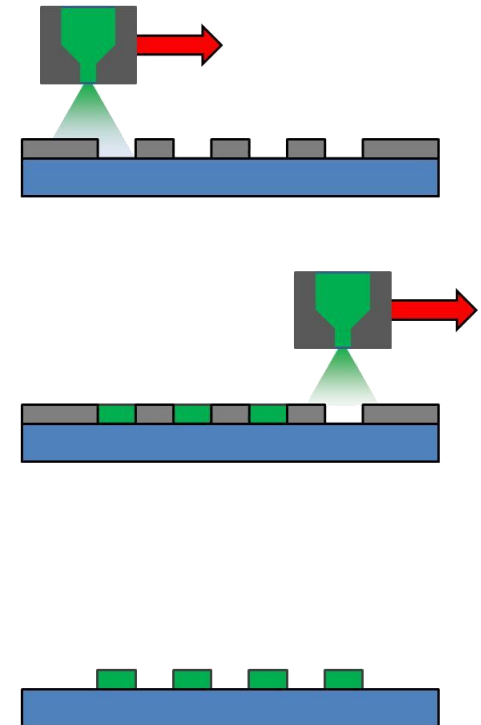
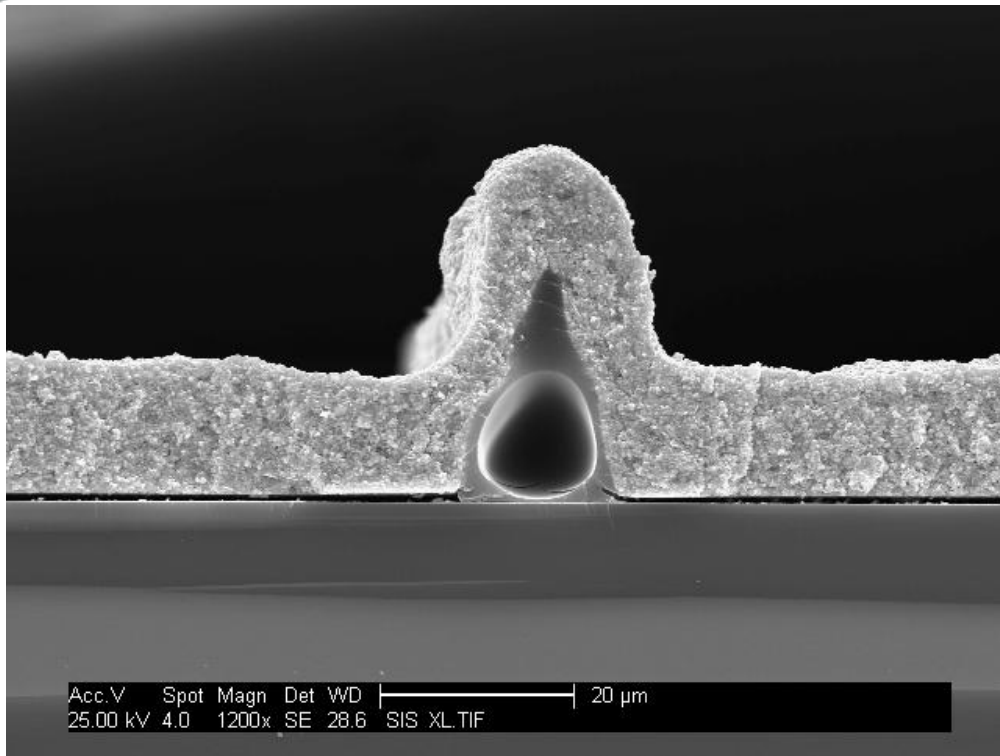
Structures

Micro moulding

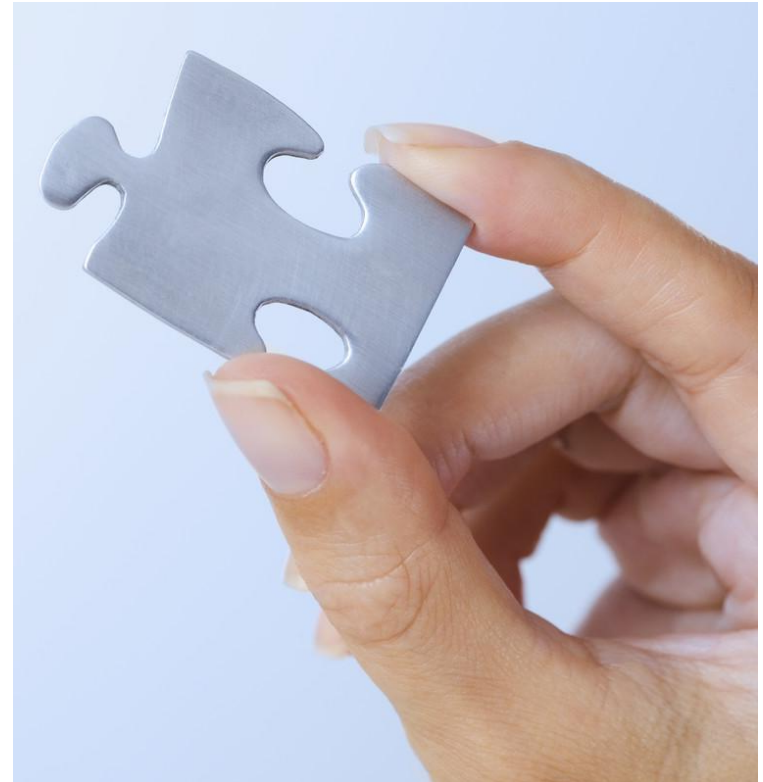


Structures

Micro moulding



- Potential Energy Harvesting Structures
- Surface structures
- Suspended structures
- Additive & beyond 2D



You've been listening to:

Professor Robert Dorey

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