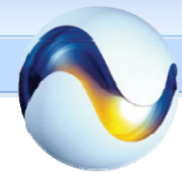

IR imaging and static laser stimulation for MEMS technological evaluation and FA

Jeremie Dhennin

Optical localization techniques workshop
Toulouse, 26/01/09

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Scope

- MEMS peculiarities
- When MEMS FA meet microelectronics FA techniques
- Case study #1: investigation of SOI release for optical switches – IR imaging
- Case study #2: micro switch contact detection – Static laser stimulation

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MEMS peculiarities

Categories	I	II	III	IV
	No movement	Movement without contacts	Movement with contacts	Sliding contacts
Examples	Chemical sensors, Inkjet printhead	Accelero, Gyro, Comb drives, Pressure sensors, Microphones	Switches, micro-mirrors, Pumps…	Gears, motors…
Failures	Contamination, Delamination, Electrical failure …	Class I + Deformations, Mechanical fatigue, Creep, Sticking by shock, etc.	Class II + Stiction, Impact rubbing, Micro welding	Class III + Wear, Stiction (Static friction)

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MEMS peculiarities

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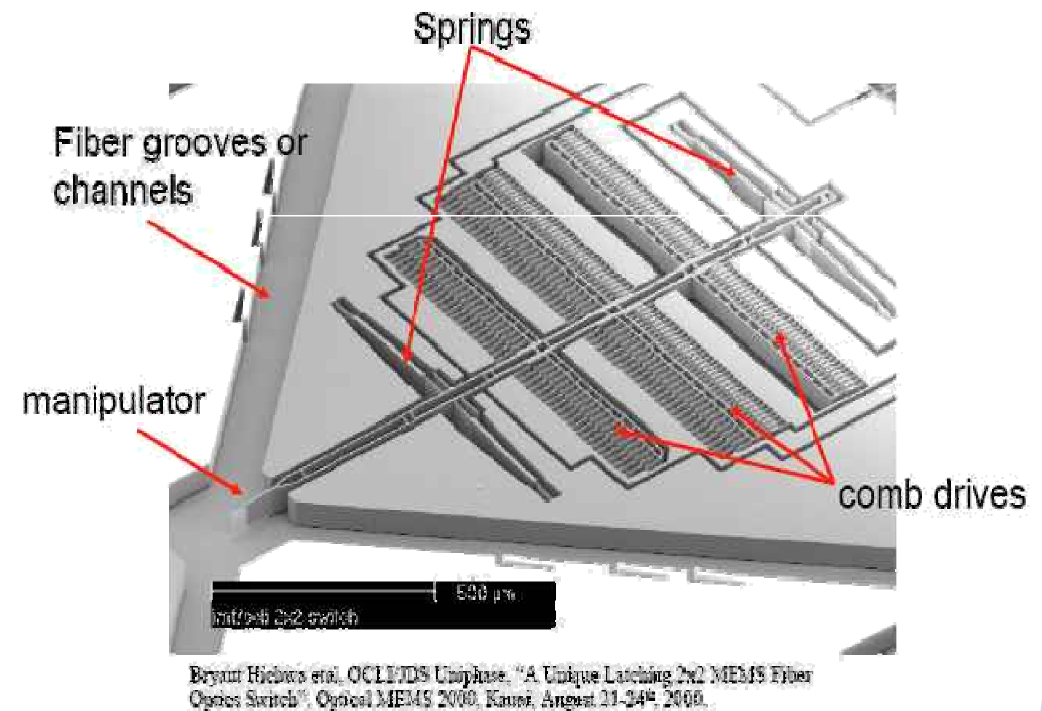
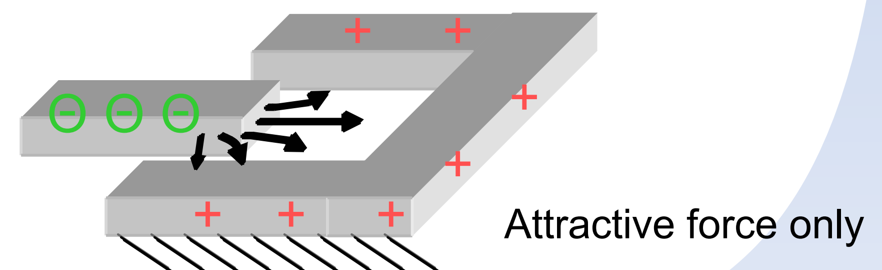
- Need dedicated techniques for FA
  - » Non intrusive
  - » Non destructive
  - » Non contact
  - » Keeping the MEMS under package



Bryant Hichwa et al, OCLI/JDS Uniphase, "A Unique Latching 2x2 MEMS Fiber Optics Switch", Optical MEMS 2000, Kauai, August 21-24th 2000.

  - » Coupling electro-mechanico-thermal characterization



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From microelectronics FA to MEMS FA

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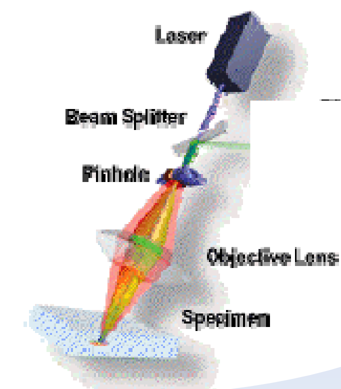
- Use of optical techniques
  - » PHEMOS 1000 from Hamamatsu
  - » 4 different objectives from 5 to 100x
  - » Resolution < 1µm enough for MEMS



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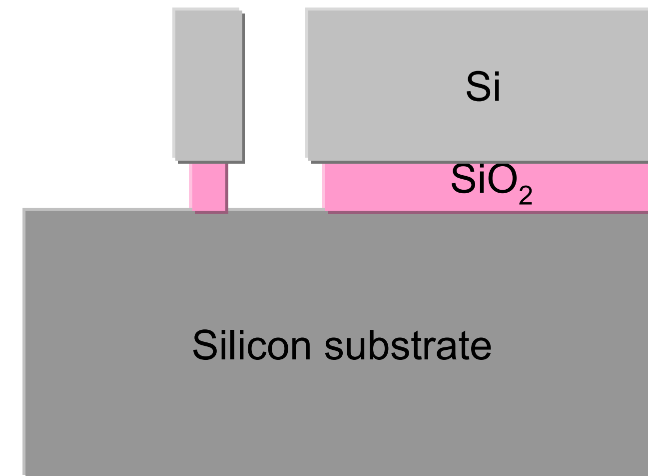
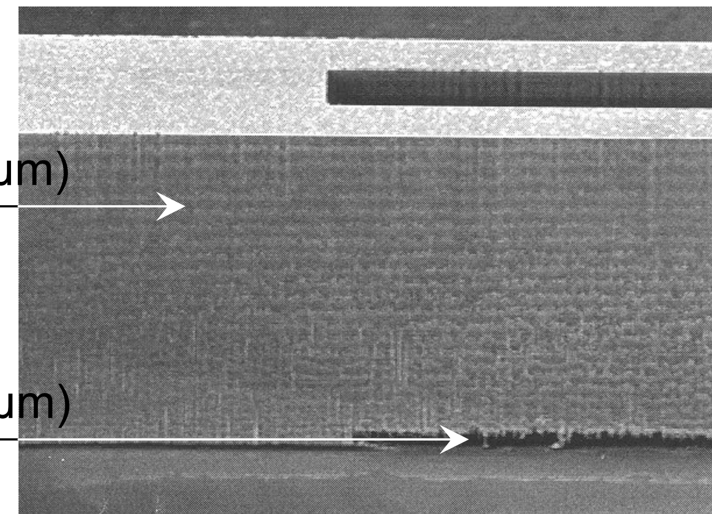
Case study #1: Investigation of SOI release

- DRIE etch of silicon layer
- Wet etching of SiO_2
  - » Isotropic
  - » Release of thin parts
- Two pitfalls: under etch and over etch





Silicon structure (thickness > 100µm)

SiO_2 sacrificial layer (thickness 2µm)

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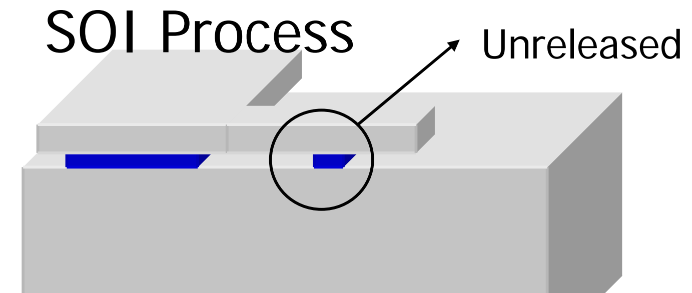
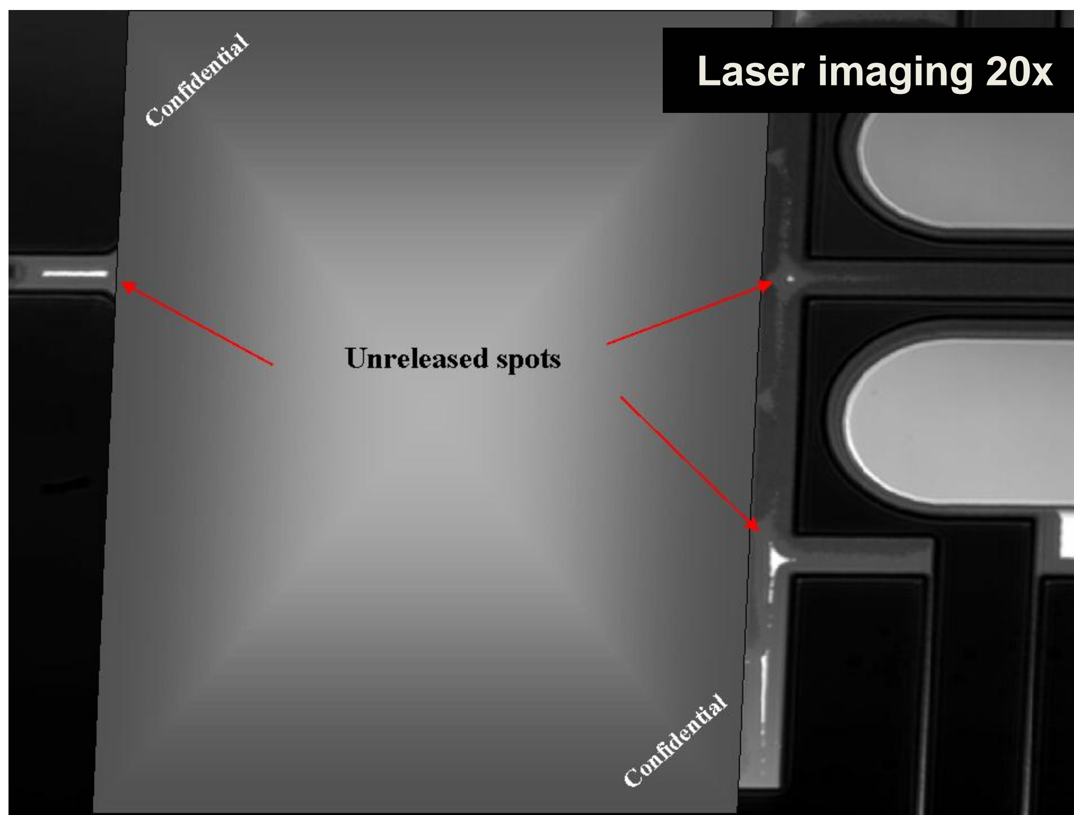
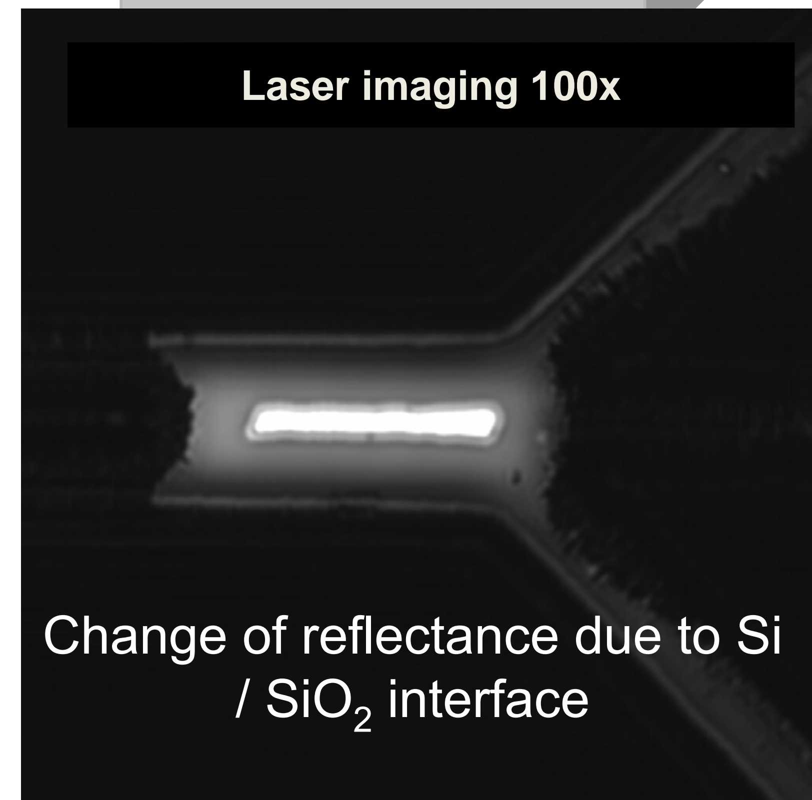
Case study #1: Investigation of SOI release

- Process optimization → etch duration







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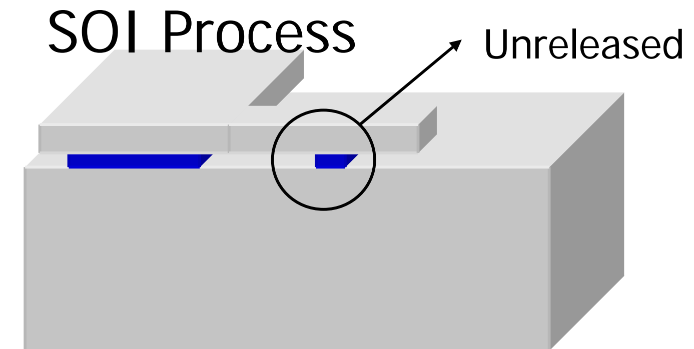
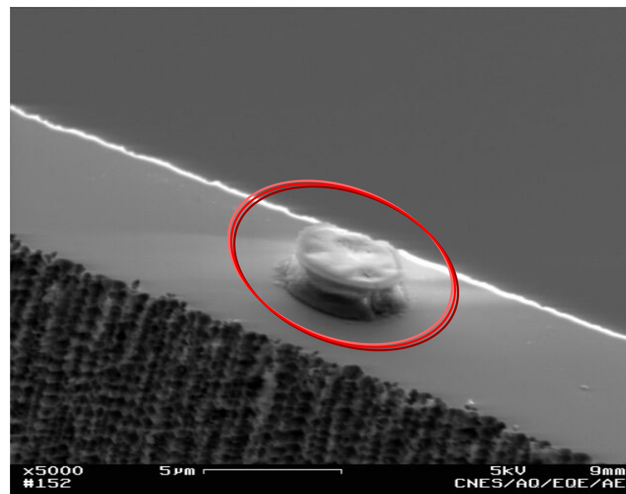
Case study #1: Investigation of SOI release

- SEM observation of SiO_2 traces after mobile part removal





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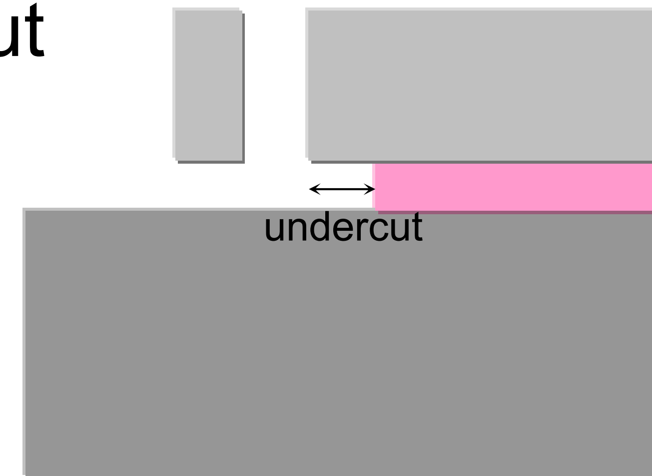
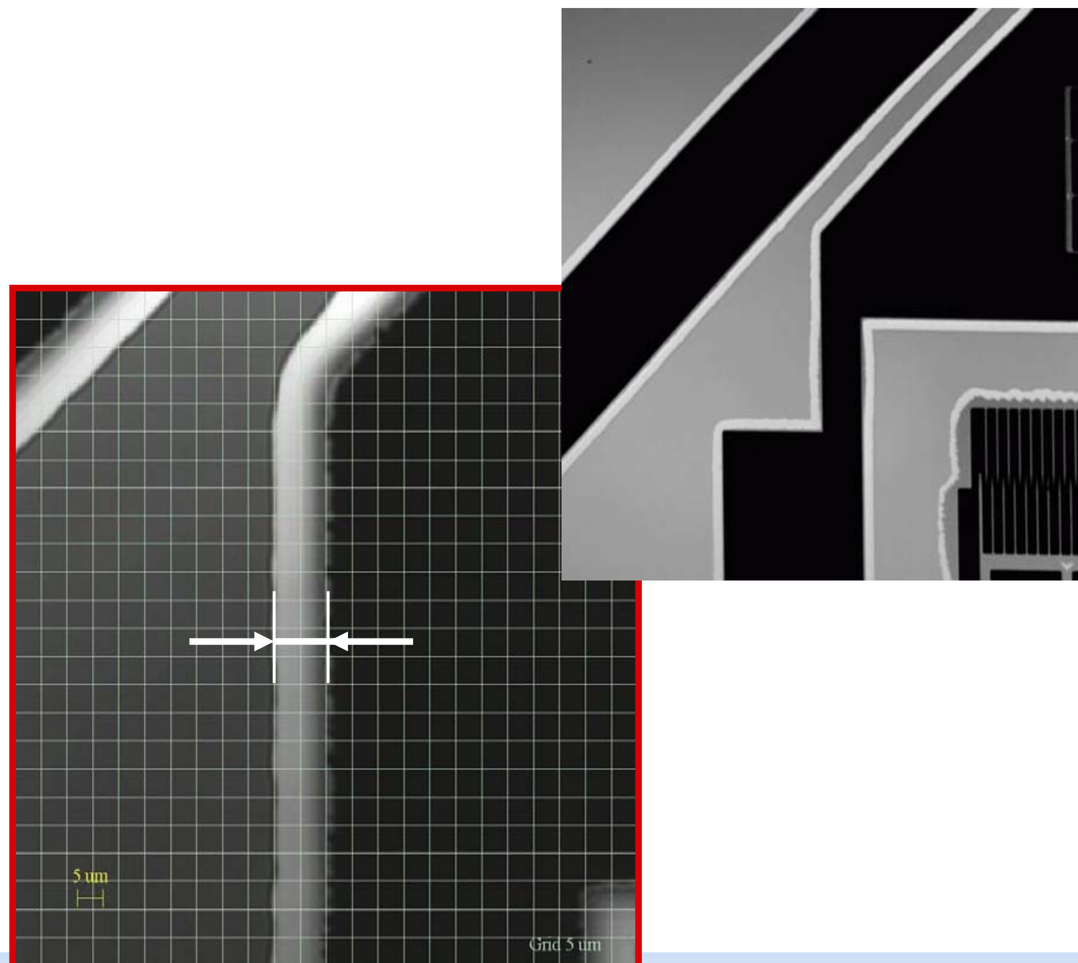
Case study #1: Investigation of SOI release

- Process optimization → undercut measurement





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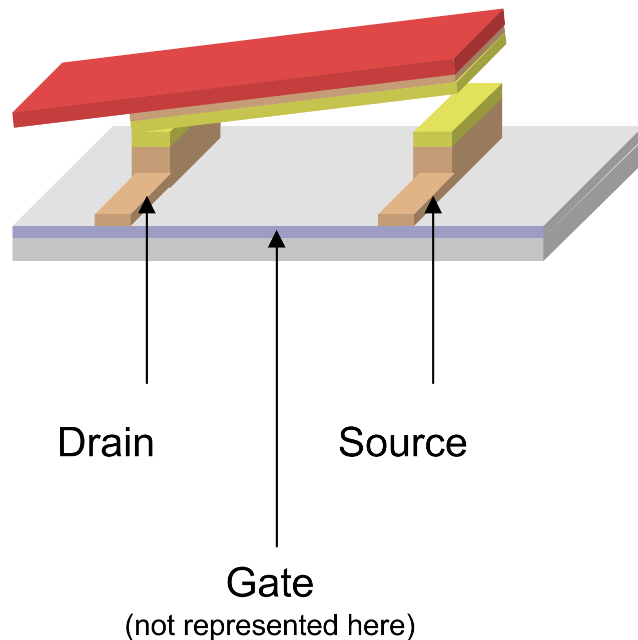
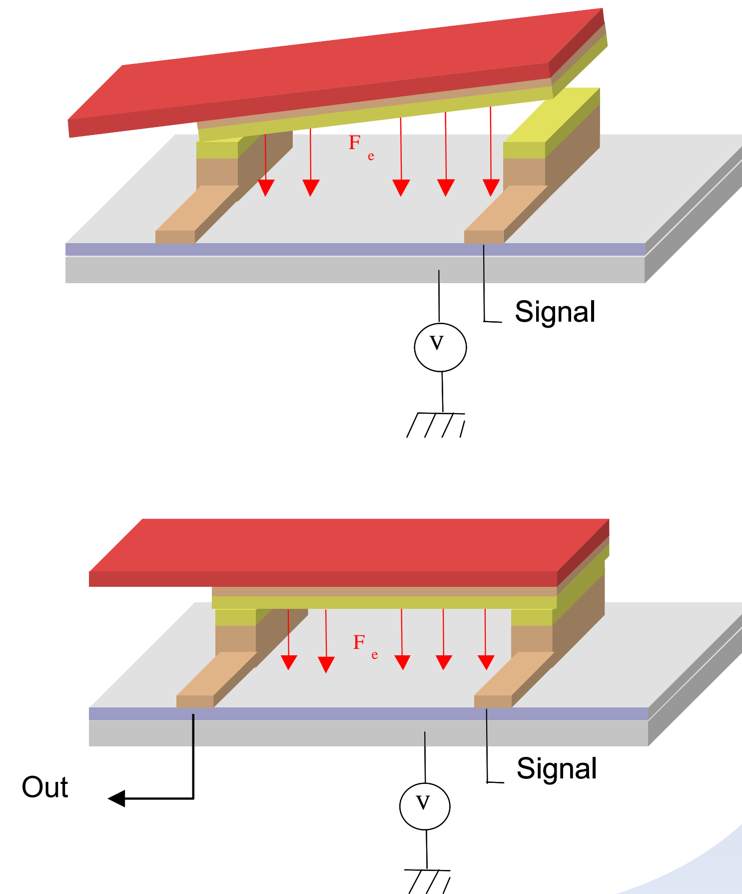
Case study #2: Micro contact detection

- Test structure: MEMS switch with metal / metal contact
- Electrostatic actuation





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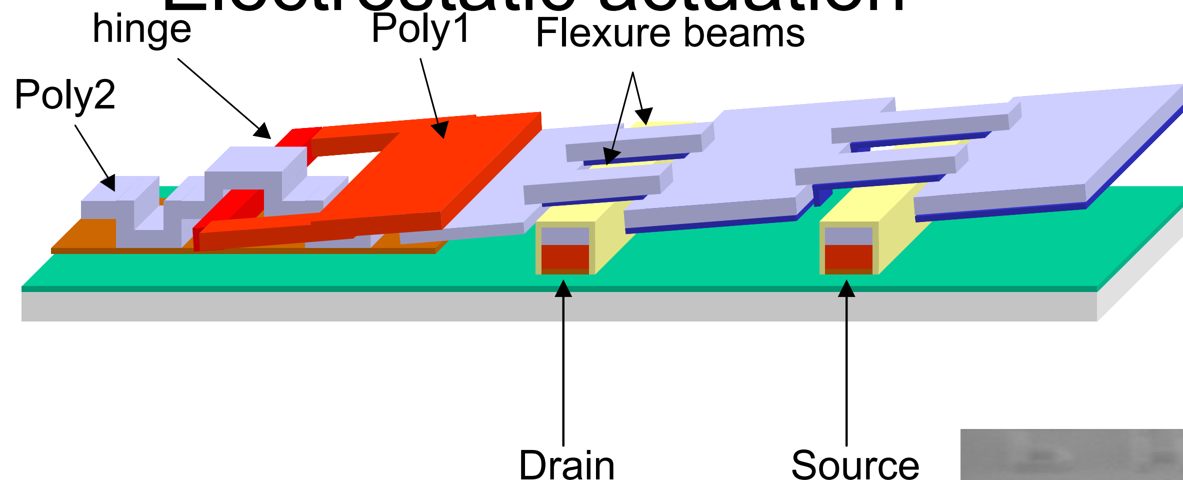

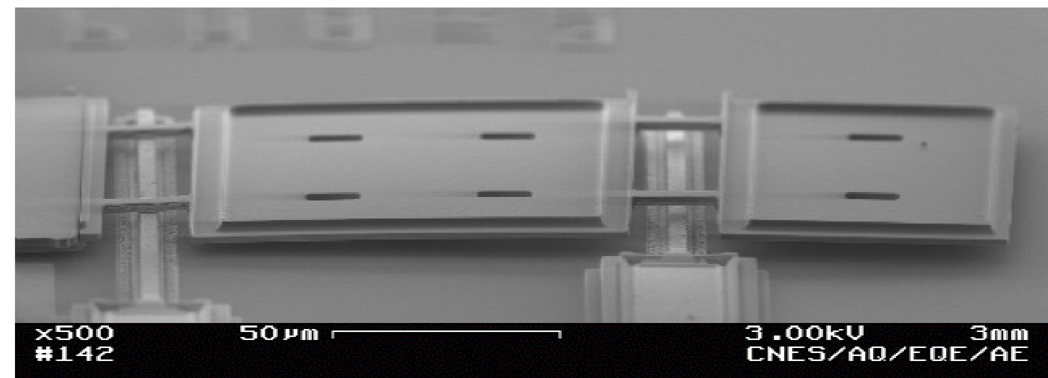

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Case study #2: Micro contact detection

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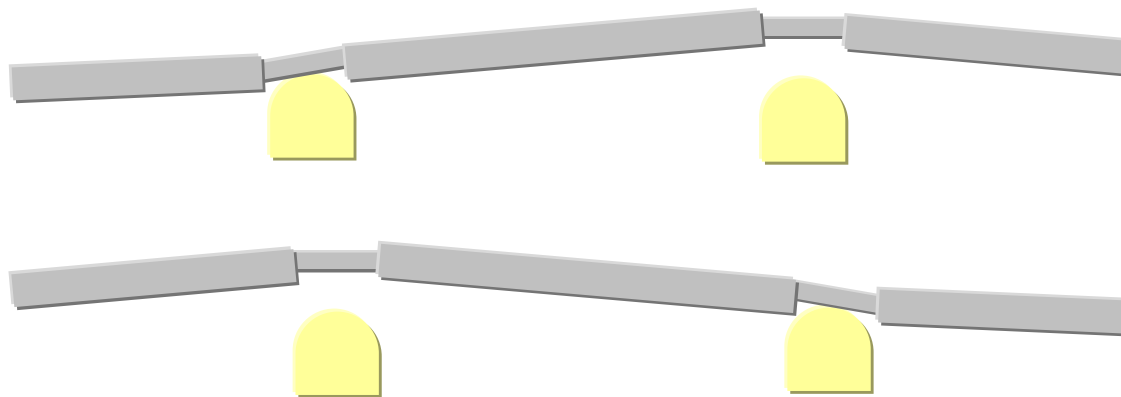
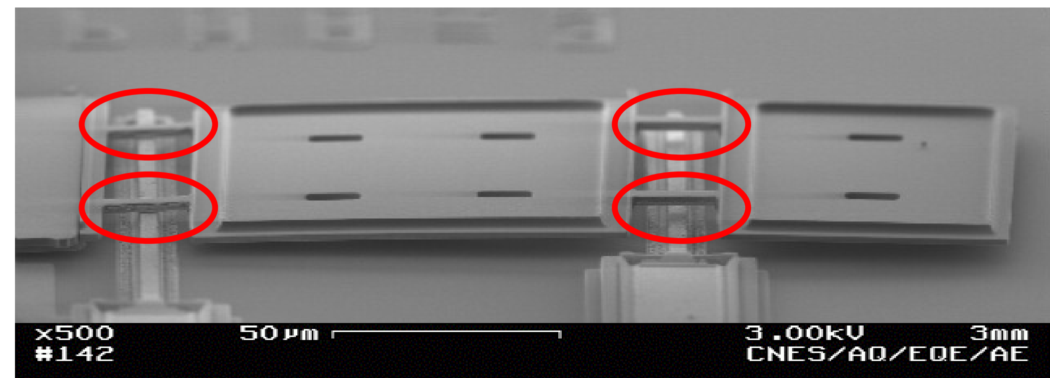
- Failure mode: Normally on
  - » Contact between the beam and the Drain/Source





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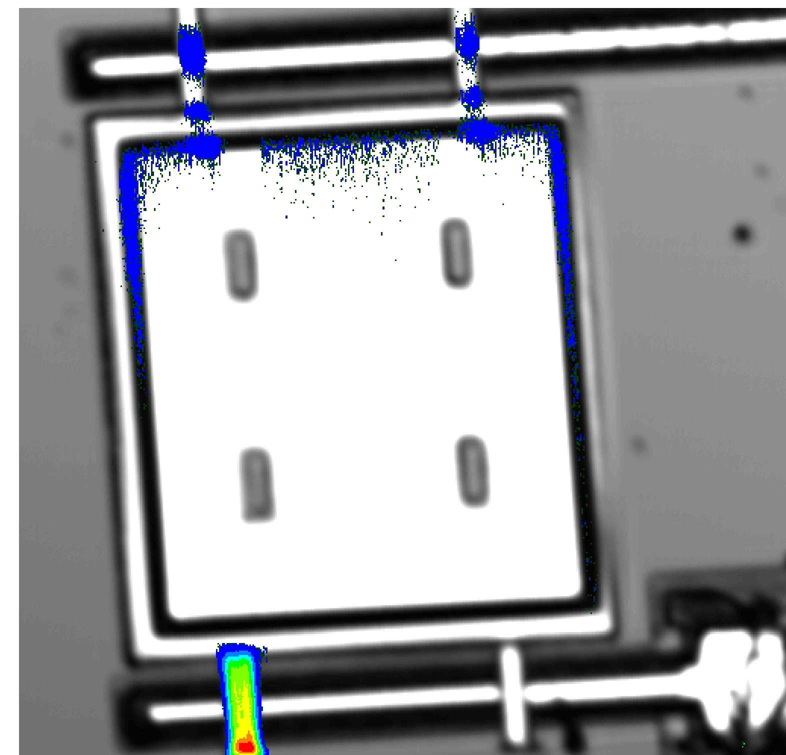
Case study #2: Micro contact detection

- Failure mode: Normally on
  - » No biased TLS: Seebeck effect imaging
  - » Accurate localization of the poor, good and no contact zones
  - » Warping of the structure due to high stress
  - » Process issue!!



20x magnification

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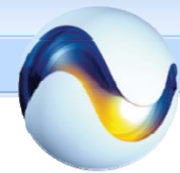

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Conclusion

- Use of IR confocal microscopy techniques for MEMS FA
  - » Simple and accurate defect localization
  - » Through Silicon cap
  - » Non destructive

  - » Very helpful for reliability studies

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