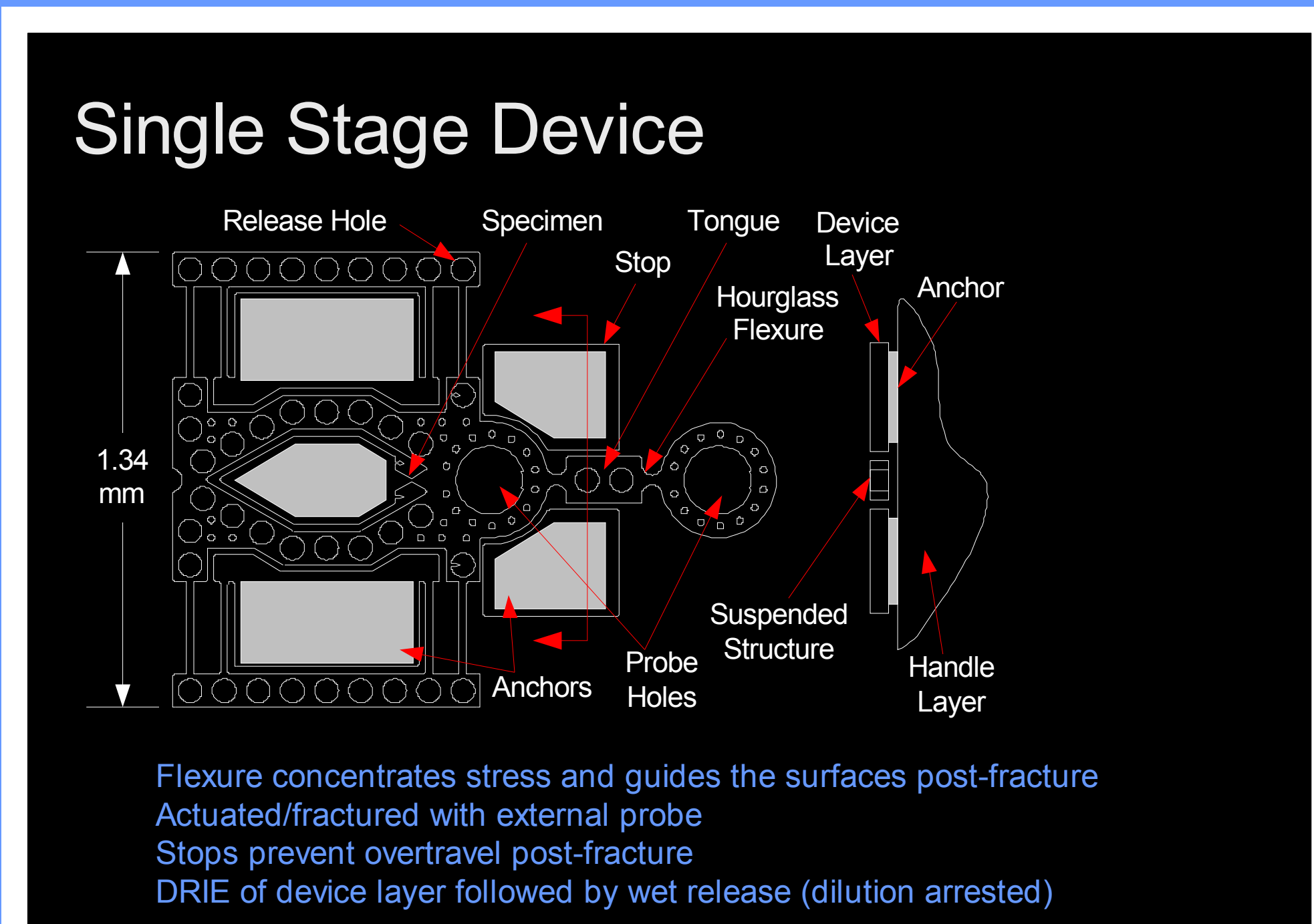


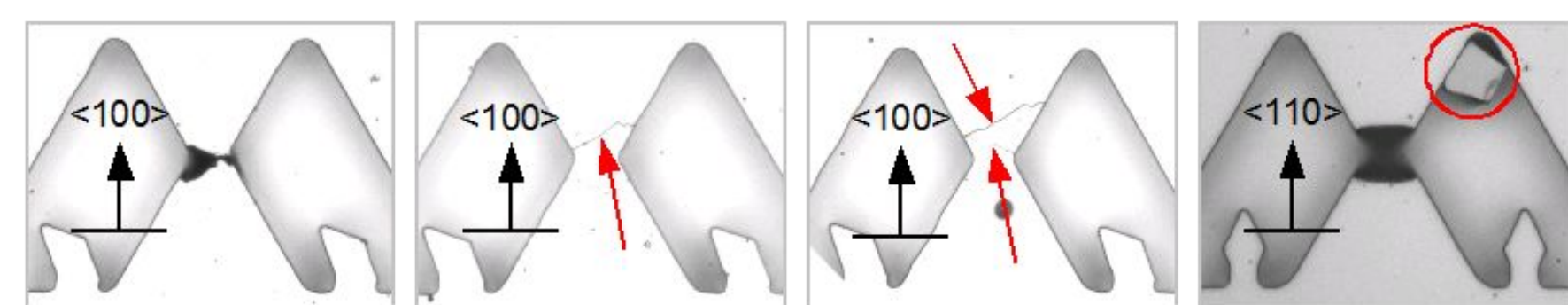
FractureGate: Fracture Fabrication of Single Crystal Silicon Nanosurfaces

MIT Mechanical Engineering – Precision Engineering Research Group
 Room 3-470, 77 Massachusetts Avenue, Cambridge, MA 02139
 (617) 253-1953, fax: (617) 258-6427

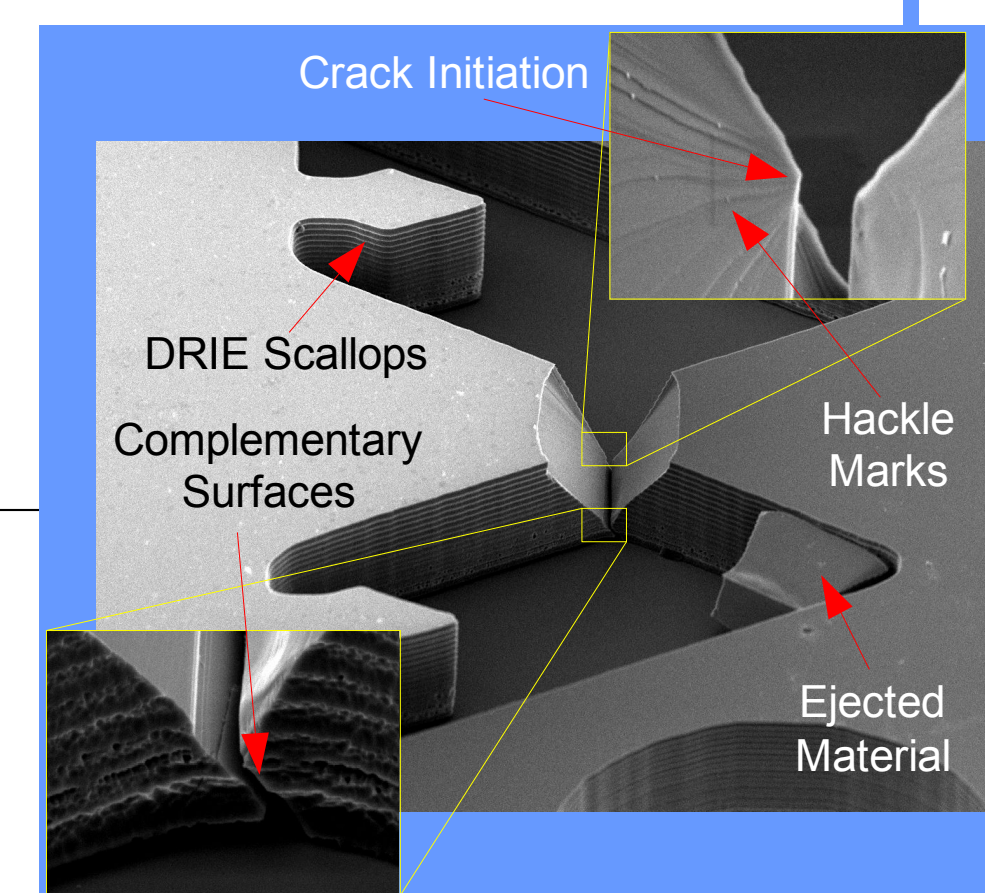
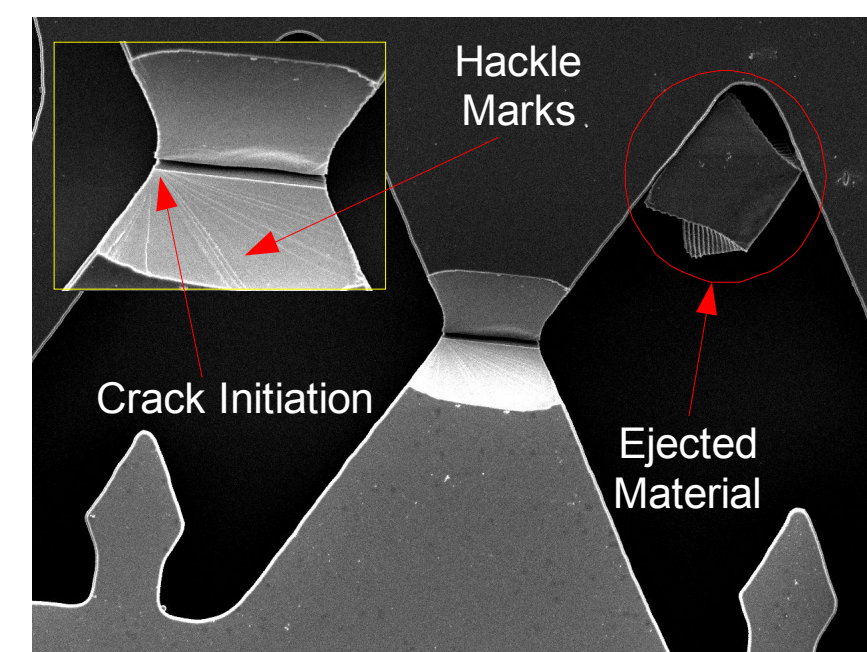
Alexander D. Sprunt & Alexander H. Slocum
 asprunt@mit.edu



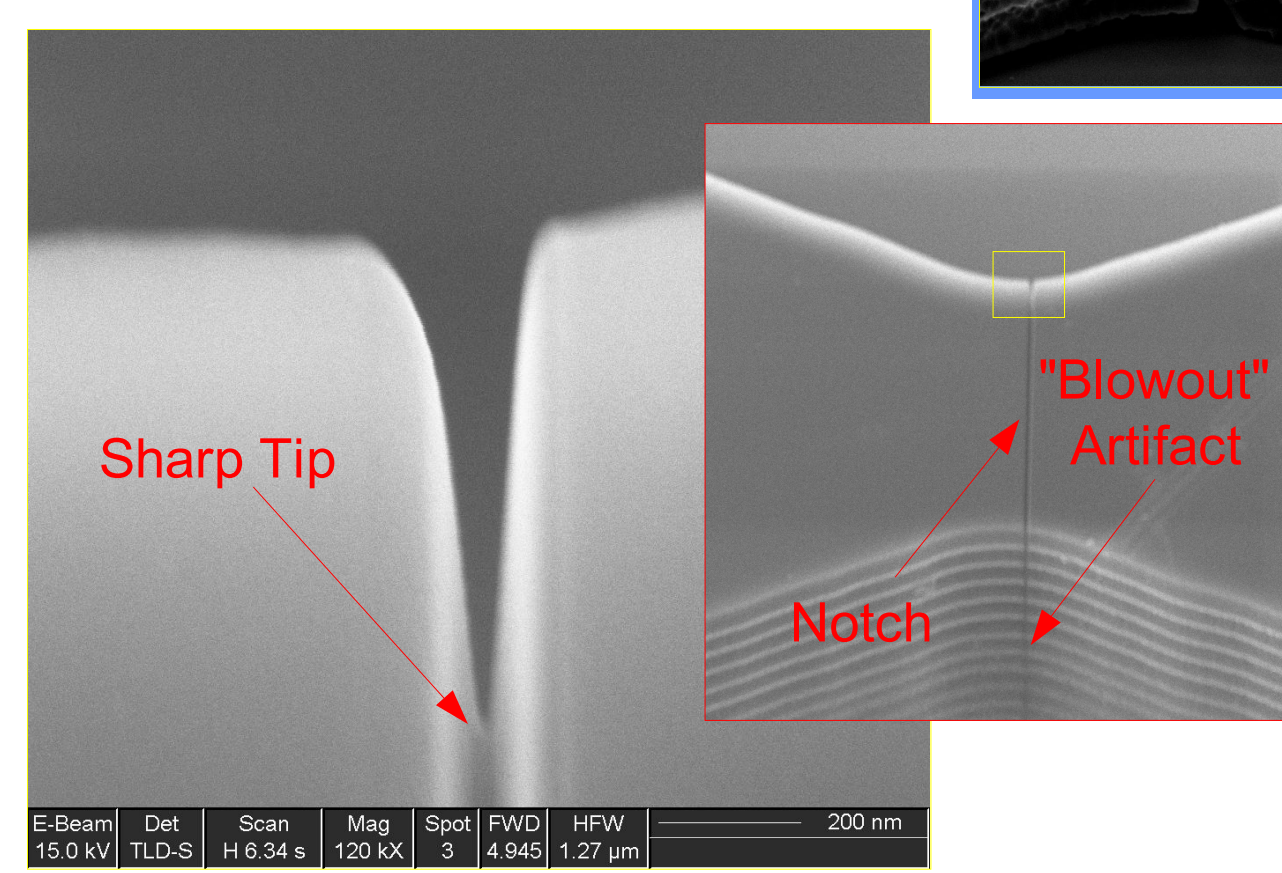
Un-notched Specimens



- (110) is better than (100)
- Material ejection
- Complementarity

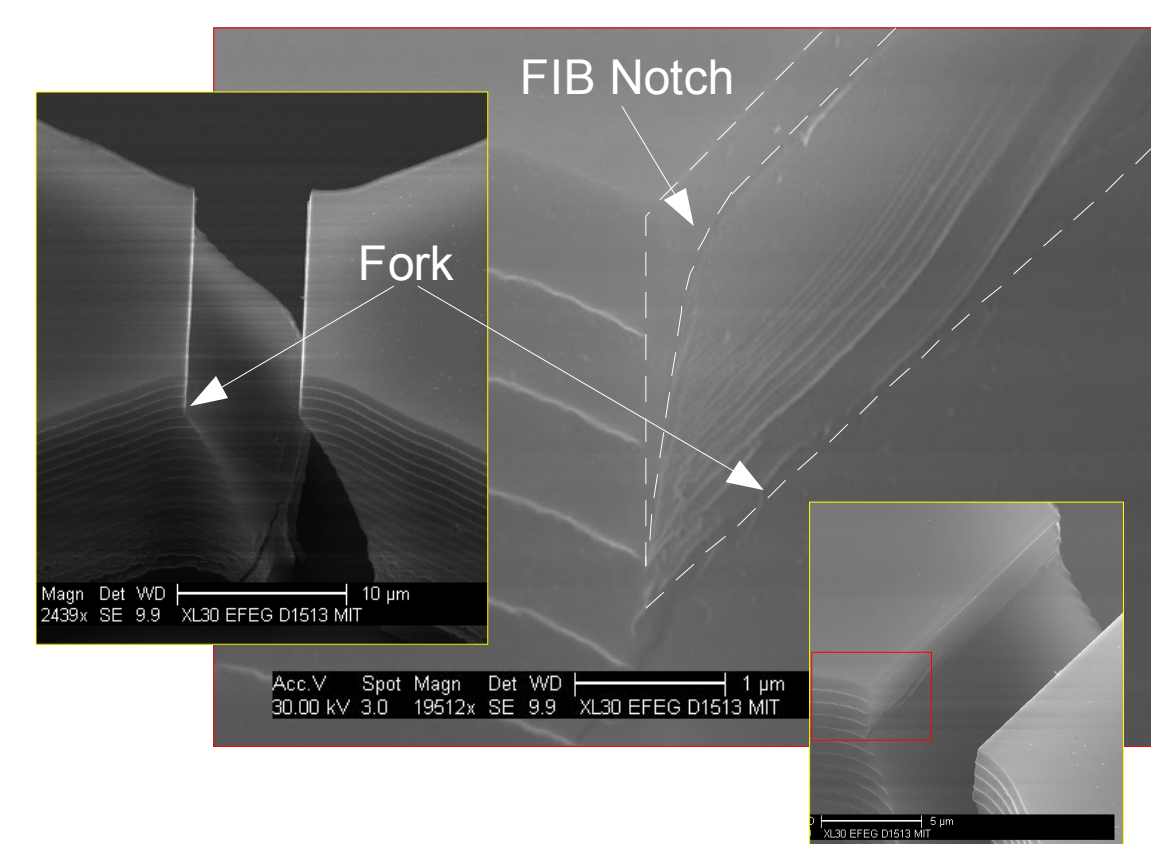


FIB Notch



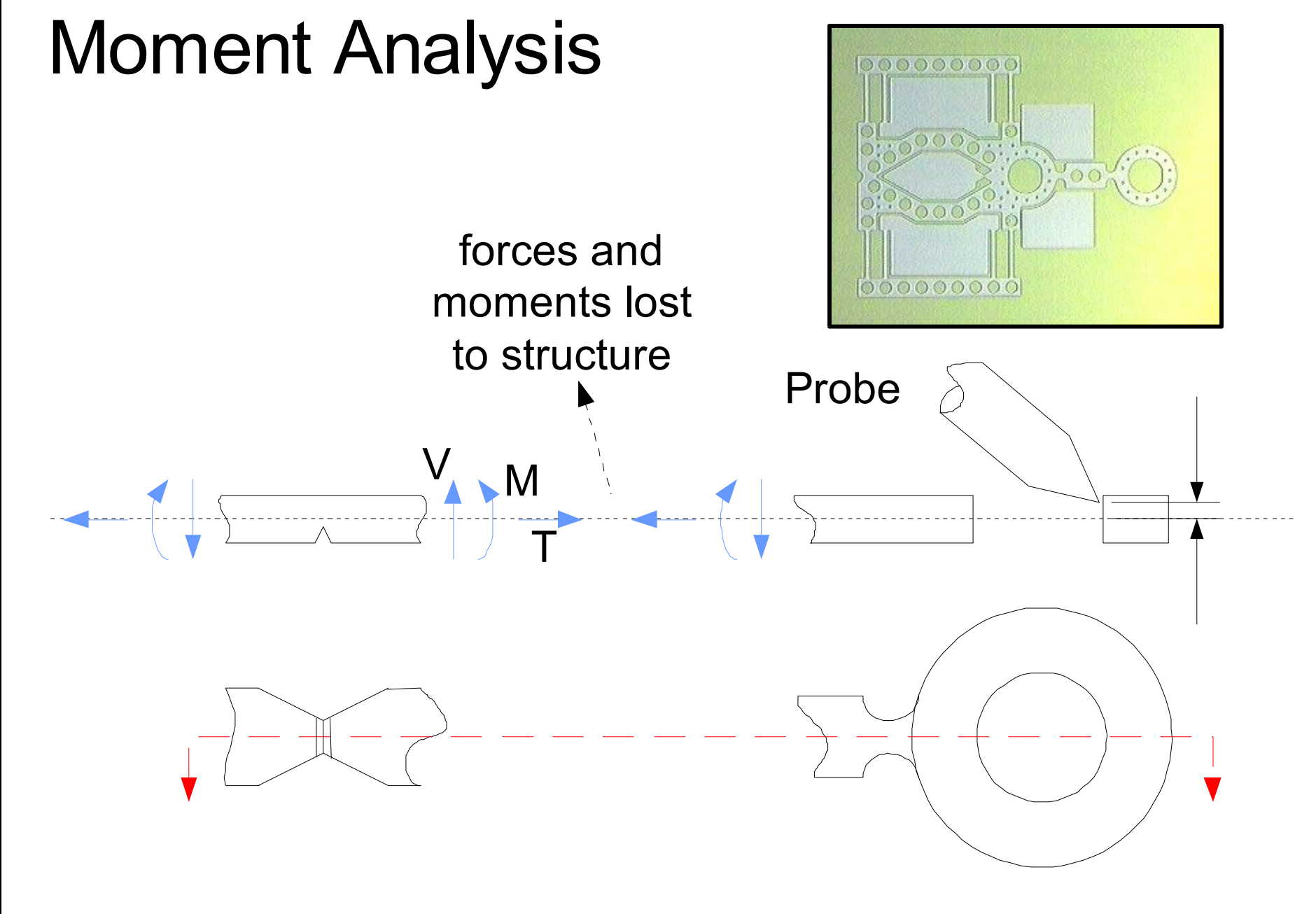
5 nm tip radius (atomic radius of Silicon is 0.12 nm)

FIB Notched Specimen

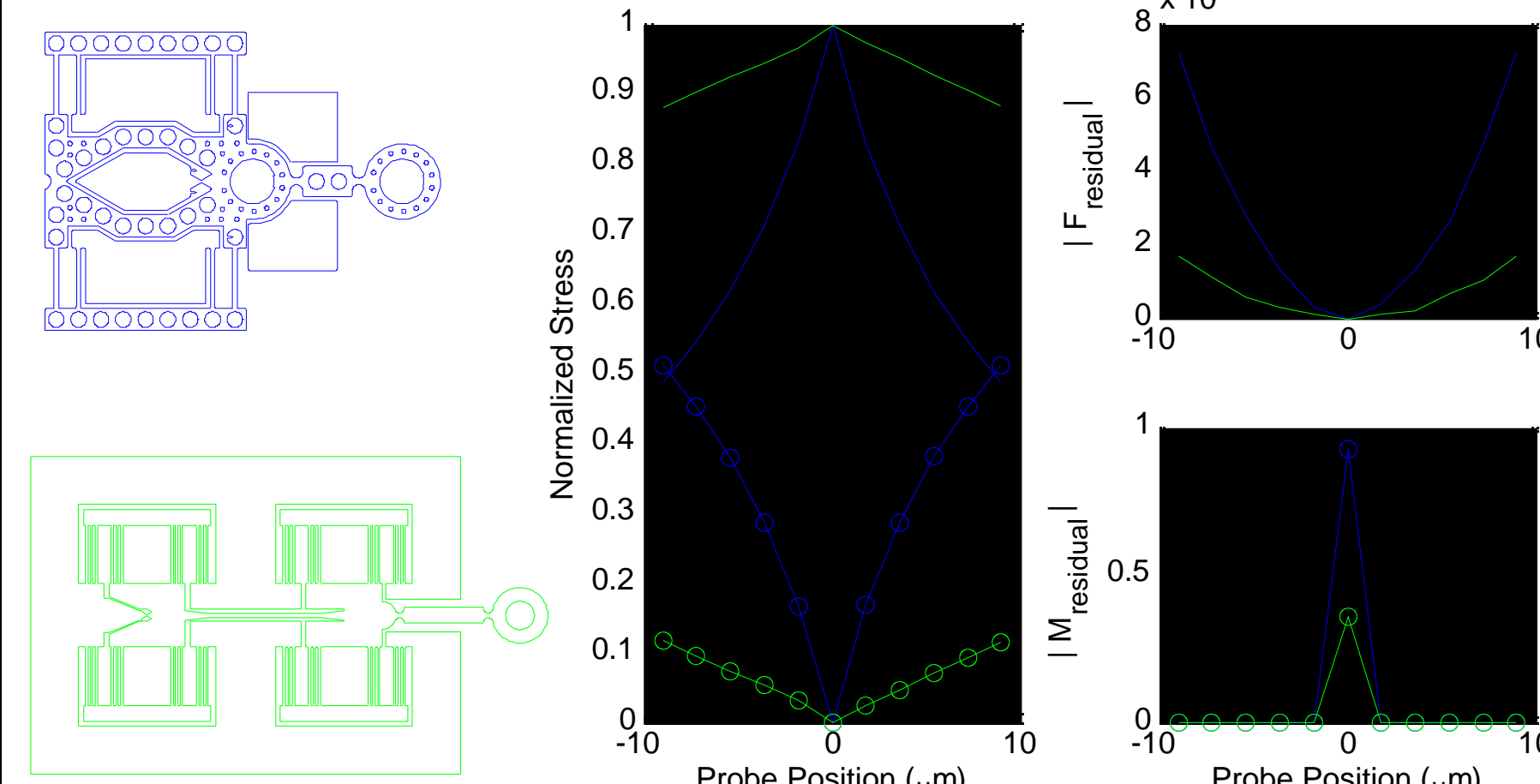


- No material ejection
- Implant damage?
- Non-planar

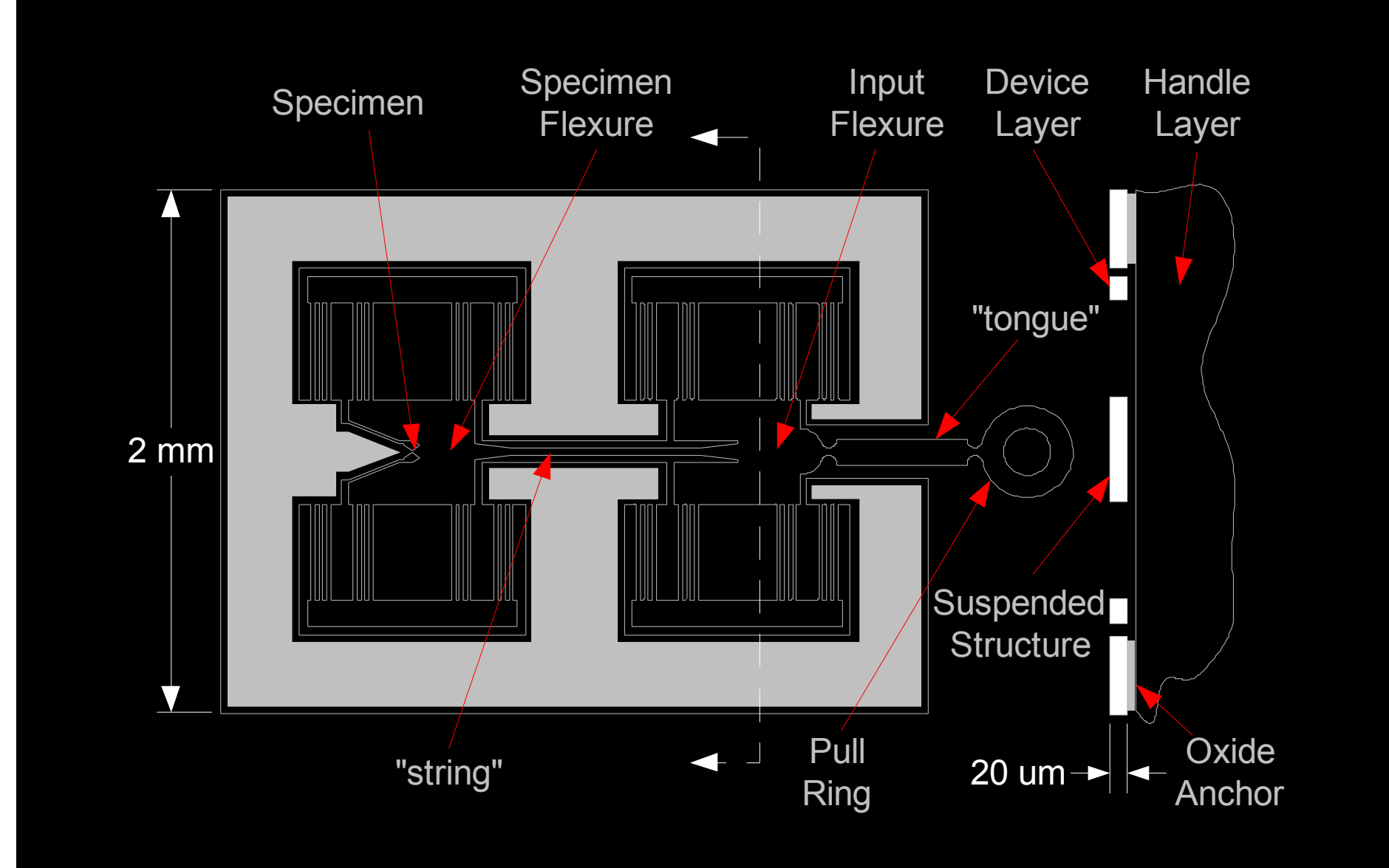
Moment Analysis



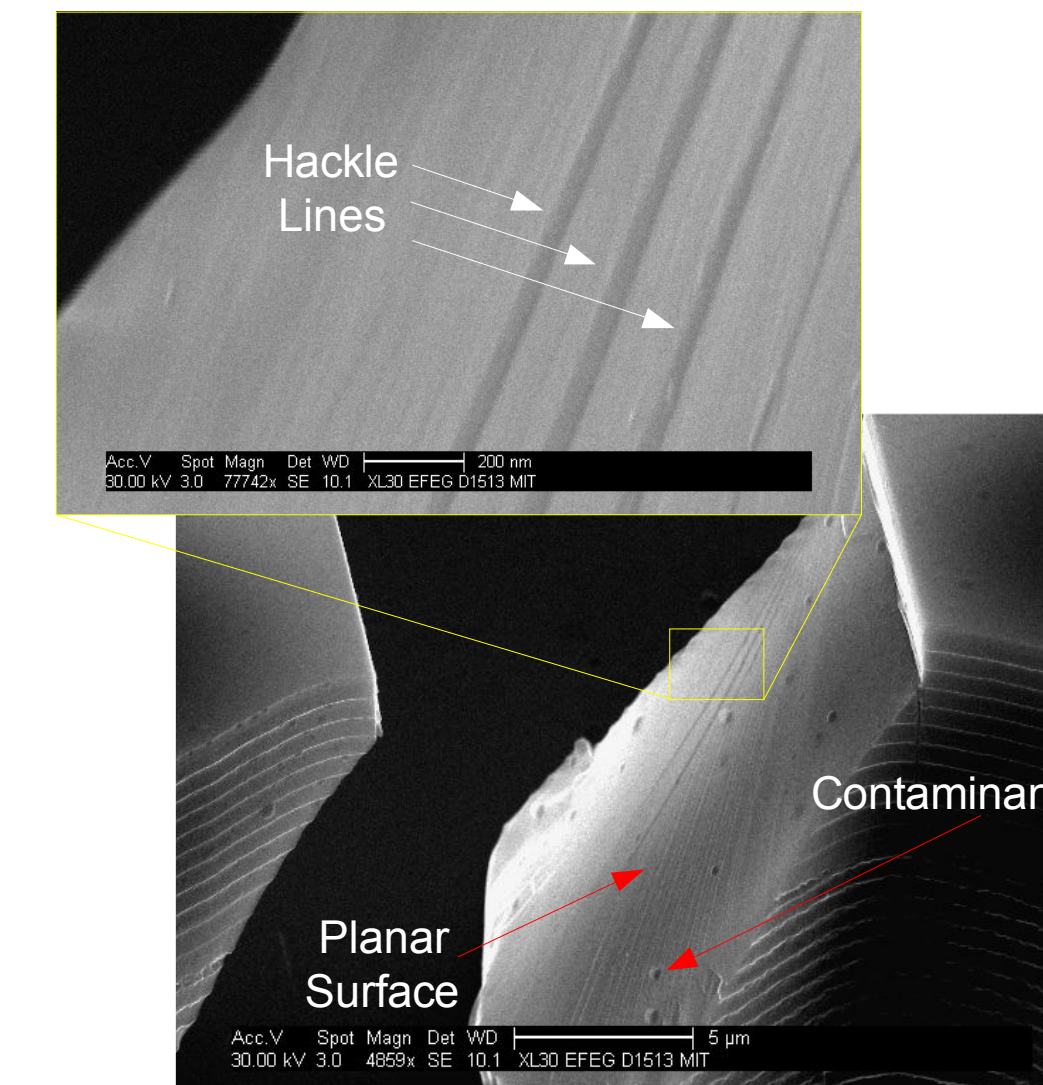
Re-Design



Two Stage Device

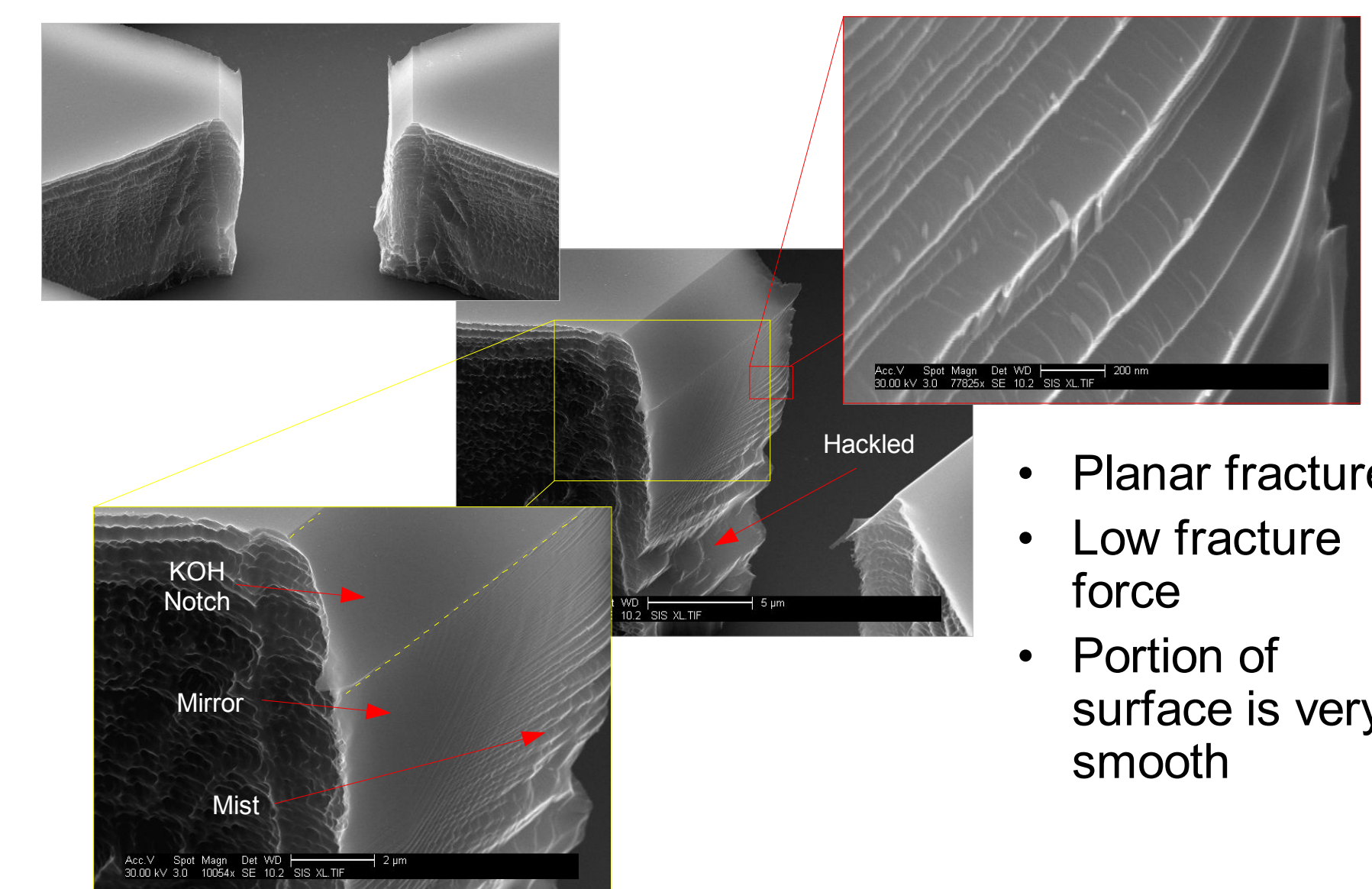


FIB Notch



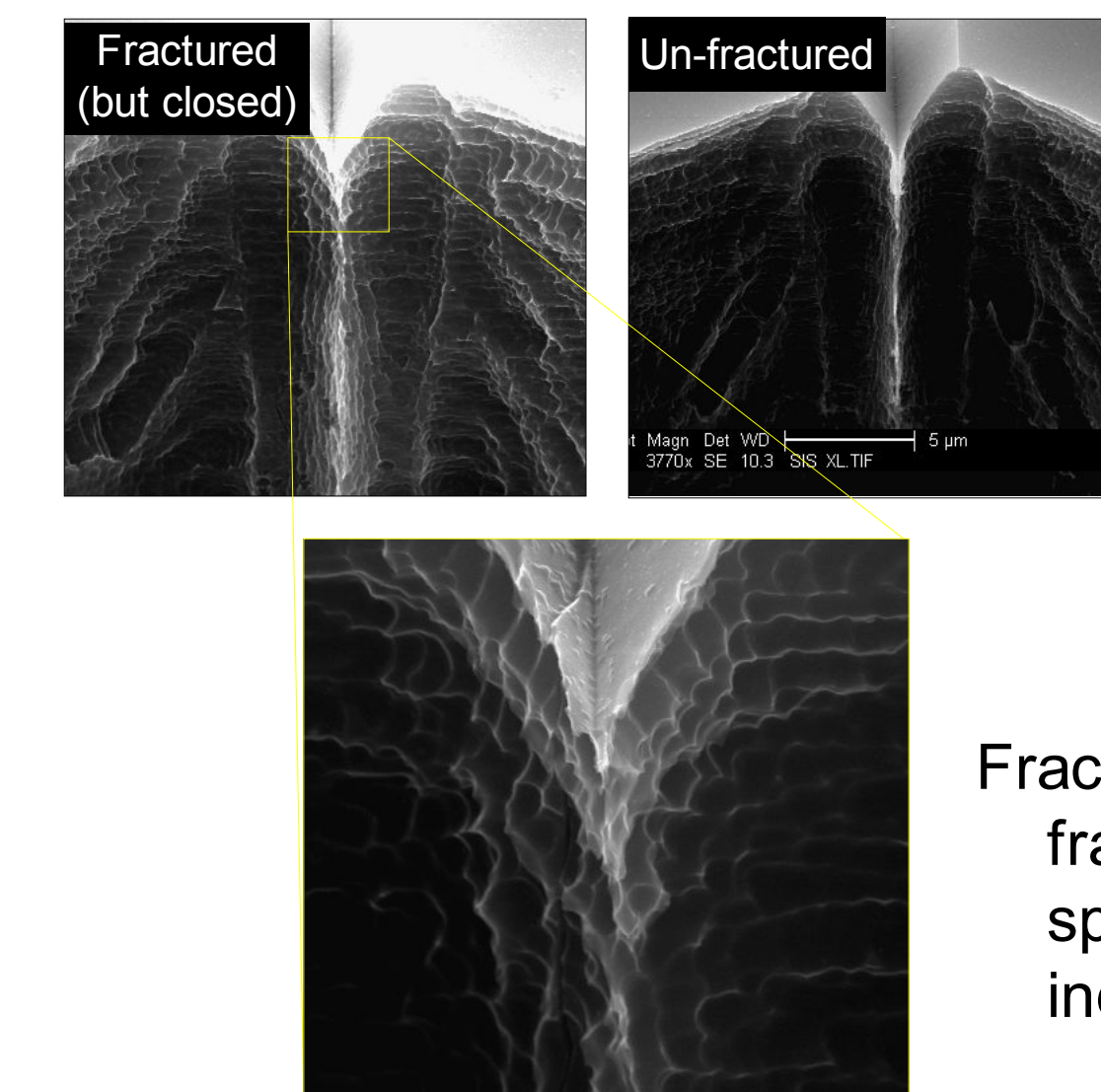
- Possible (111) plane
- 61° inclination
- Edge initiation

KOH Notch, 20µm Device Layer



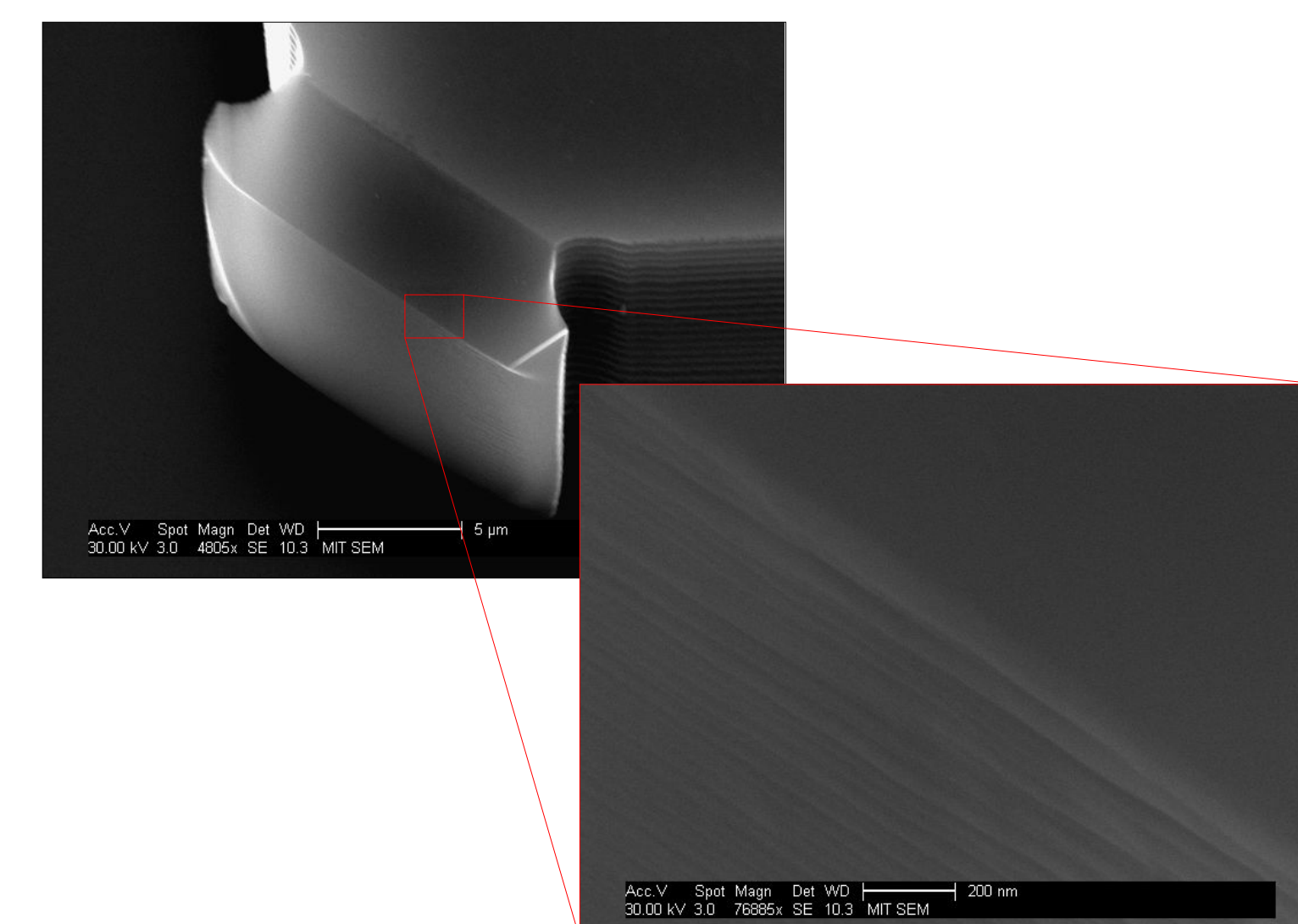
- Planar fracture
- Low fracture force
- Portion of surface is very smooth

KOH Complementarity



Fractured and un-fractured specimens are indistinguishable

KOH Notch, 10µm Device Layer

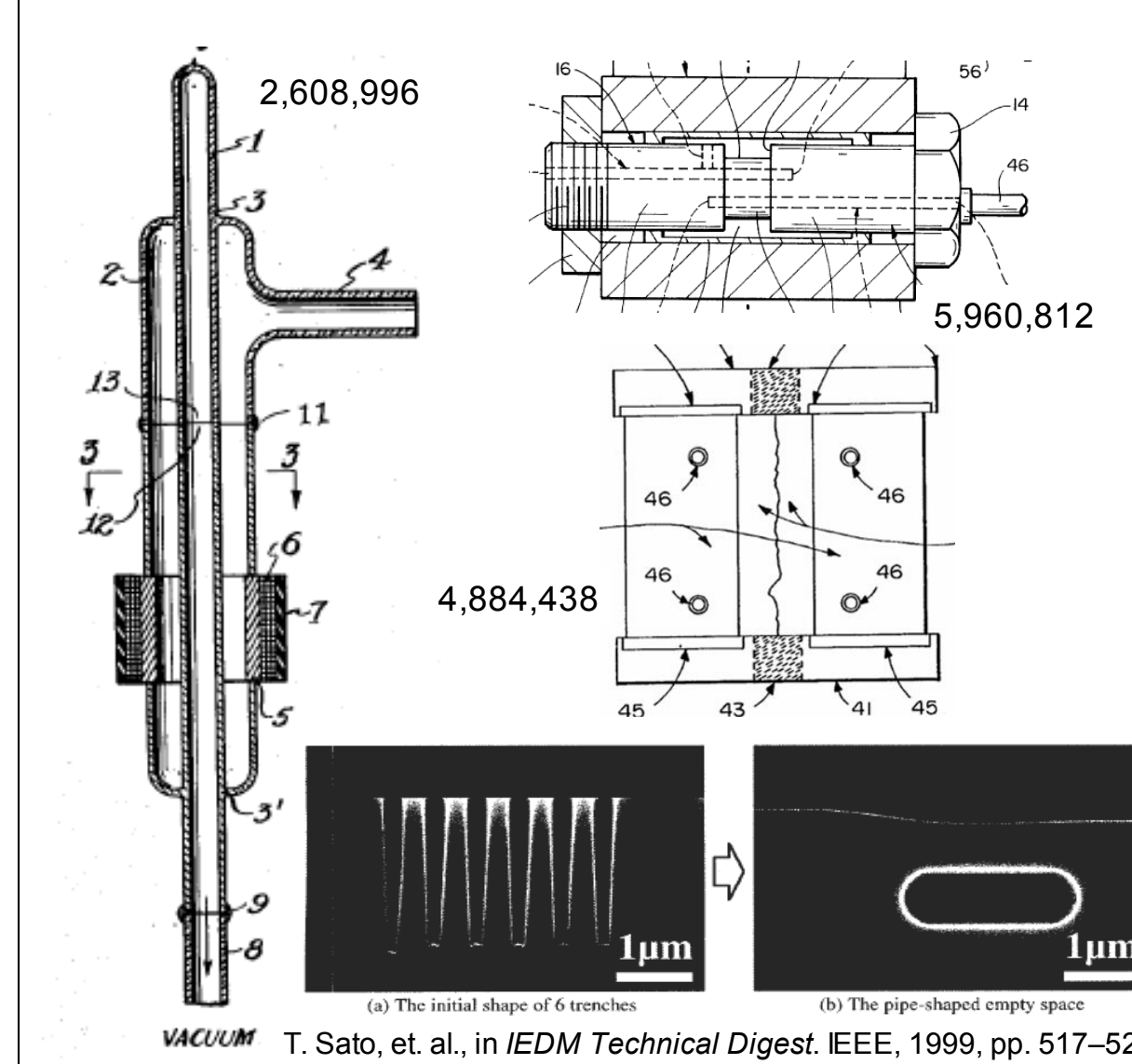


Acknowledgements

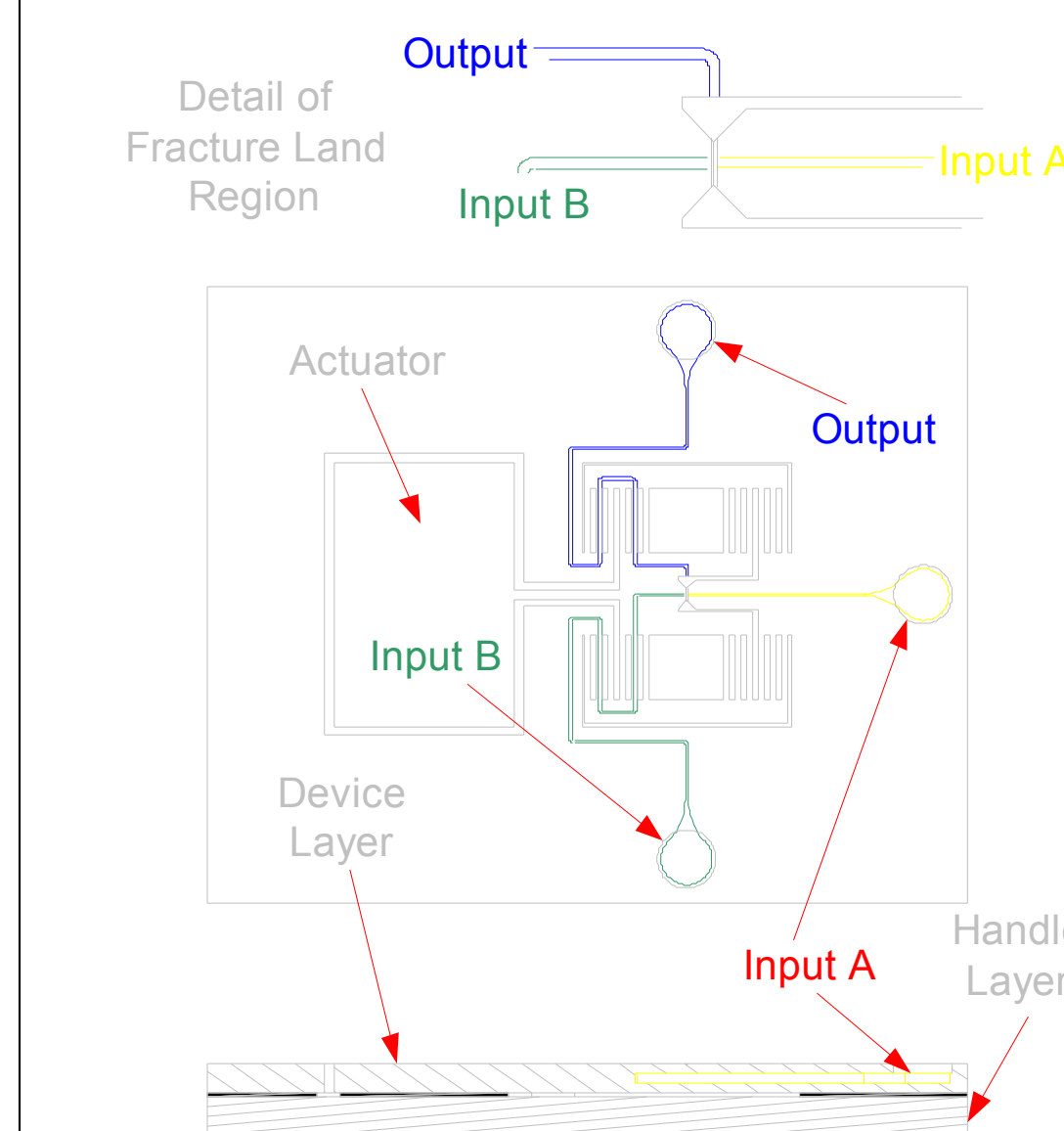
- Center for Bits and Atoms, NSF grant CCR-0122419
- Microfabrication and testing was done at MIT's Microsystems Technology Laboratory.
- Deshpande Center for Technological Innovation
- MIT Media Lab: Molecular Machines Group
- Jian Li and Joachim Sihler - Flextester



MicroValve

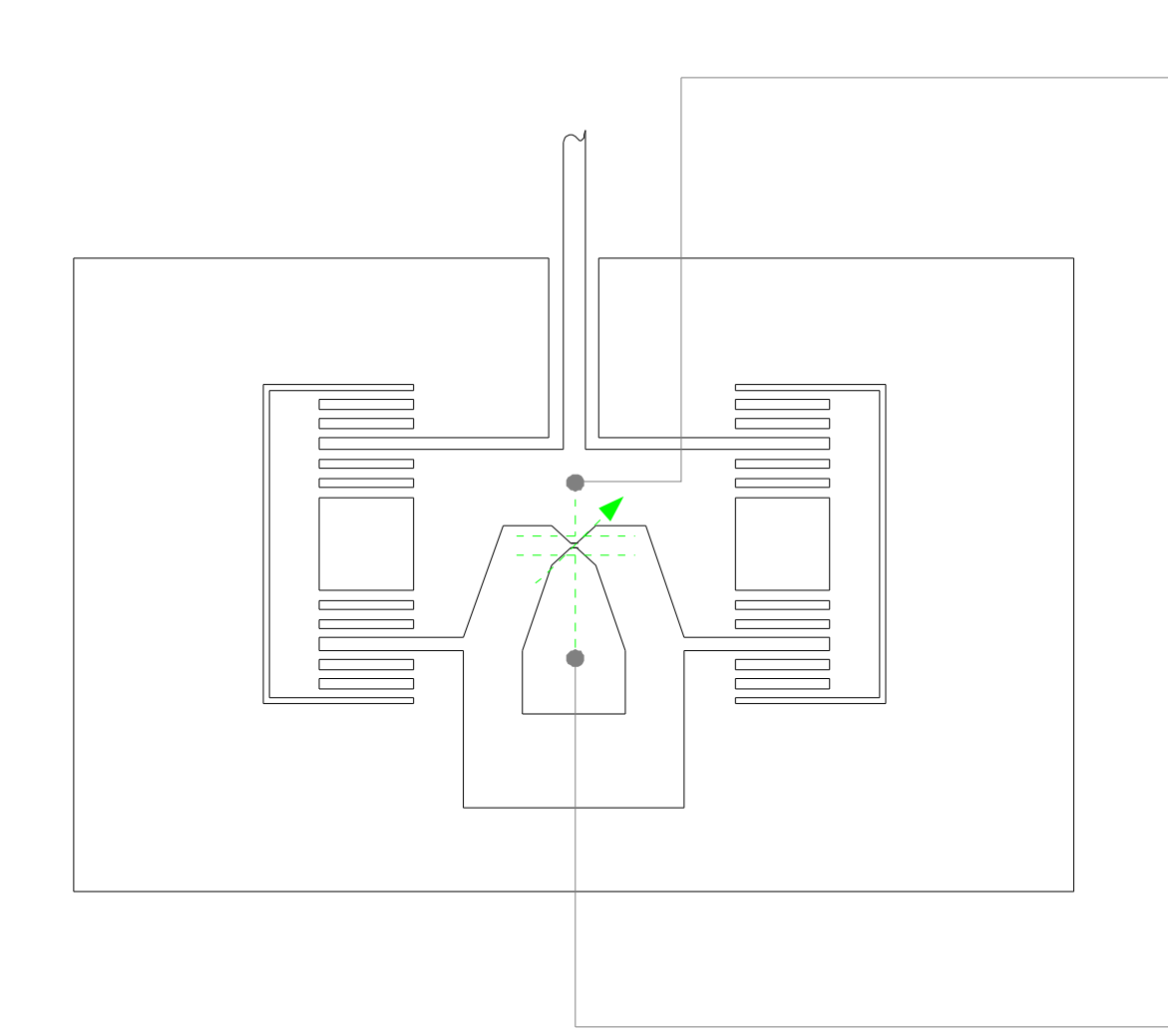


- Precision flow control with variable orifice formed by controlled separation of precision surfaces (2,608,996)
- Single use on/off valve for storage applications (5,960,812)
- Variable orifice formed from fractured surfaces (4,884,438)
- Hydrogen Annealing for the creation of fluid channels



- Flow controlled by separation of fracture surfaces
- Long term storage of material using initial fracture for release
- Potential for combining two inputs at the "gate."

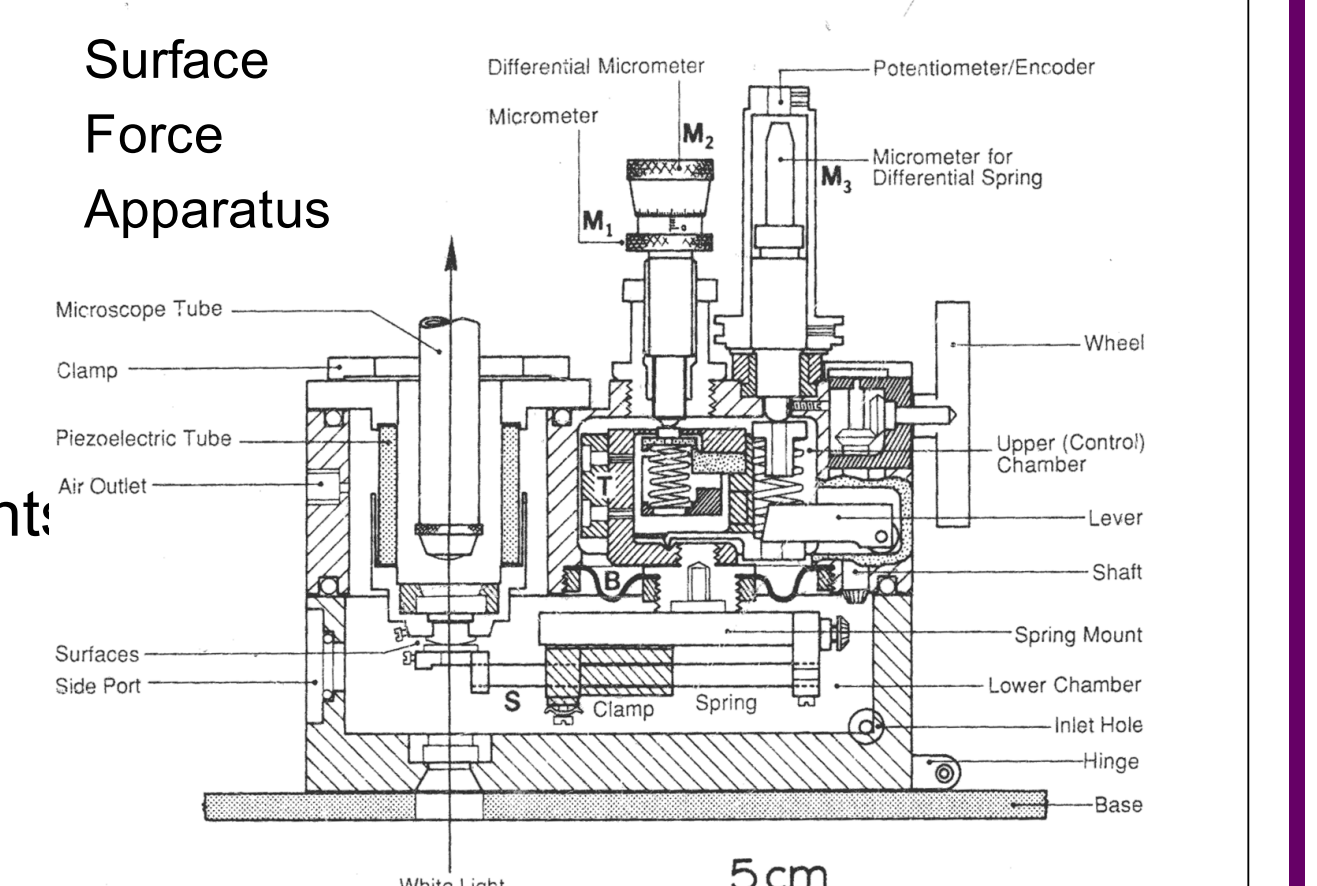
Variable Capacitor



- RF applications as a circuit element
- Combine with valve concept for use as a sensor
- Minimize parasitic capacitance
- Actuator isolation
- Field concentration

Physics-in-Gap

- Surface Force Apparatus
- Casimir Force Measurement
- Tunneling in Solvent:



Patricia M. McGuigan and Jacob N. Israelachvili, *Journal of Materials Research*, 5(10):2232-2243, October 1990.