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High aspect ratio SU-8 tips for cost-efficient bio-probe fabrication

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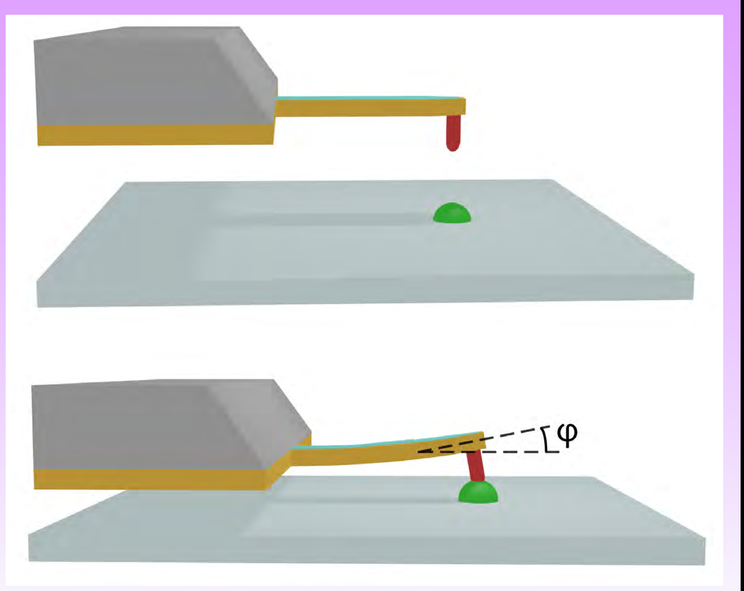
Introduction

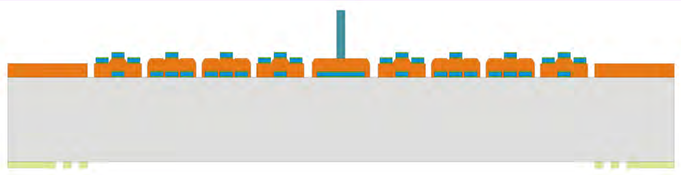
Studies[1] have reported significant cellular stiffness changes coupled with cancer, and micromechanical cantilevers have been shown[2] to be a reliable tool to measure this change through indentation measurements, as shown on right. To achieve cell force spectroscopy at high through-put, this work aims towards the technological development of a 2D array of micromechanical cantilevers, designed to perform indentative measurements in parallel. A major implied challenge is the fabrication of high aspect ratio tips that define well the contact point with the sample. Here, we reveal a novel process for how such tips can be patterened onto a Si_xN_y MEMS structure using SU-8 photolithography. Well-known adhesion problems of SU-8 structures in KOH are effectively circumvented without need for complex anchoring structures[3].



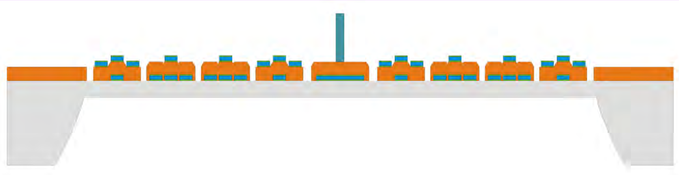
1. S. Suresh. Acta Biomaterialia, 3(4):413–438, Jul 2007.
2. S. E. Cross, Y.-S. Jin, J. Rao, and J. K. Gimzewski. Nature Nanotechnology, 2:780–783, Dec 7 2007
3. M P Larsson, R R A Syms, and A G Wojcik. J.Micromech.Microeng., 15(11):2074–2082, Nov 2005.

Process

a. Starting point: Si_xN_y MEMS with electrodes defined, back-side release mask patterned.



b. Standard SU-8 photolithography process to define tip.

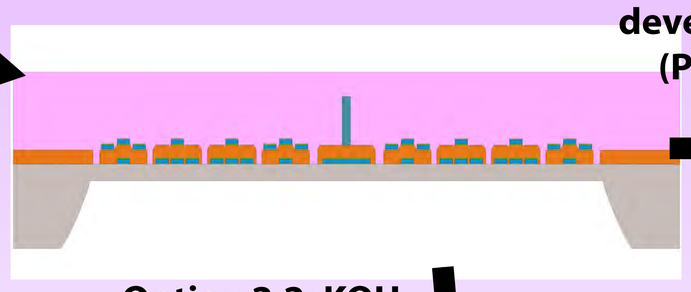


c. RIE Si etch + back-side mask removal.

Option 1: Highly selective standard KOH etching (Amb. T) → **Bond is attacked! All SU-8 structures delaminate!**

Options for continuation?

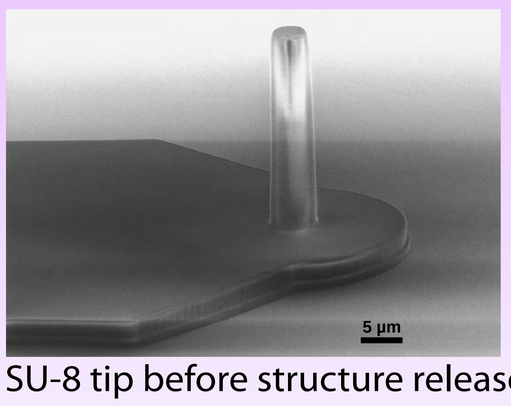
Option 2: Application of SU-8 protection layer + softbake



Option 2.1: KOH + standard SU-8 development (PGMEA)

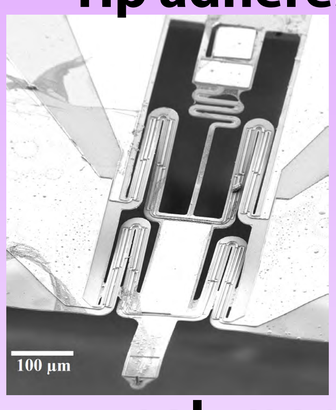
Option 2.2: KOH + development in hot SVC-14 (70 °C)

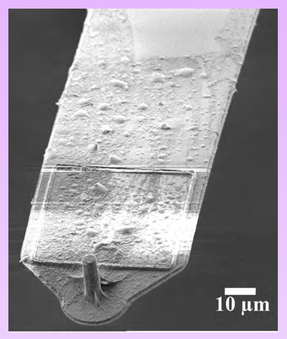
Tip adheres and residues delaminate!



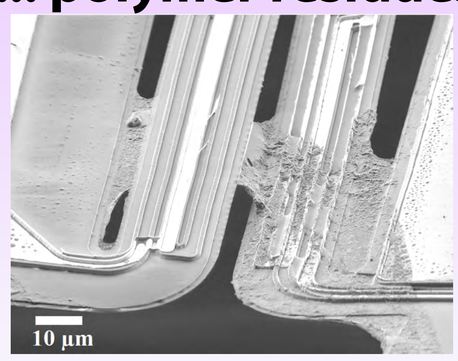
SU-8 tip before structure release (b & c).

Tip adheres, but...





... polymer residues!

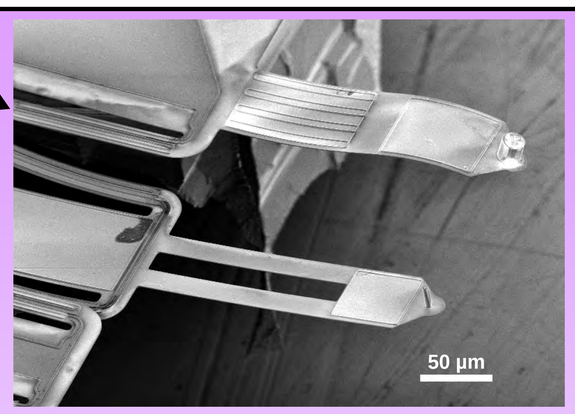


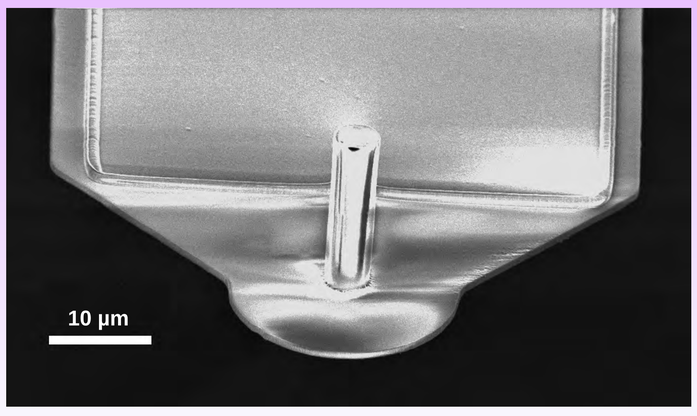
Results and conclusion

SU-8 pillars on Si_xN_y MEMS structures fabricated

- 20 µm high
- 4 µm radius
- Well adapted tip features for bio-probe applications

- Adhesion in KOH without need of anchoring structure
  =
  Major process simplification
- Cost-efficient process
- Only low temperature steps





Reference

J. Henriksson, *Actuated MEMS and NEMS for parallel cell force spectroscopy and gas sensing applications*, PhD Thesis (2014)