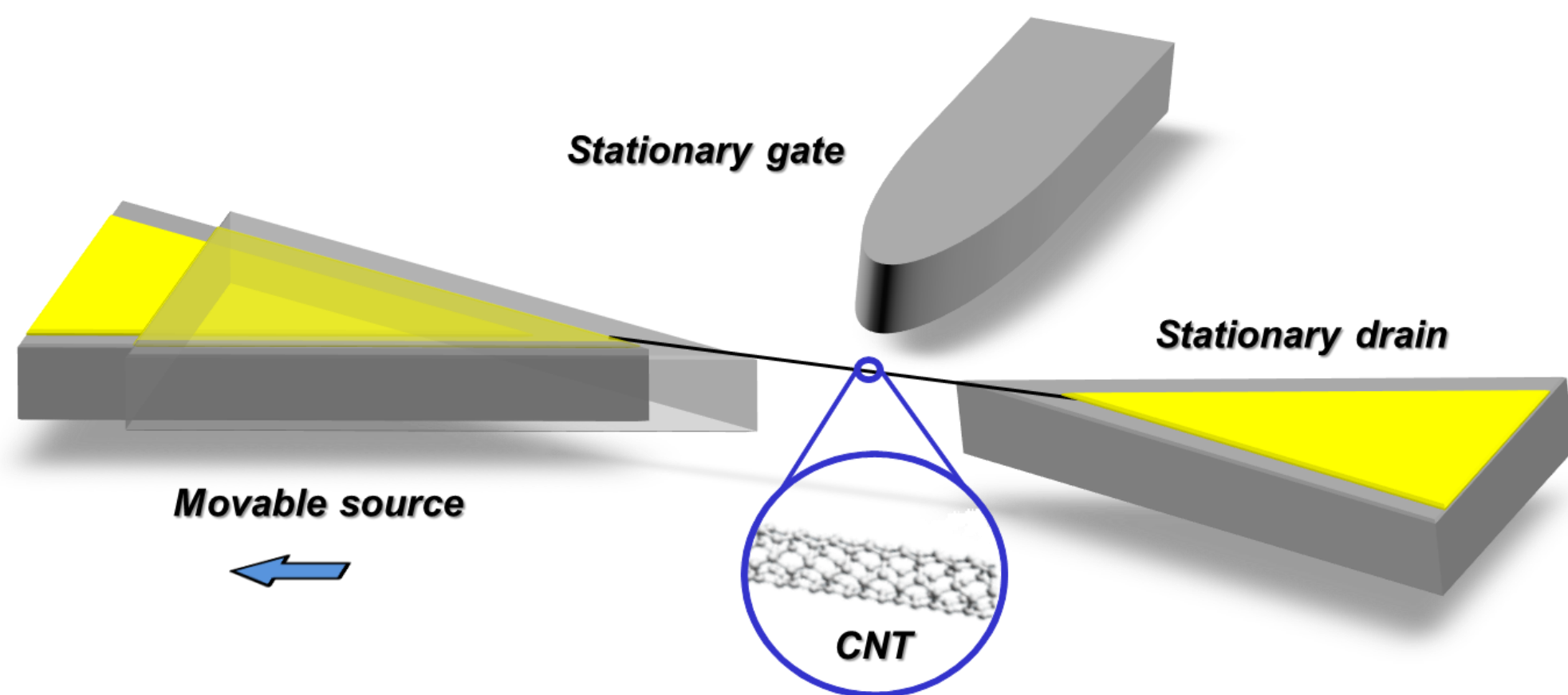


Integration of low-defect suspended CNTs on MEMS with reliable electrical and mechanical conditions

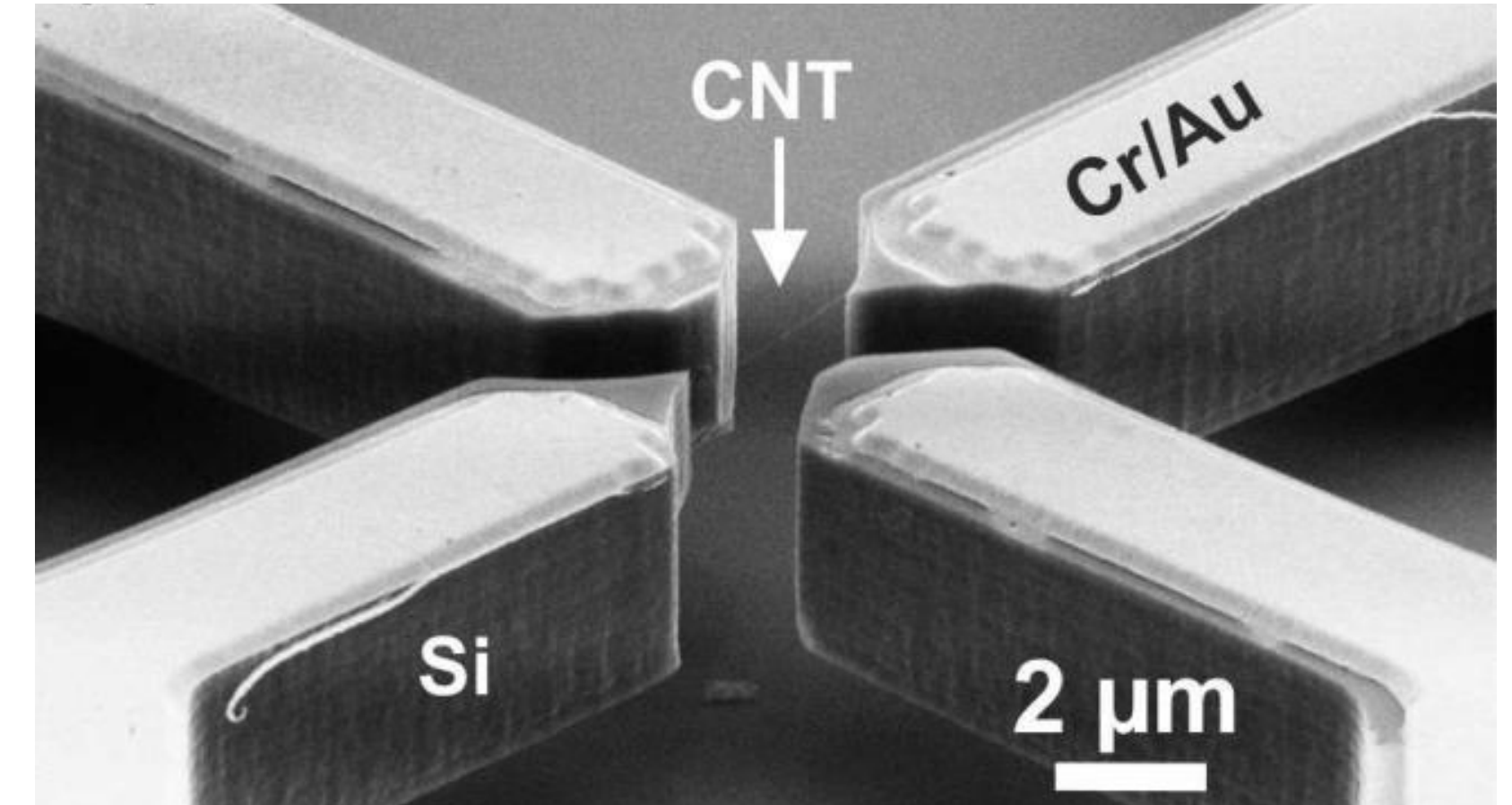
Shih-Wei Lee, Matthias Muoth, Cosmin Roman, Stuart Truax, Christofer Hierold

Micro and Nanosystems, Department of Mechanical and Process Engineering, ETH Zurich, 8092 Zurich, Switzerland

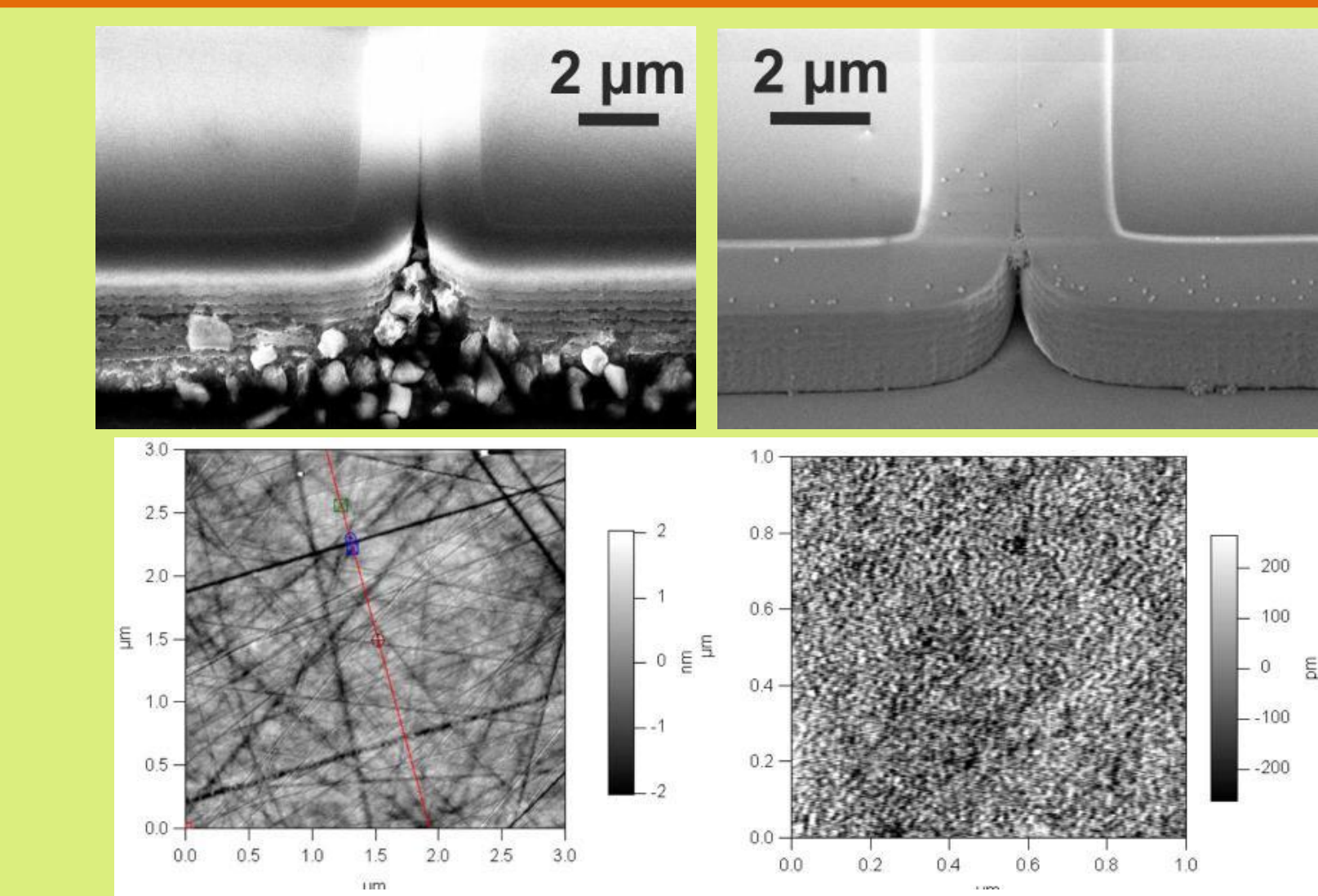


Abstract

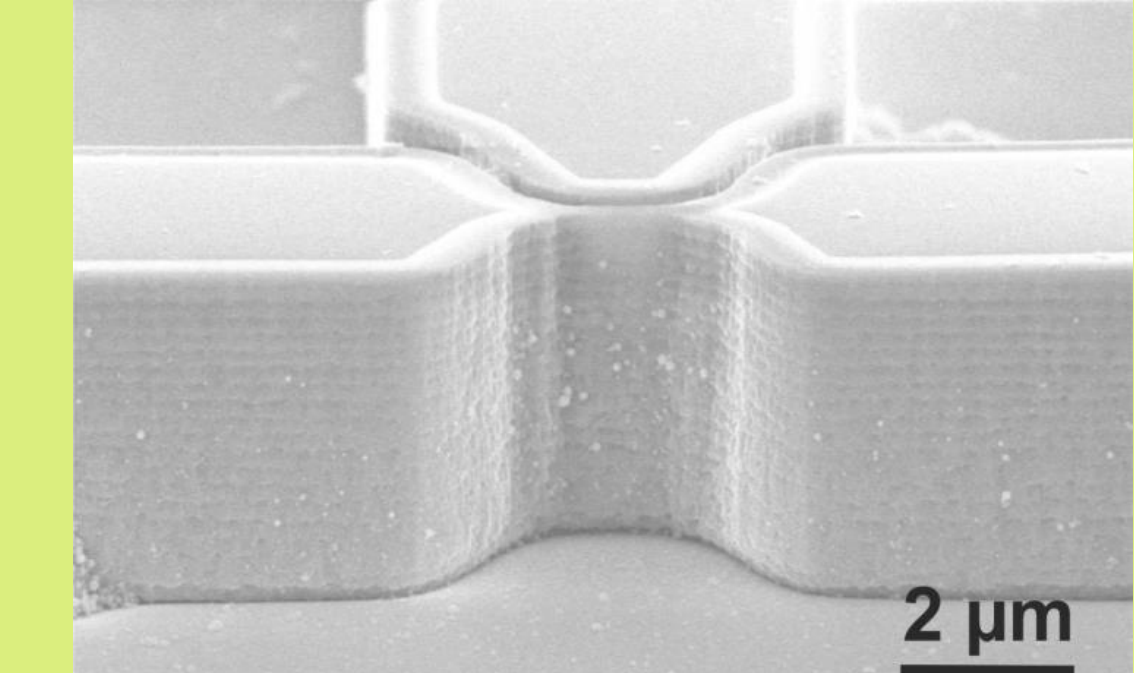
The present developed process flow in this poster is capable of integrating **low-defect suspended CNTs** into **MEMS** actuators with **reliable electrical contacts** and **robust mechanical clamping**. The fabricated CNT-MEMS devices were characterized and demonstrated in on-chip tensile tests.



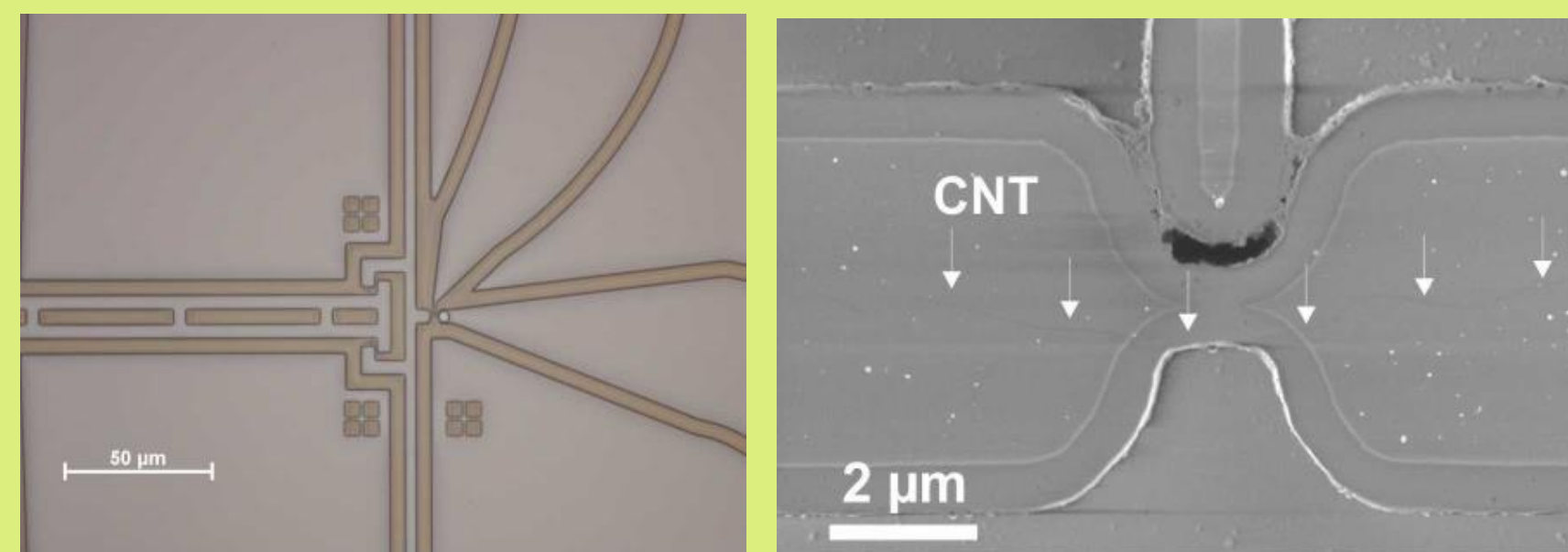
Integration process



Polished surface conditions (step b)

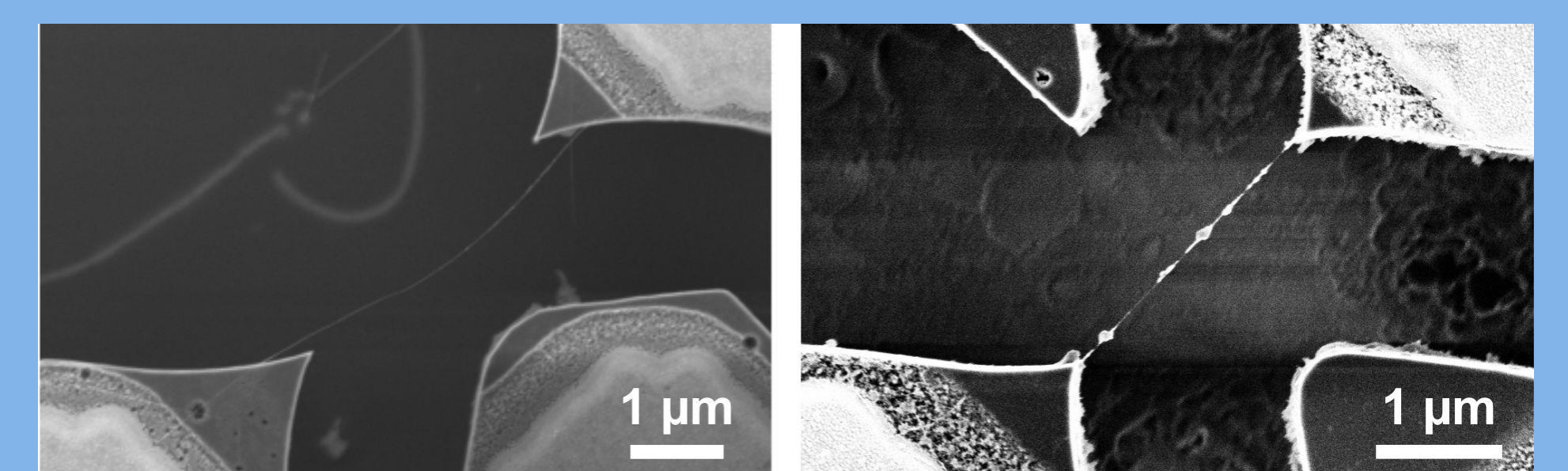
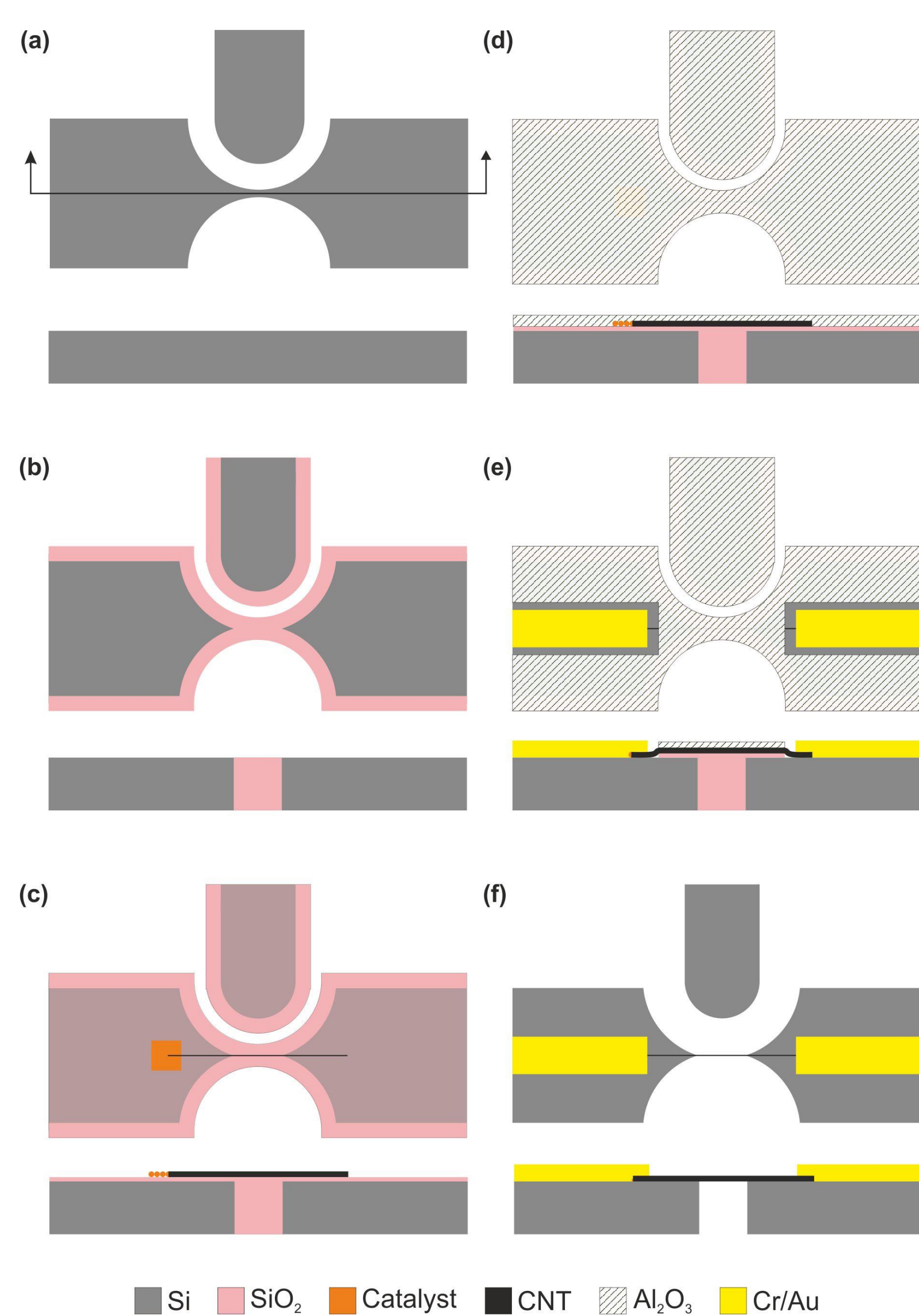


Polished oxide bridge (step b)

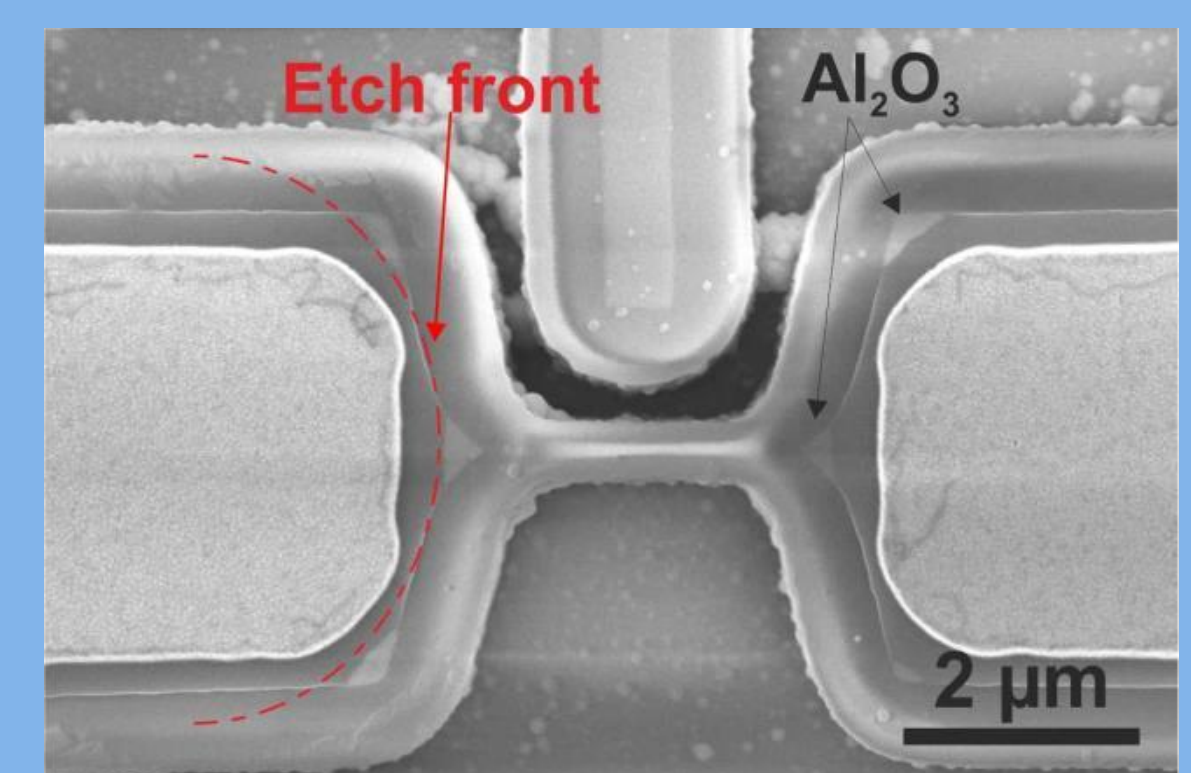


Patterning the growth site of CNT (step c)

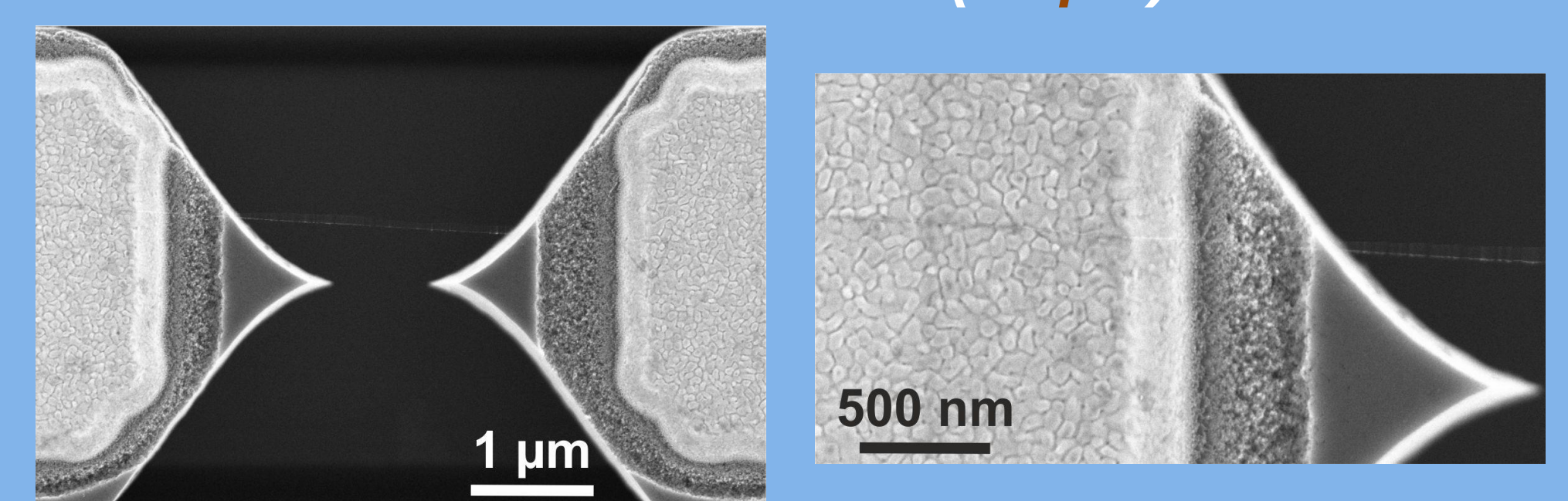
Integration process flow



Suppression of residual resists by an ALD Al_2O_3 layer (step d)

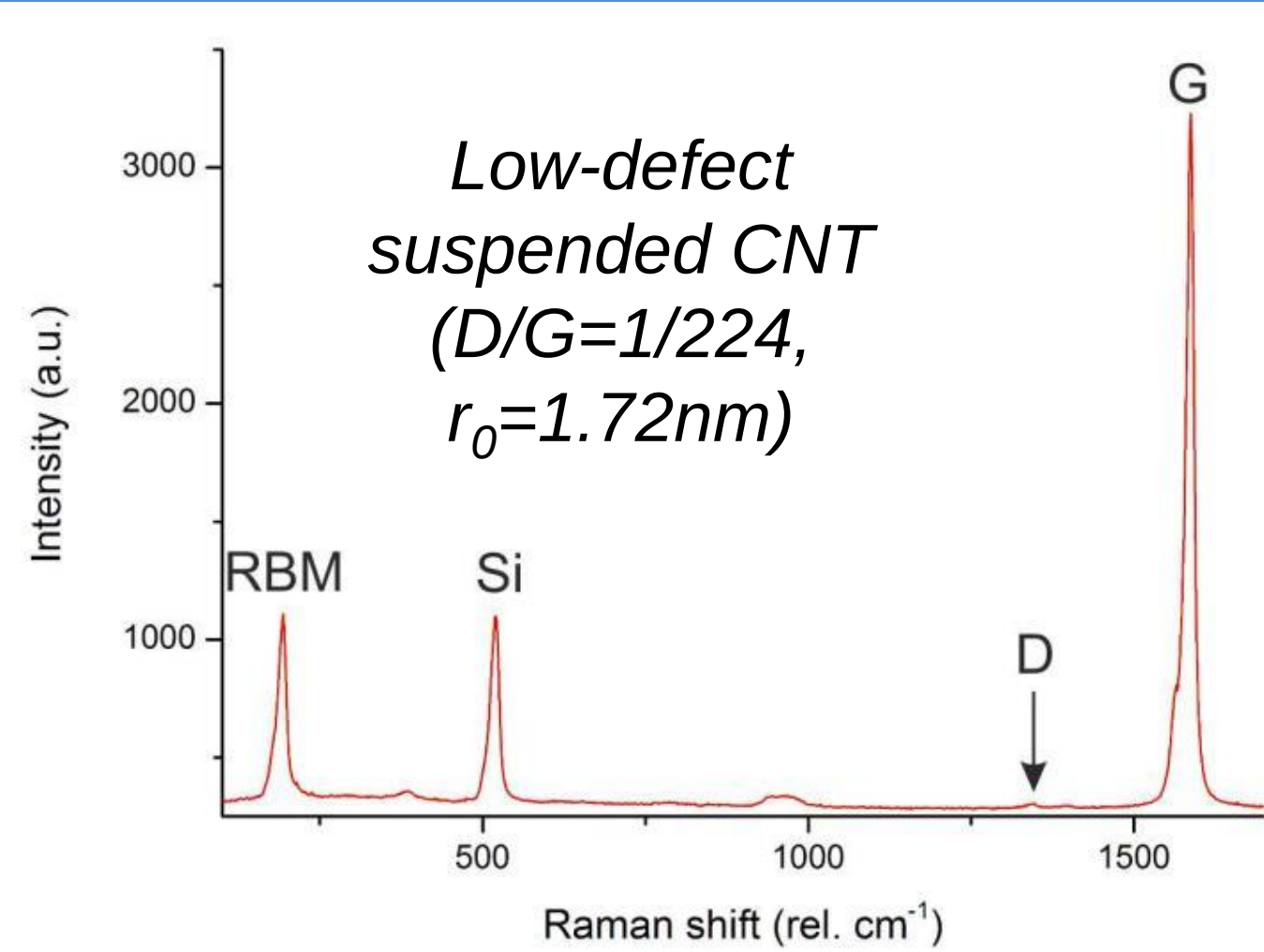


Etching of Al_2O_3 and SiO_2 by HF and Cr/Au metallization (step e)

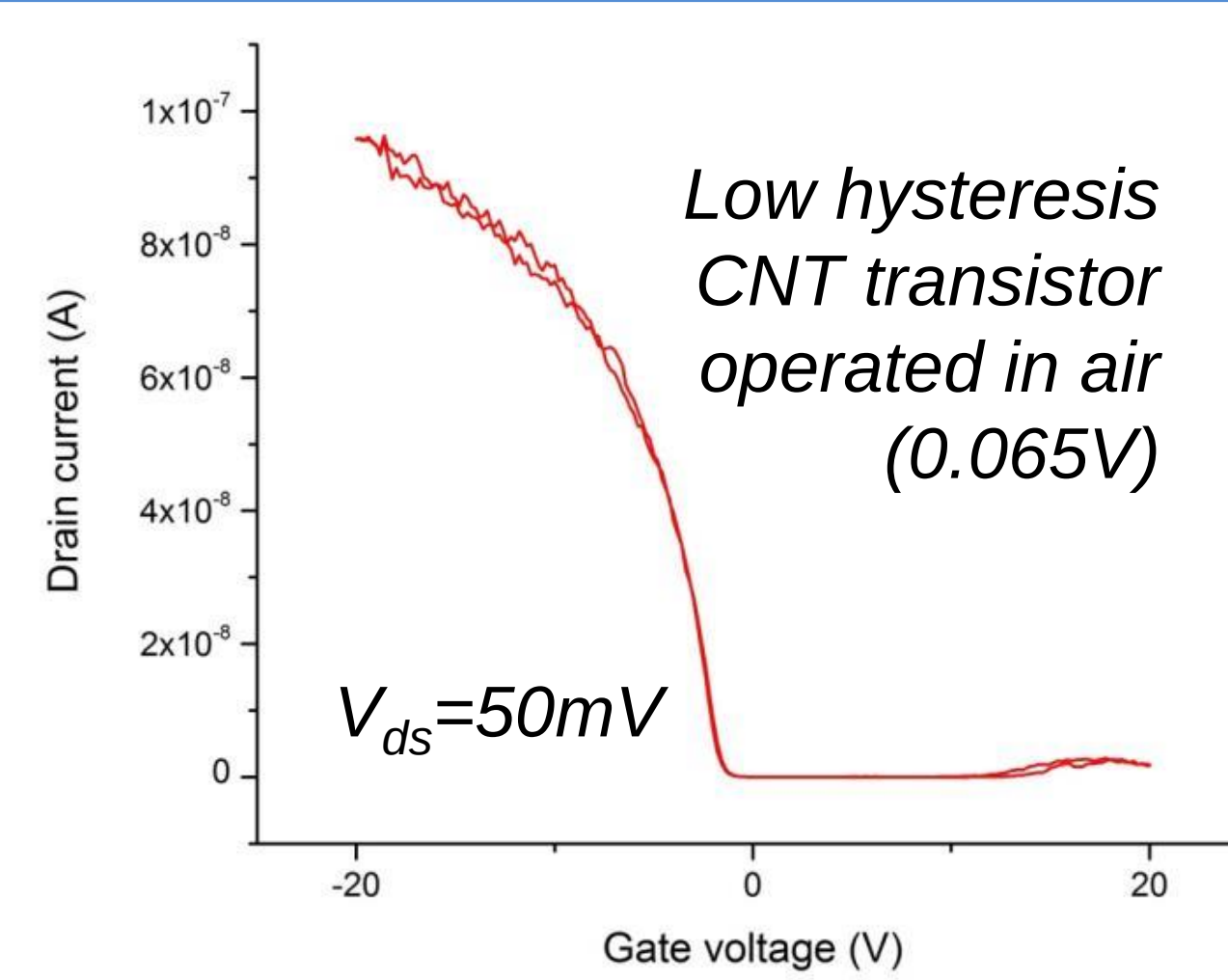


Suspended CNT with clamped-clamped configuration (step f)

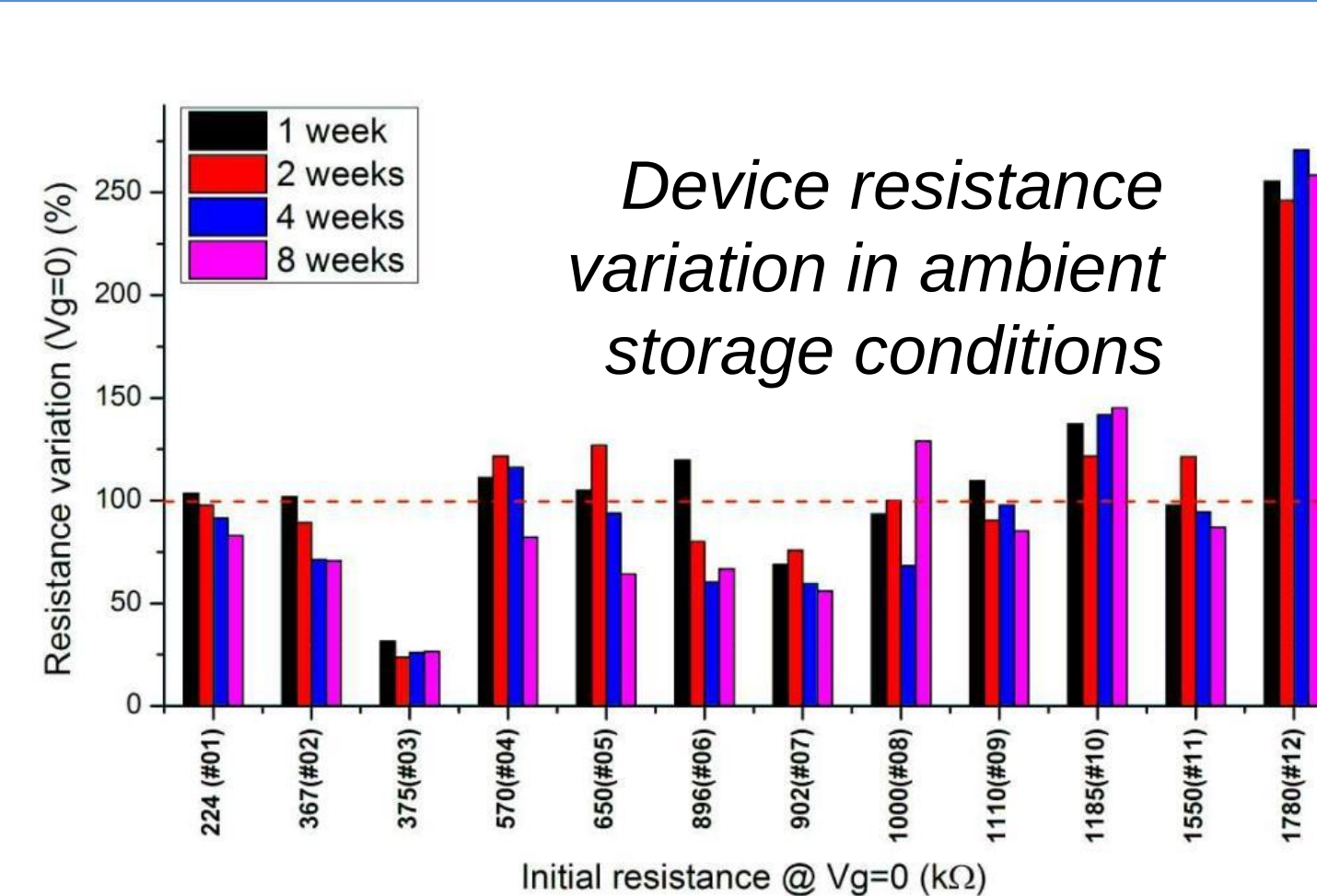
Characterization



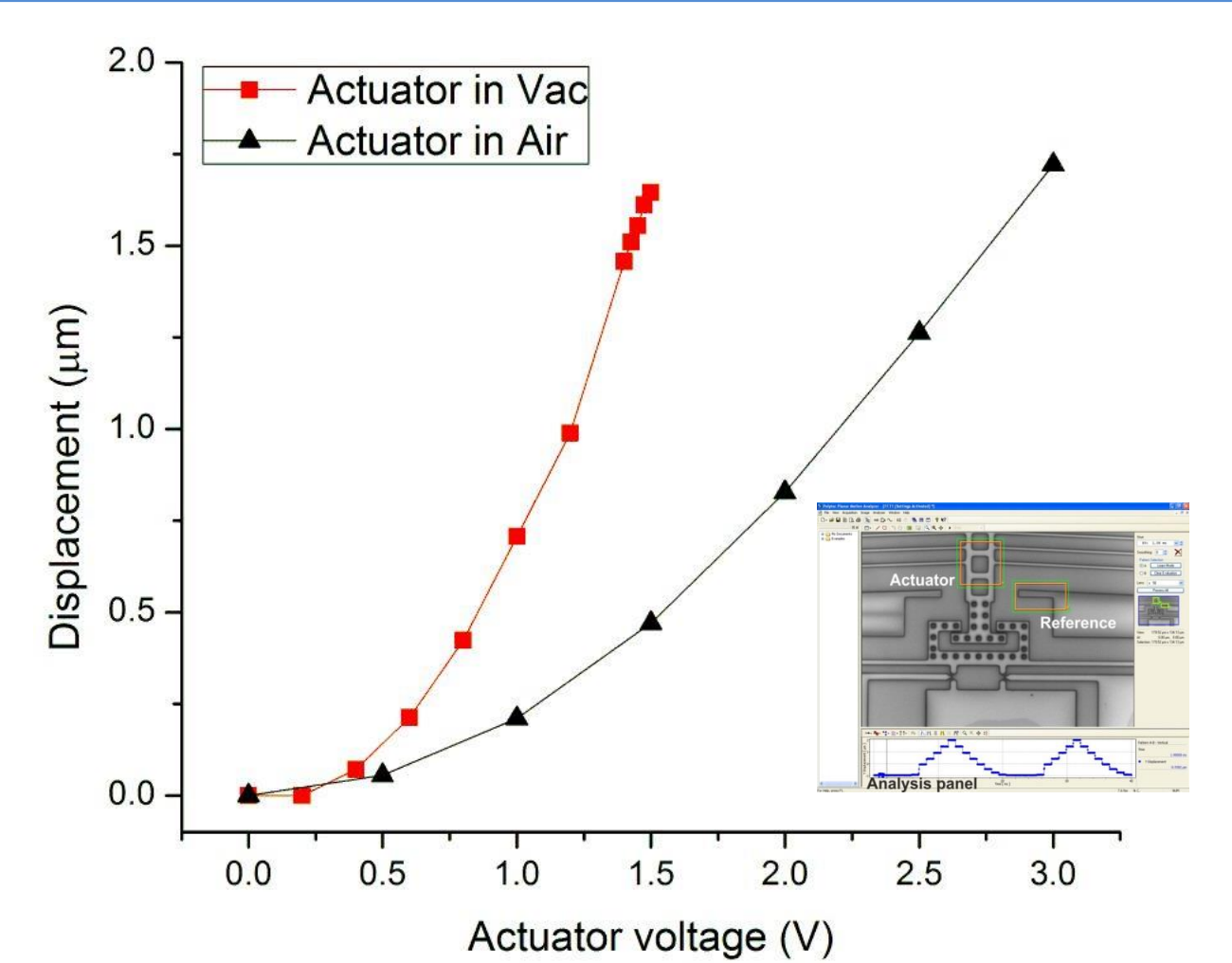
CNT quality by Raman spectroscopy



Transistor characteristics by electrical measurement

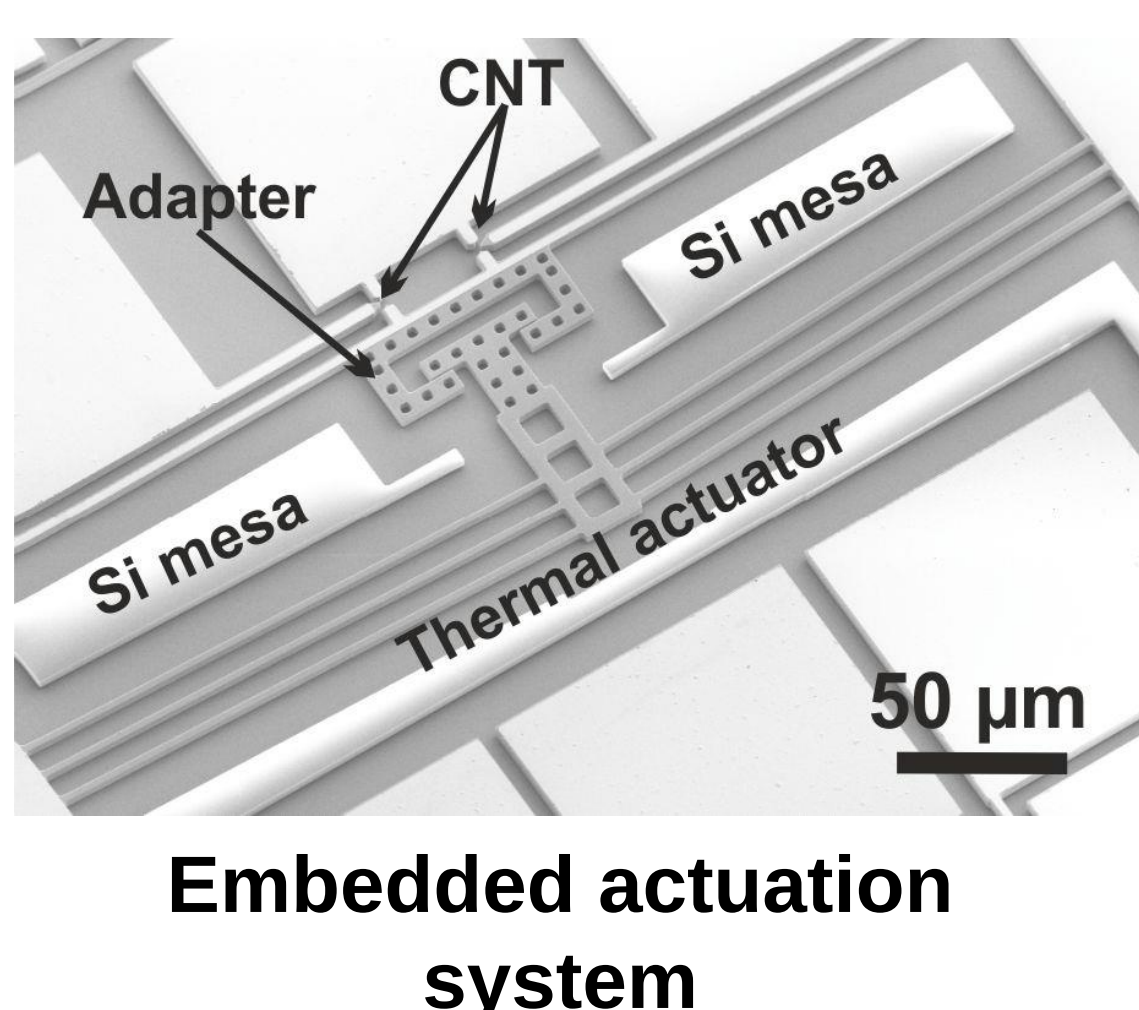


Monitor device stability by electrical measurement

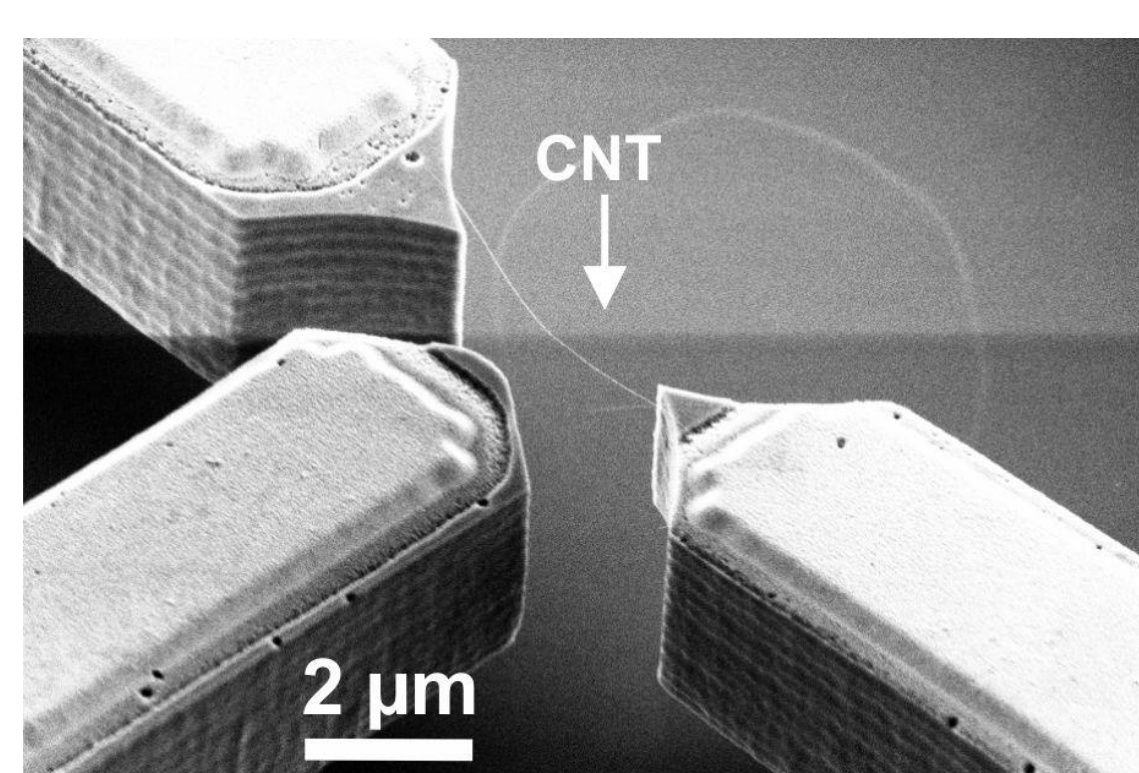


Actuator performances by plane motion analyzer

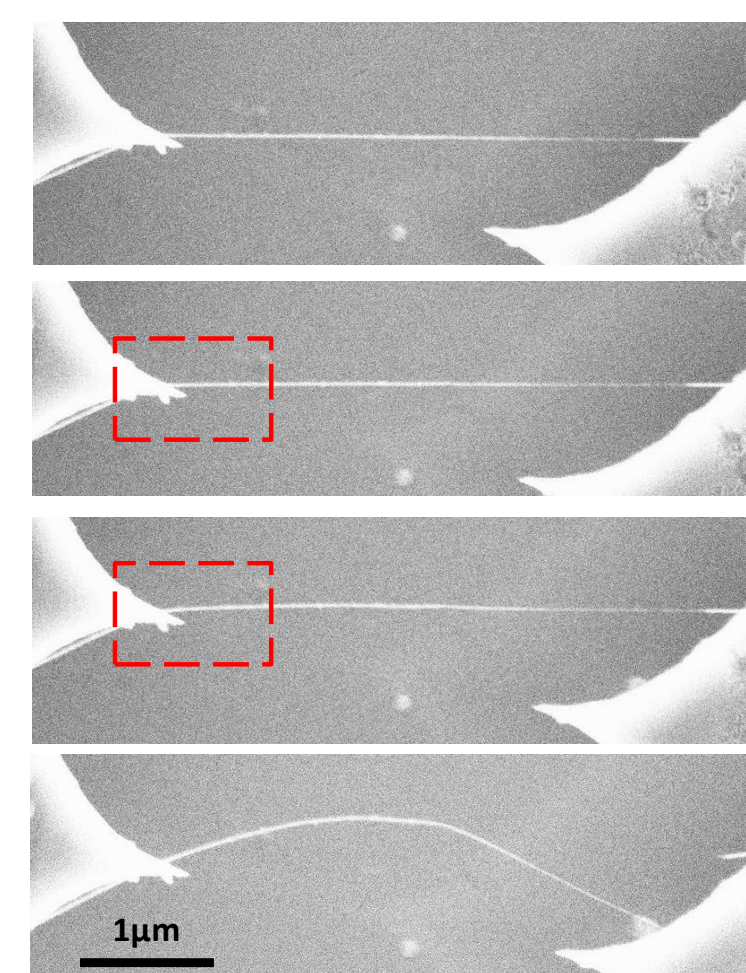
Demonstration



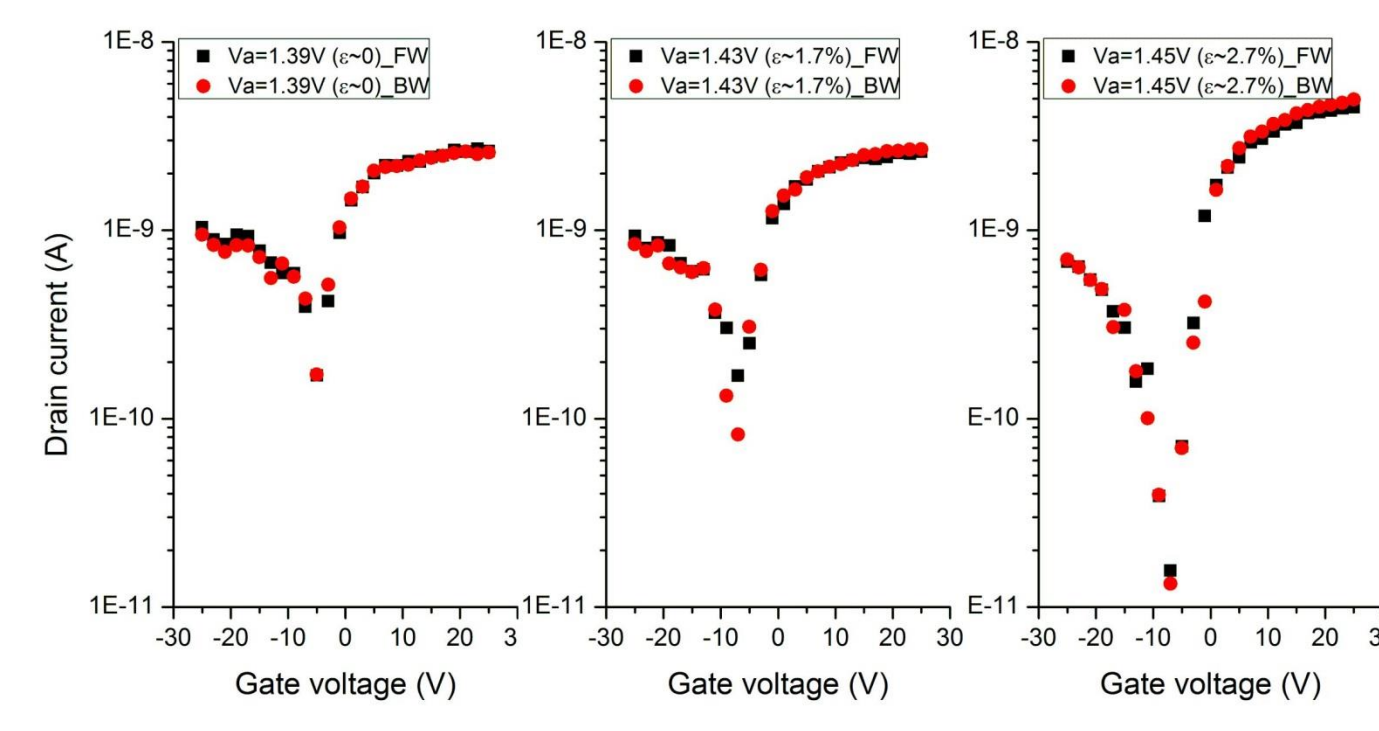
Embedded actuation system



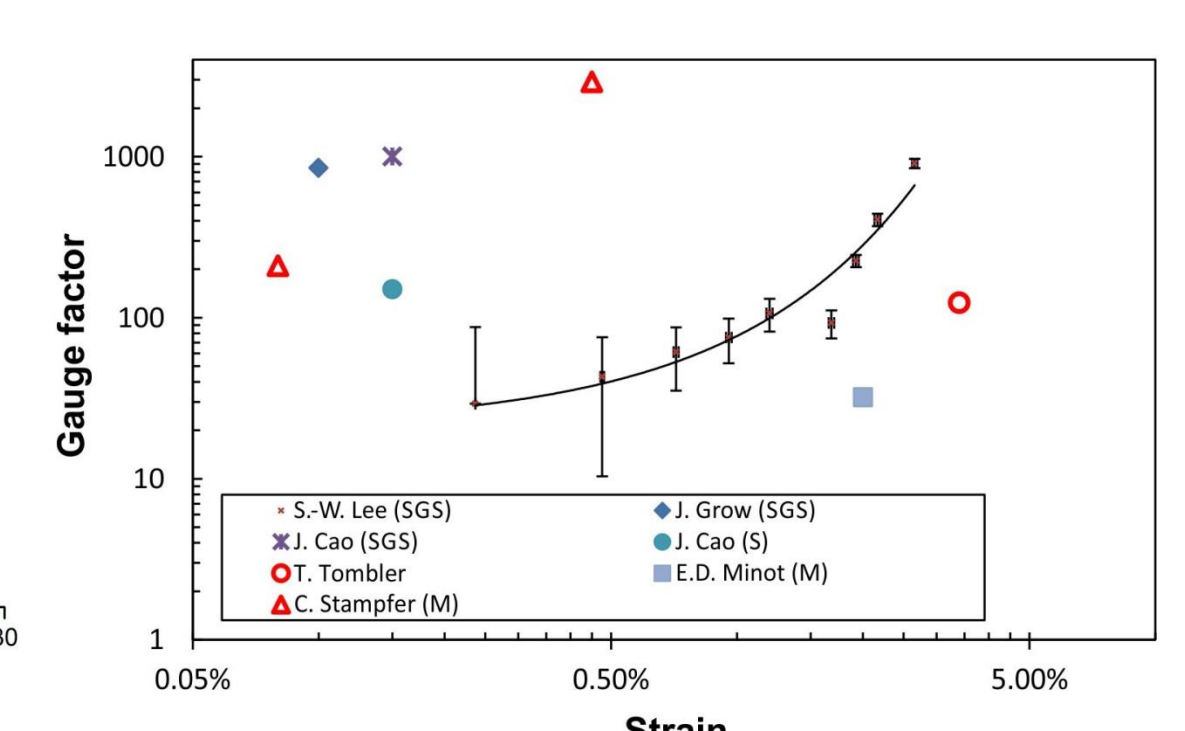
Integrated suspended CNT onto predefined micro Si structures



Preliminary tensile test



High reproducibility/reversibility of the electro-mechanical tests of suspended CNTs.



Tunable gauge factor of suspended CNTs from 29 ($\epsilon=0.2\%$) to 908 ($\epsilon=2.6\%$).

Acknowledgements

This research has been funded by Nano-Tera.ch, a program of the Swiss Confederation, evaluated by SNSF.

Reference

- [1] S.-W. Lee, et al., IEEE NEMS 2011
- [2] T. Tomblor, et al., Nature 405
- [3] J. Cao, et al., Phys Rev Lett 90
- [4] J. Grow, et al., Appl Phys Lett 86
- [5] E. D. Minot et al., Phys Rev Lett 90
- [6] C. Stampfer et al., Nano Lett 6