Additive Micro-Manufacturing @ EPFL
Materials, Tools, and Systems

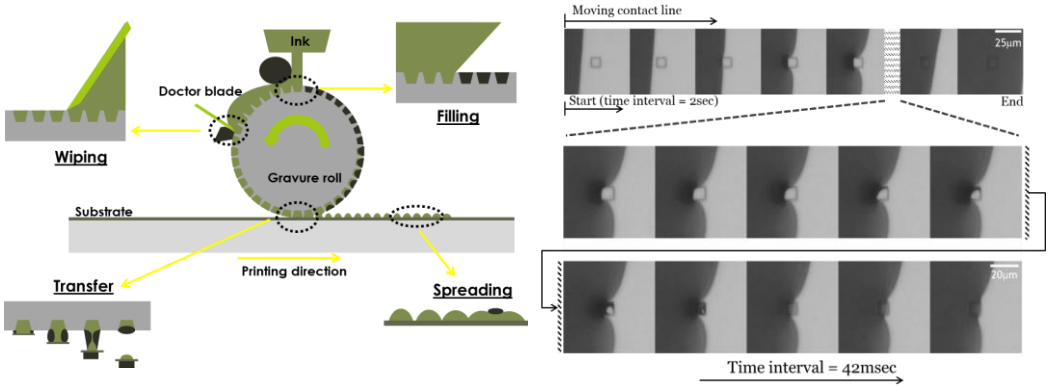
Vivek Subramanian
Institute of Microengineering
École polytechnique fédérale de Lausanne

The challenge…

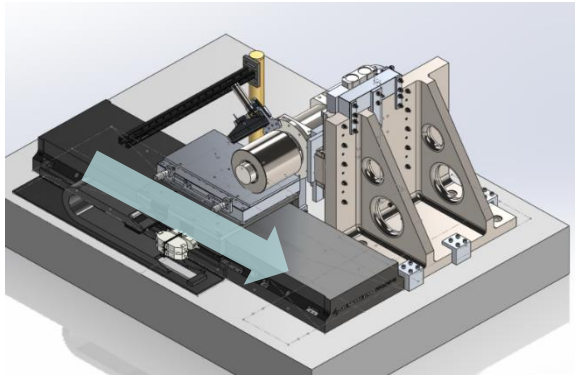
How do we get from this…

To this?

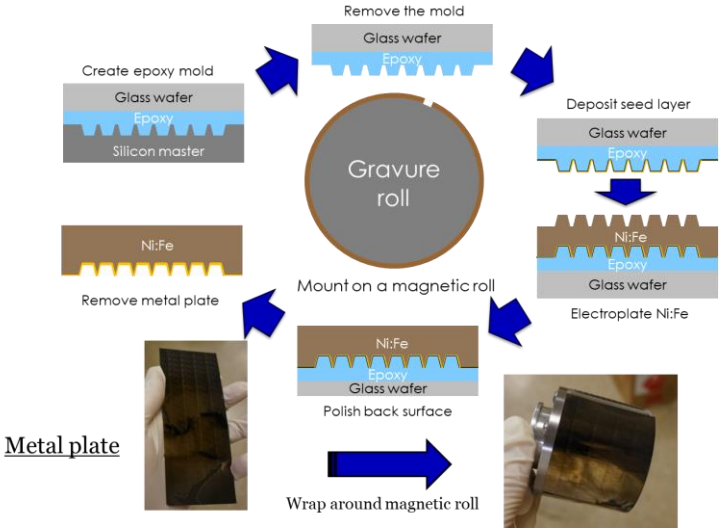
Science-driven tool development



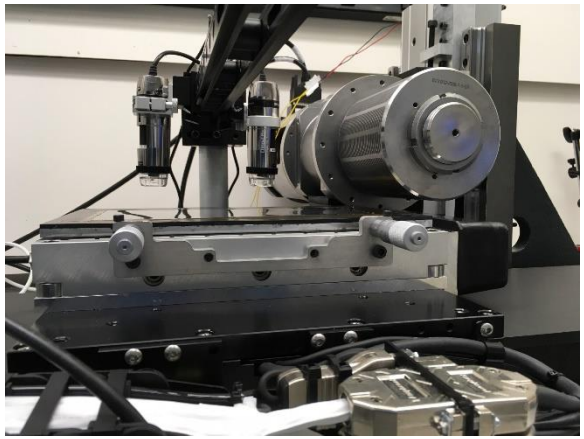
Deep understanding process physics



Science-driven tool design

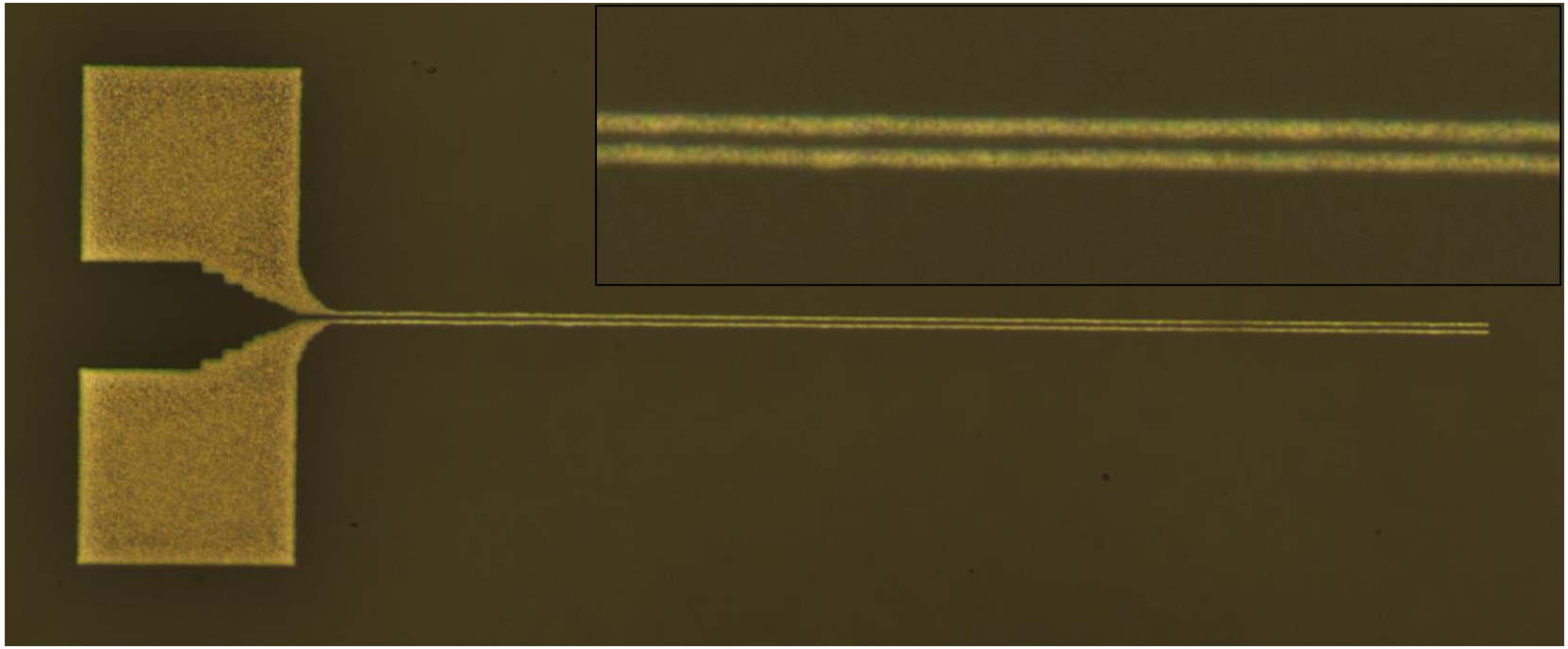


Coupled process technology development



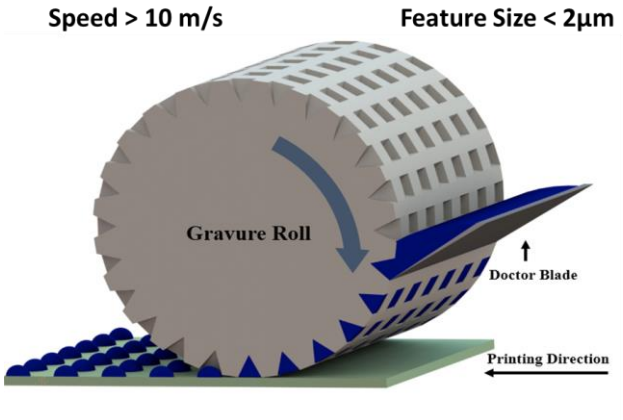
Precision tool development

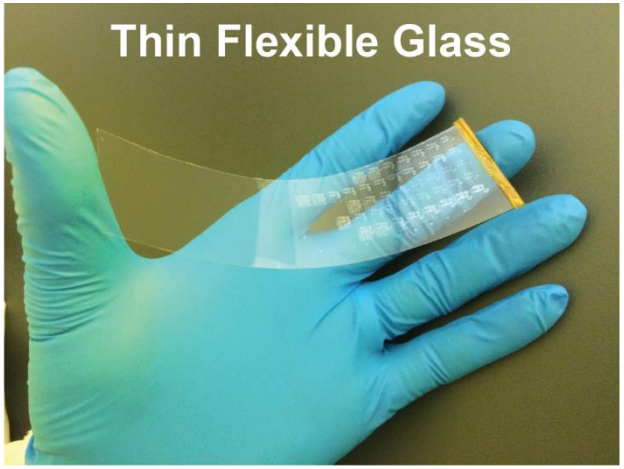
~1μm Printed Channel



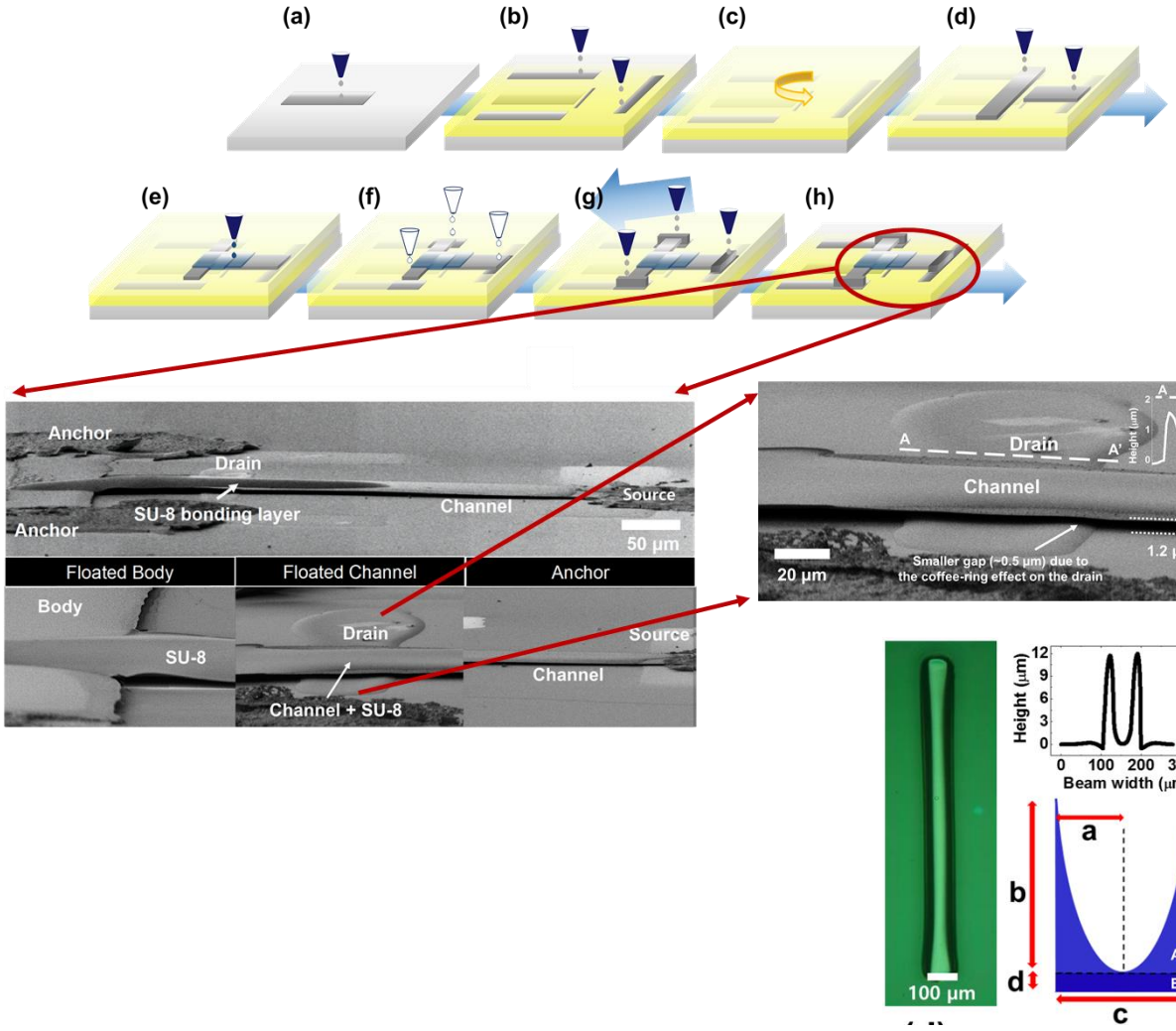
Example: Conformal Electronics

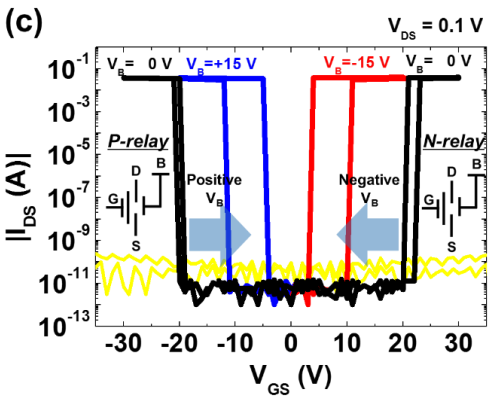
Gravure allows high speed additive patterning at a high-resolution

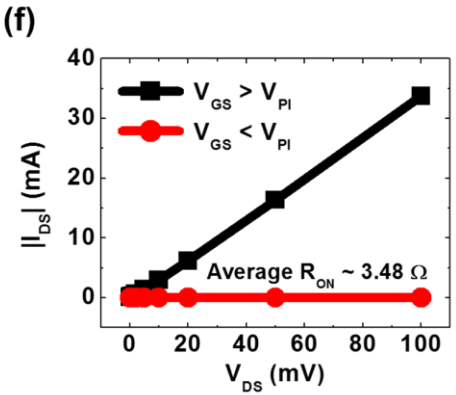




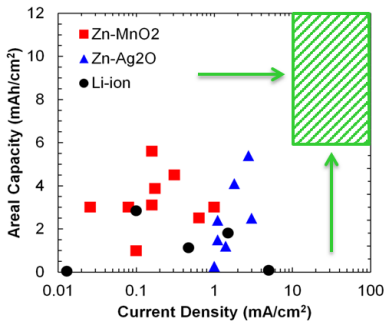
Printed 3D MEMS



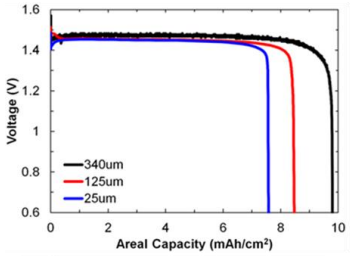




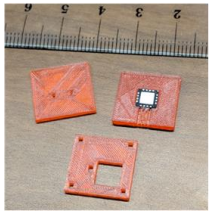
Example: Chip-integrated batteries for autonomous motes

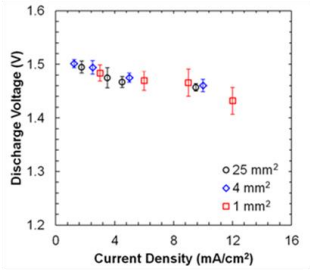


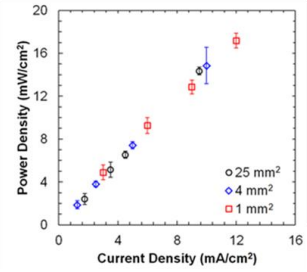
- Understand the application needs
- Develop the materials and processes
- Integrate to realize the target device

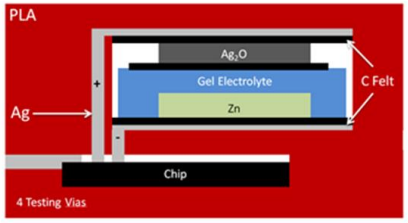


Electrode Thickness (µm)	Ag_2O Utilization (%)	Internal Resistance (Ω)
340	78	27.0
125	86	19.3
25	77	14.2

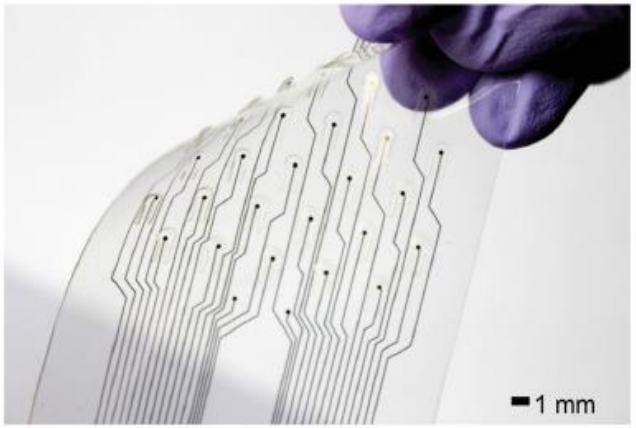


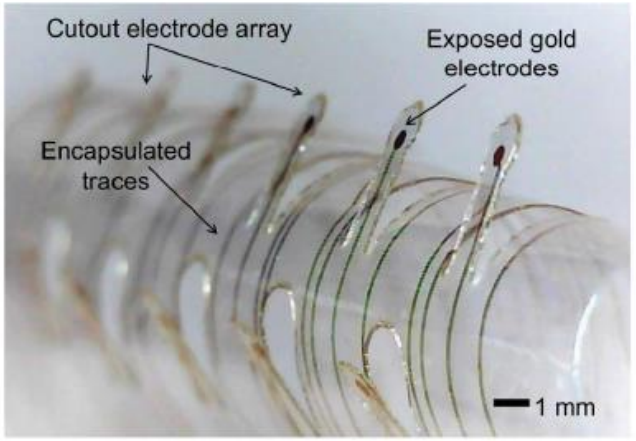






Precision Bio-interfaces

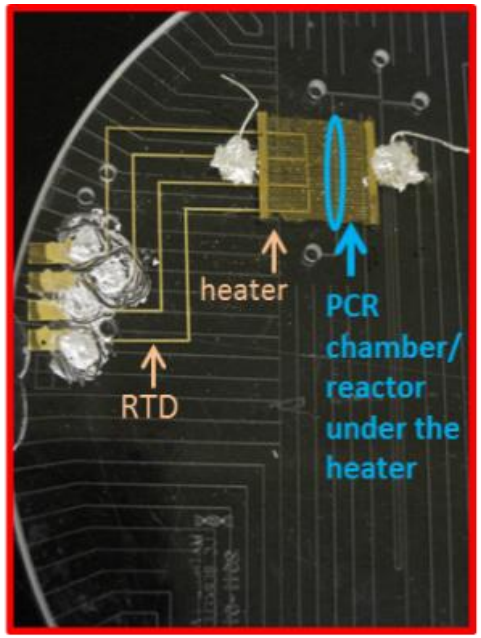




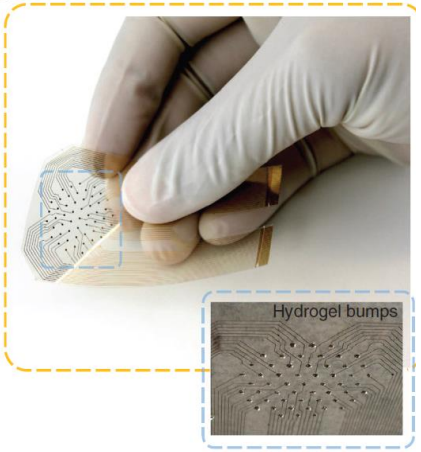
Swisher et al. Nature communications 6 (2015).
Khan, Yasser, et al. *Advanced Functional Materials* (2015).

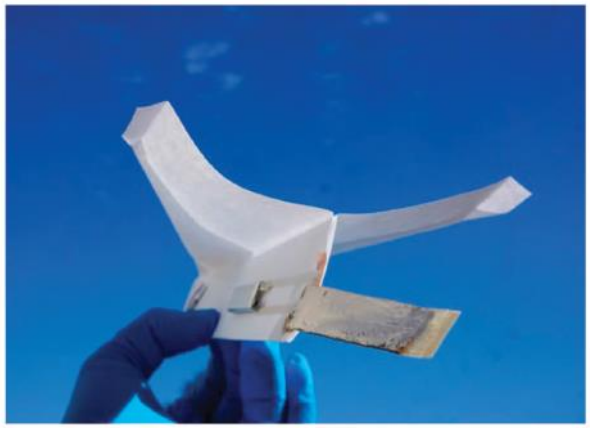
Additive Integration of Intelligence

Additive Bioreactor with integrated printed valves, flow channels, and sensors



Printed pressure ulcer detector (already in clinical trials)





Intelligent glider with printed battery, actuator, and electronics

Where will additive micromanufacturing take us?

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

New complex precision systems with dense integration of functionality offering

- Lighter and more robust systems
- More cost-effective manufacturing
- New form-factors
- Design freedom