

# Micro & Complex Fluids (MCF) Lab.

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**Seungho Kim**

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# Principal Investigator



## Seungho Kim

Assistant Professor, Pusan Natl. Univ., Korea (2022-Present).  
Staff Researcher, Samsung Semiconductor R&D Center, Korea (2020-2022).  
Postdoc, Cornell Univ., USA (2018-2019).  
Postdoc, Virginia Tech, USA (2017).  
Postdoc, Seoul Natl. Univ., Korea (2016).  
Ph.D, Seoul Natl. Univ., Korea (2016).

### *Honors & Awards*

Young Engineer Award, Korean Society for Precision Engineering (2022)  
Young Engineer Award, The Korean Society of Visualization (2022)

### *Professional Activities*

Committee member, Korean Society of Mechanical Engineers (2023-present)  
Committee member, The Korean Society of Visualization (2023-present)  
Member, Korean Society for Precision Engineering (2022-present)  
Member, American Physical Society (2011-present)

### *Invited talks*

"Visualization and mechanical analysis of liquid droplets on biological surfaces," 2023 KSME Fluid Engineering Division, Seoul, Korea (May, 19, 2023)  
"Analysis of mechanical interaction between droplets and bio-inspired surfaces," KSPE 2022 Autumn Conference, Daegu, Korea (Oct. 20, 2022)  
"Visualization of droplet and particle flows in nature," 2022 Spring Meeting of KSVI, Incheon, Korea (May 20, 2022)  
"Microfluid mechanics in semiconductor manufacturing processes," Intel Corporation, Portland, USA (Oct. 17, 2019)

# Research areas

1  $\mu\text{m}$



Interfacial flows

1 mm

1 m

$F_{\text{surface}} > F_{\text{body}}$ : Experiment based- $\mu\text{FSI}$

Keywords: Fluid interfaces, surface tension, wettability

## Surface tension



Tensile state like a stretched rubber band



Small  $\lesssim 1 \text{ mm}$

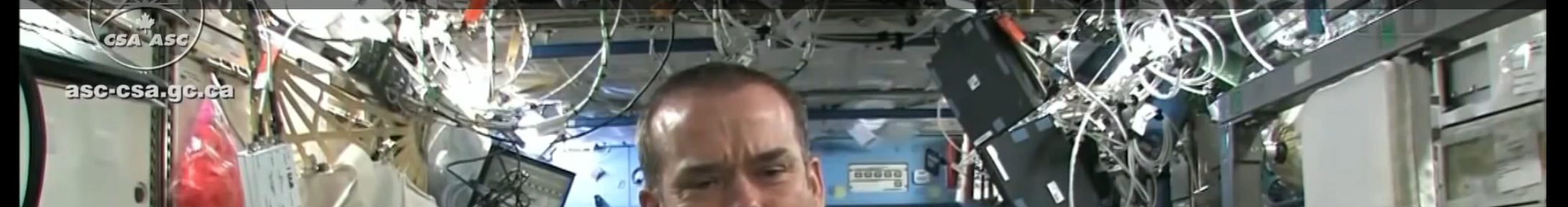
Human-sized water droplet?

## Capillary length

$$\text{Capillary length } (l_c) = \sqrt{\frac{\text{Surface tension}}{\text{Density} \times g}} \quad \text{For water} \rightarrow 2.7 \text{ mm}$$

: Length scaling factor that relates gravity and surface tension

## Wringing out a wet washcloth in spaceship



If surface tension gets important, you cannot wring out water.

You must handle **liquids** differently!



x 2

# Experts in nature who skillfully use microfluidics

Water strider (*A. remigis*)



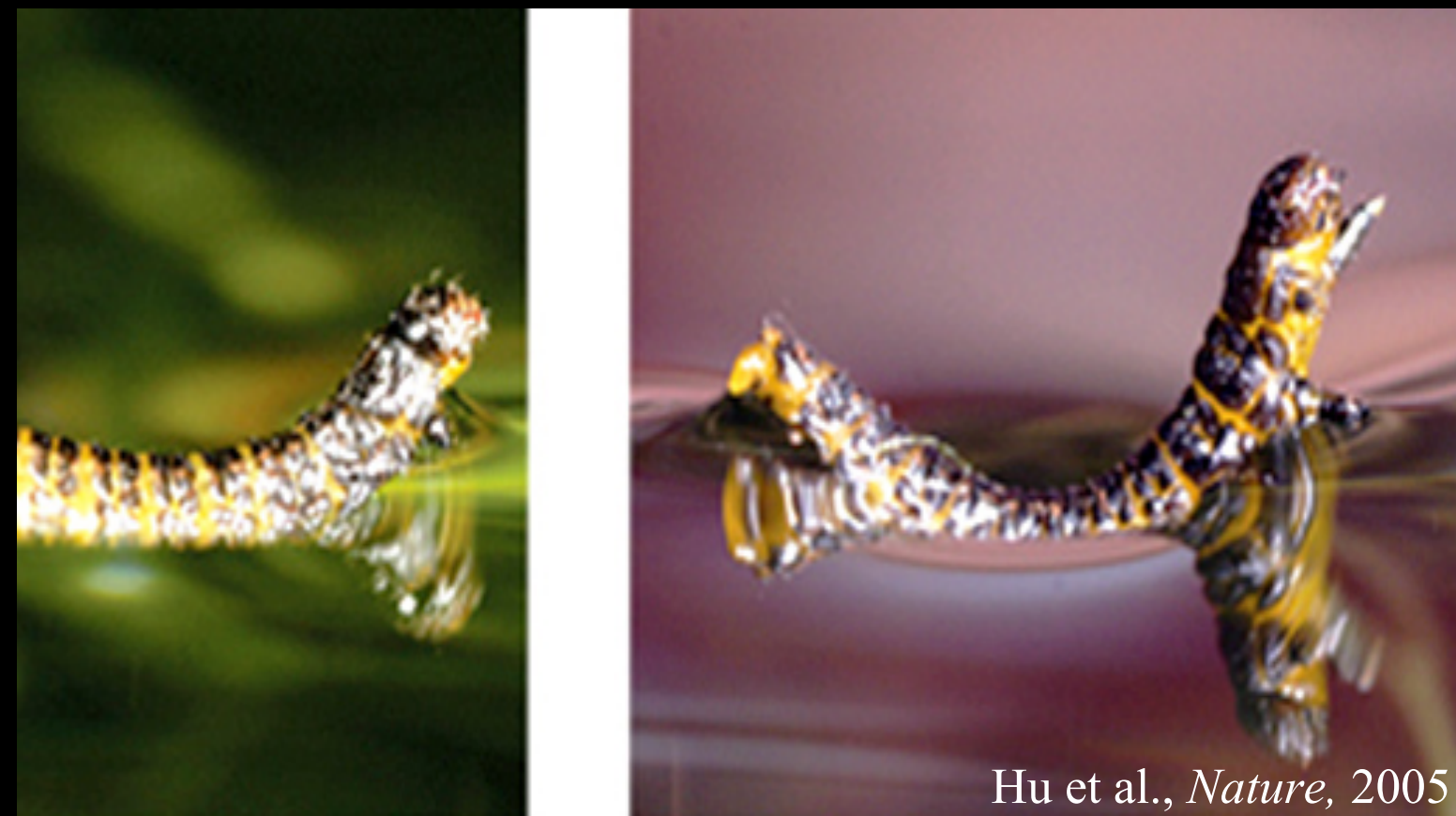
Water spider (*A. aquatica*)



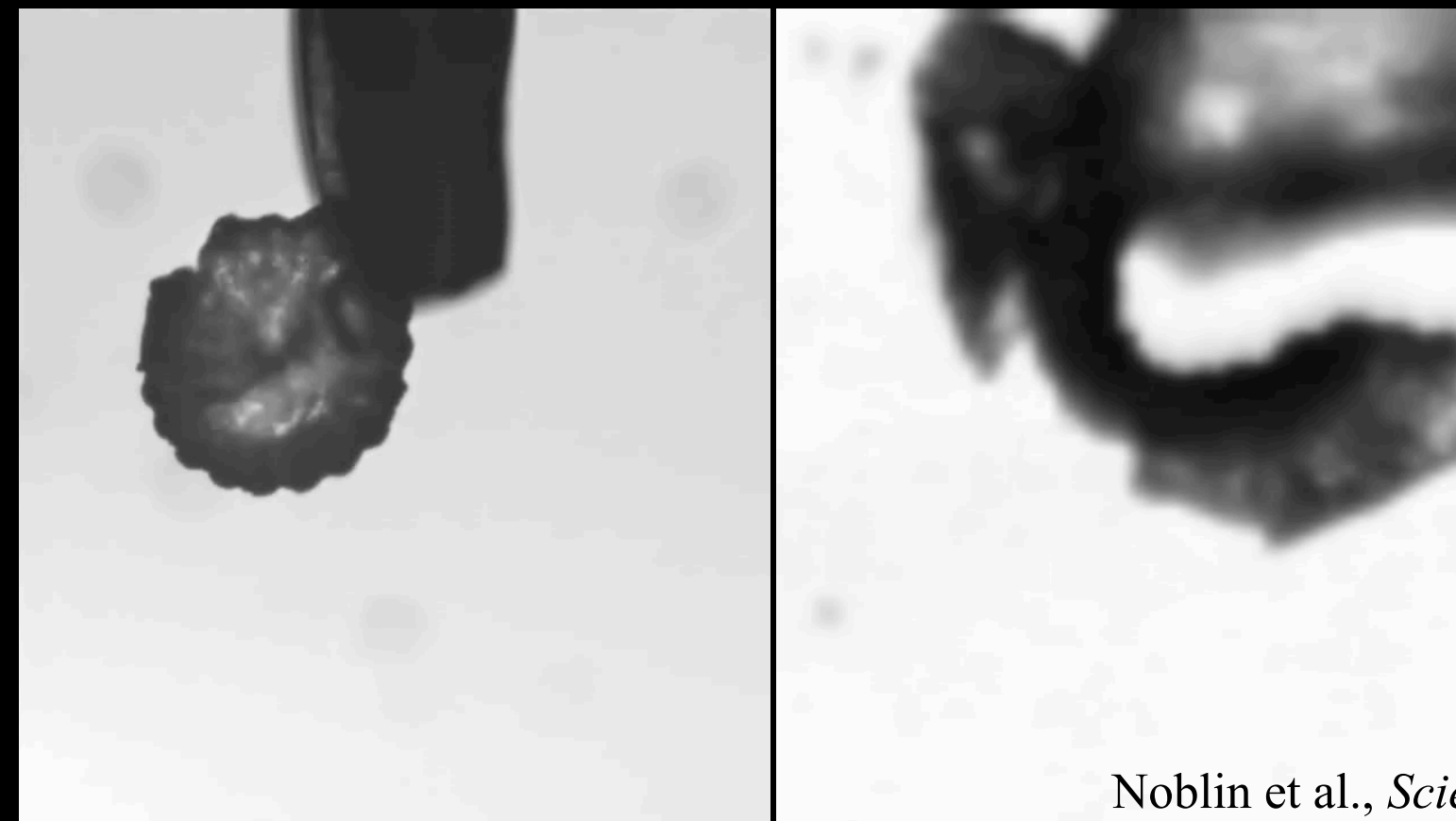
Longbill bird (*P. tricolor*)



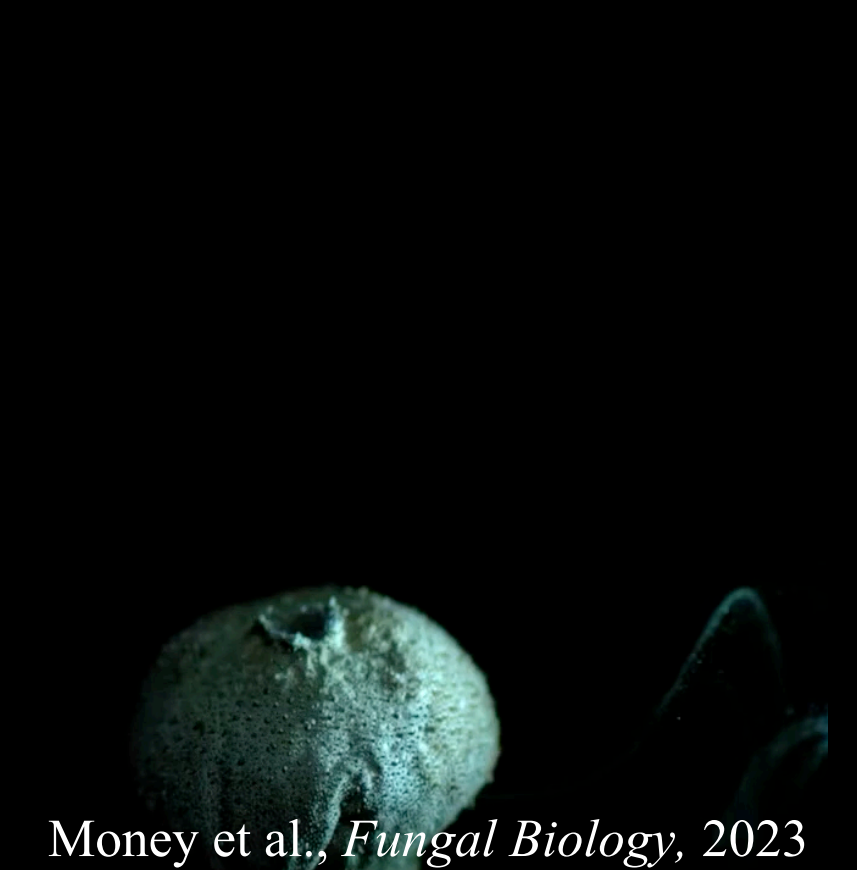
Larva & springtail



Fern sporangium

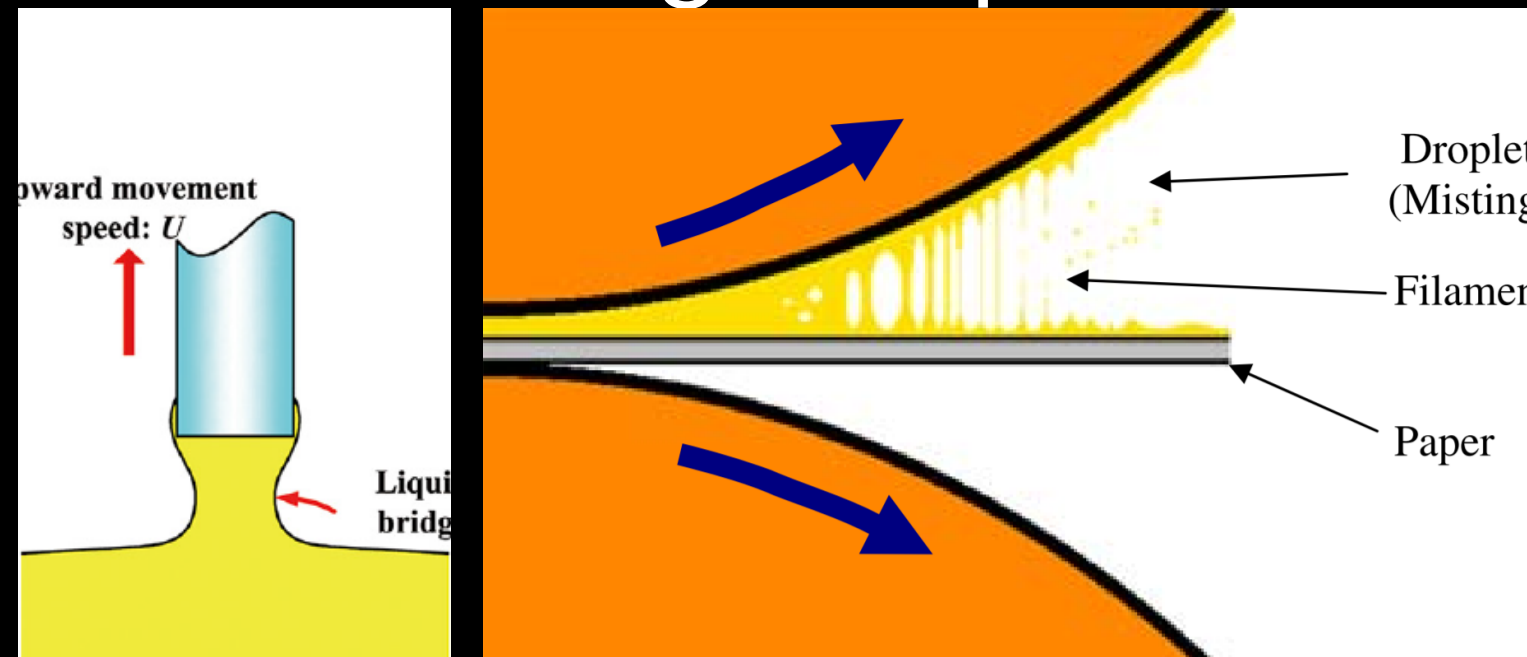


Mushroom spore



# Industrial fields that need the understanding of microfluidics

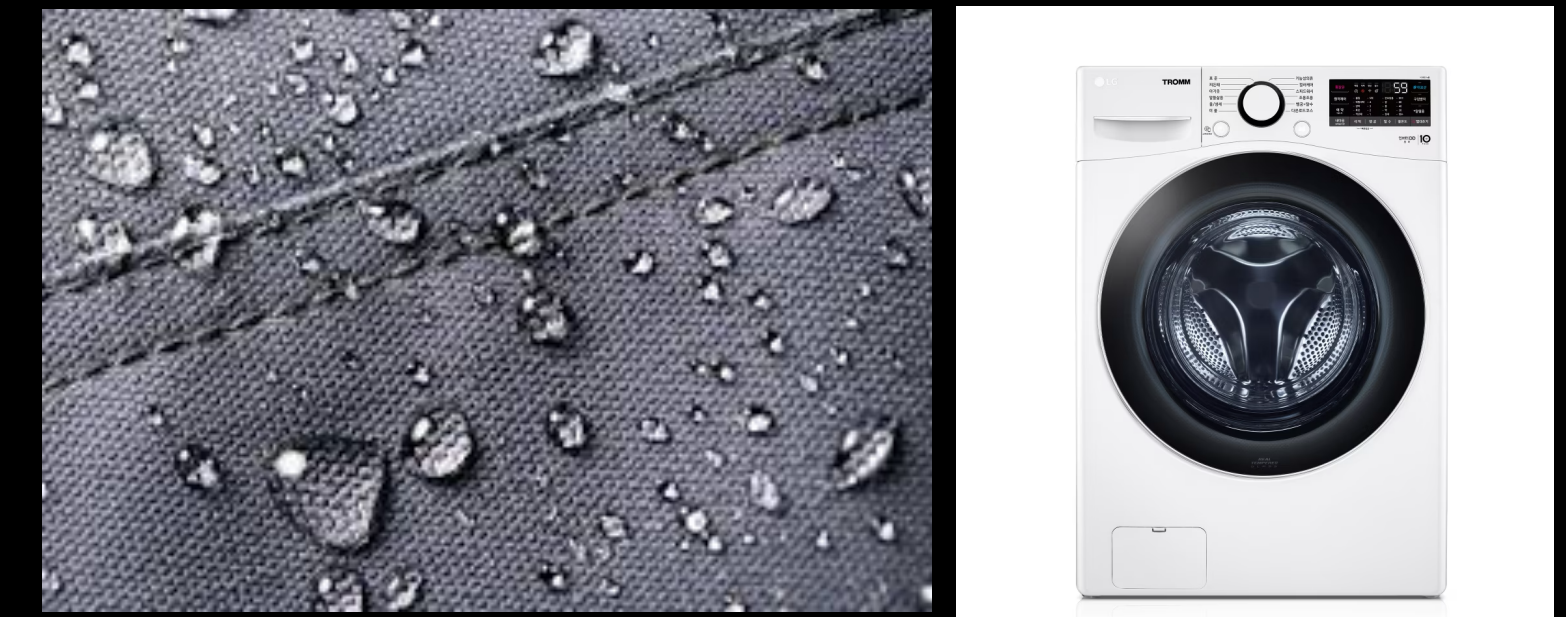
## Coating and paint



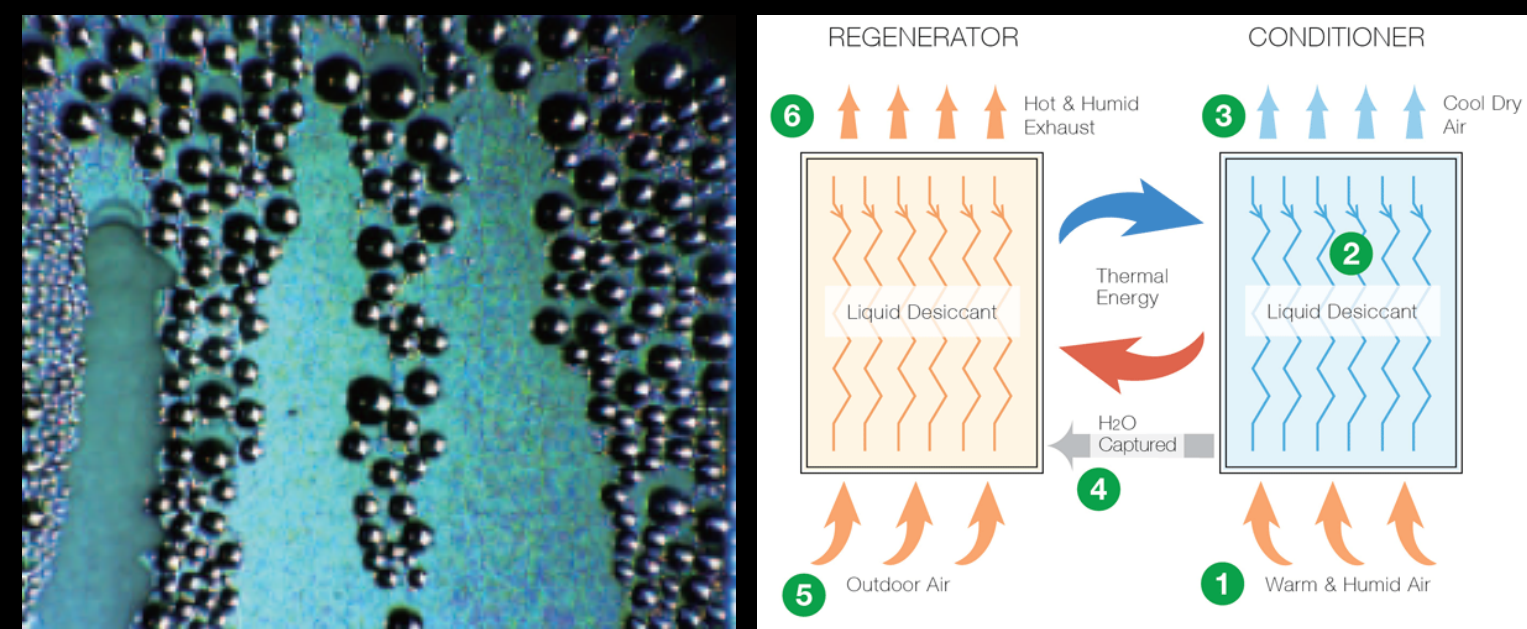
## Inkjet printing



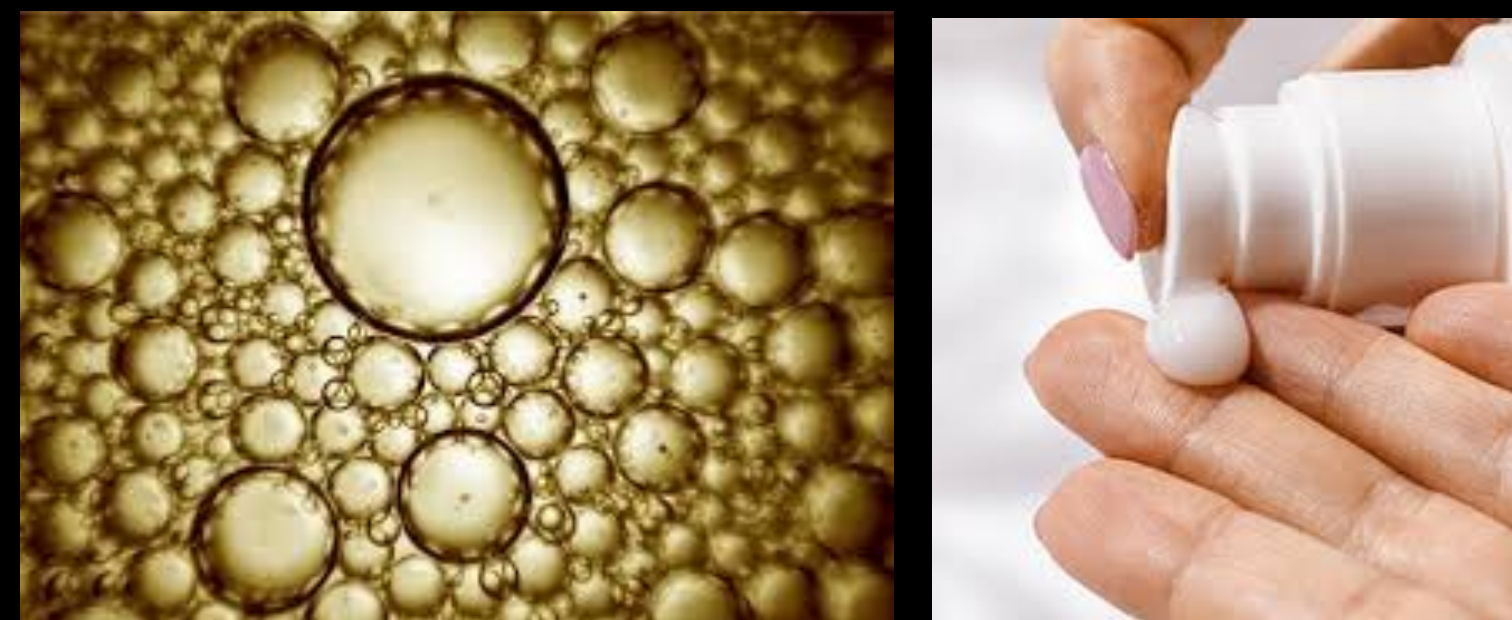
## Cleaning



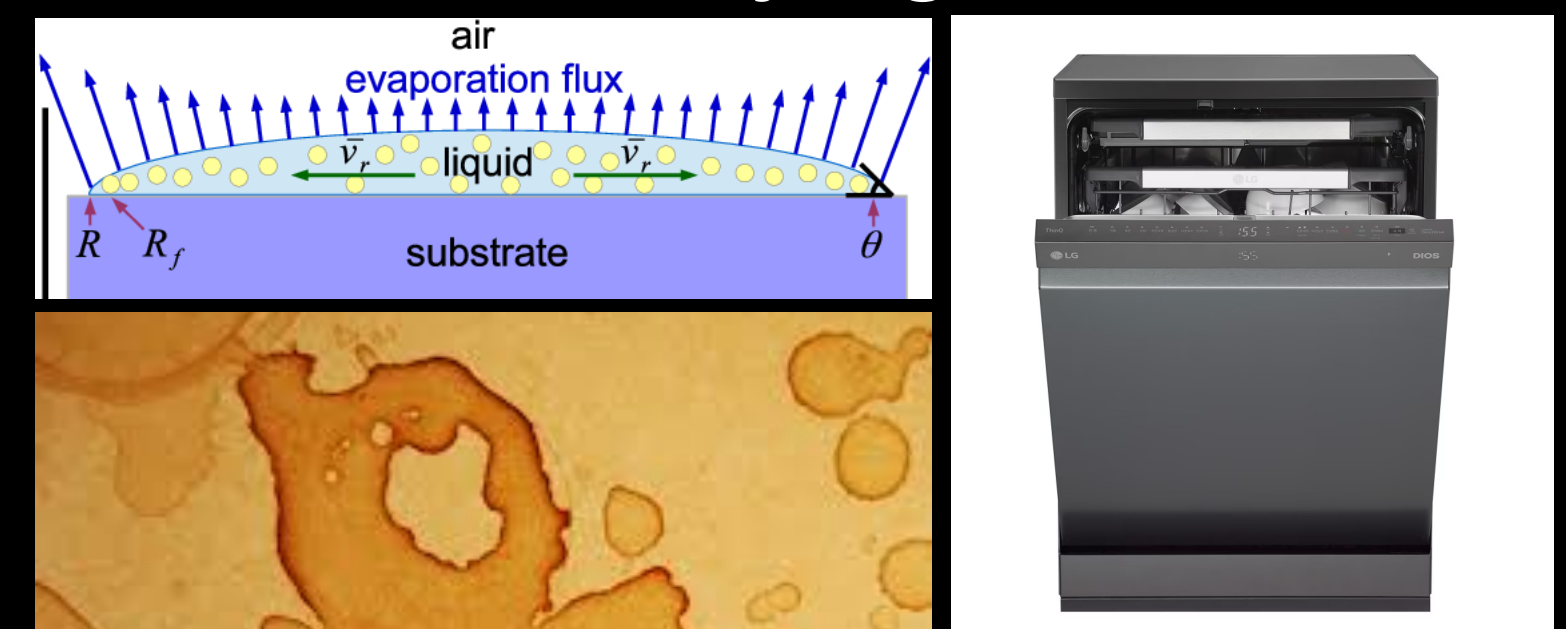
## Condensation



## Cosmetic



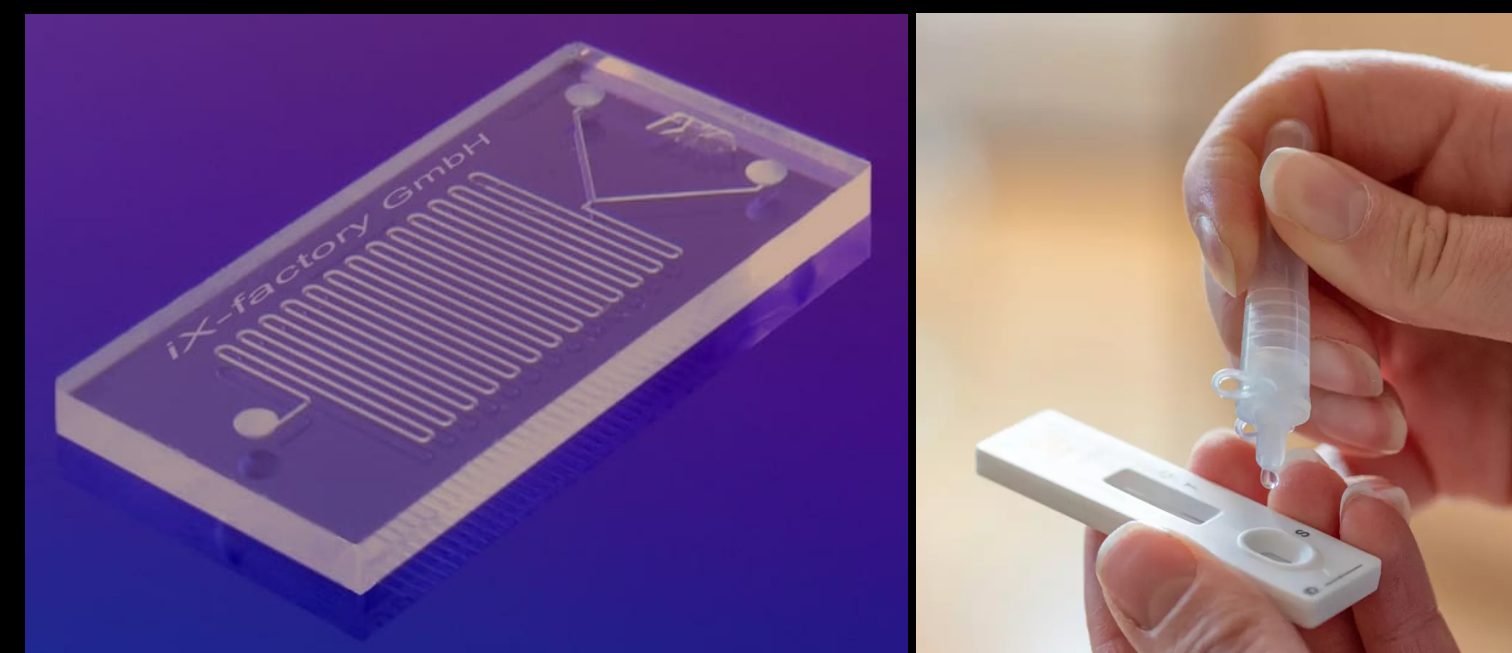
## Drying



## Water-oil separation



## Biomedical device



## Semiconductor



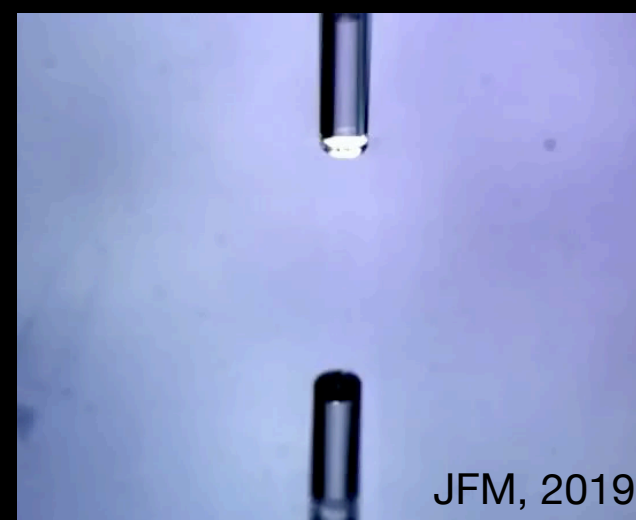
# Research overviews

## Microfluidics

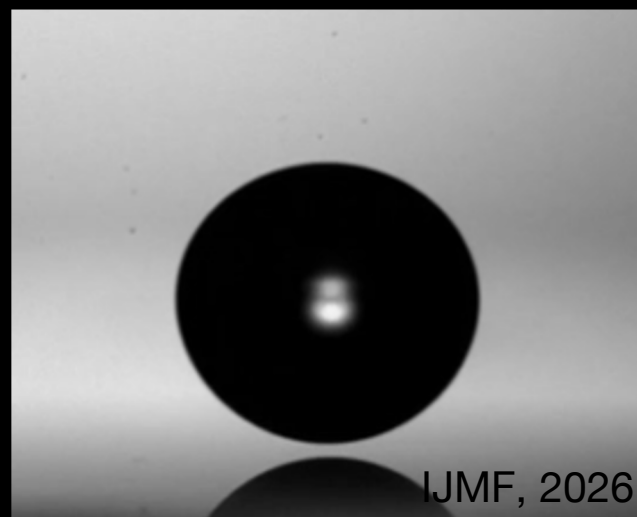
Bubble bouncing



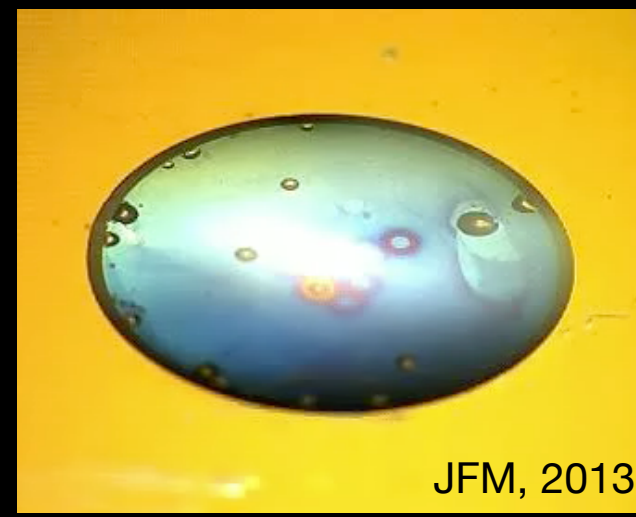
Film dewetting



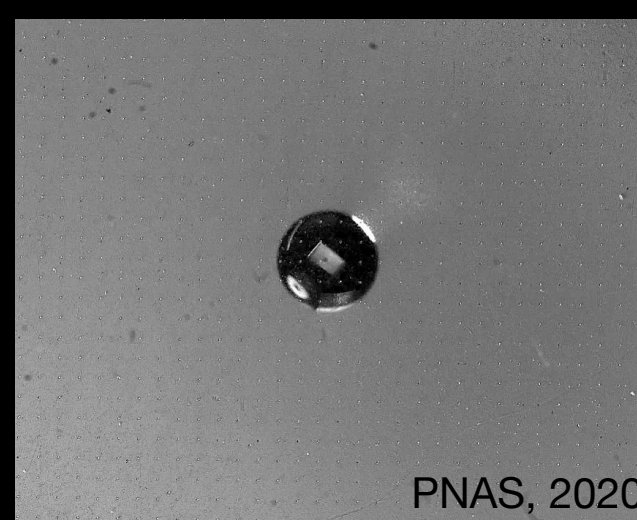
Drop bouncing



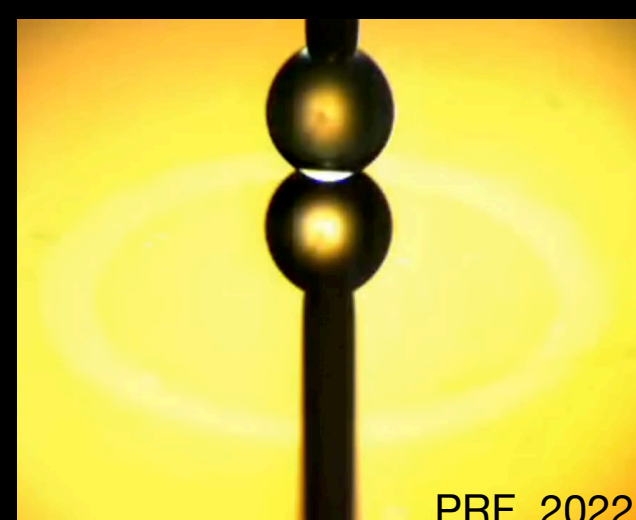
Film bursting



Drop explosion

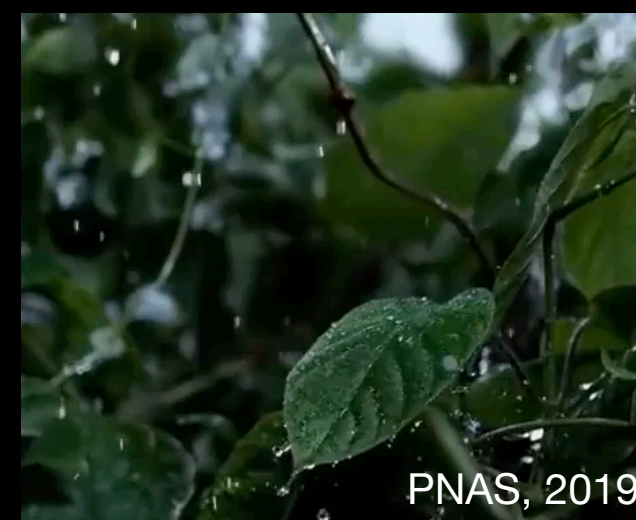


Film patterning



## Biofluids

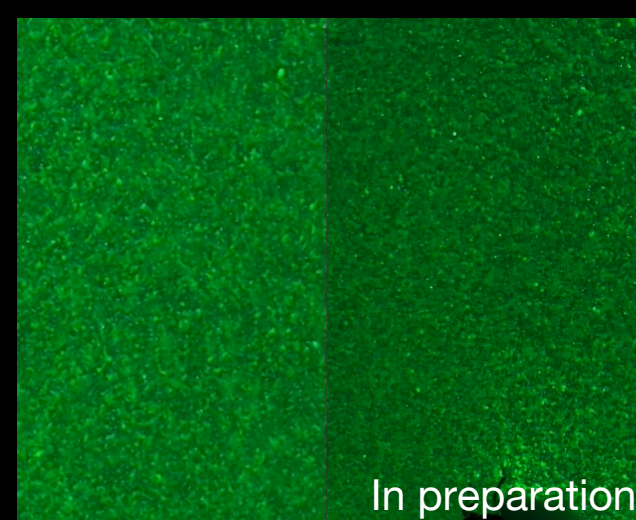
Biological surfaces



In-body droplets

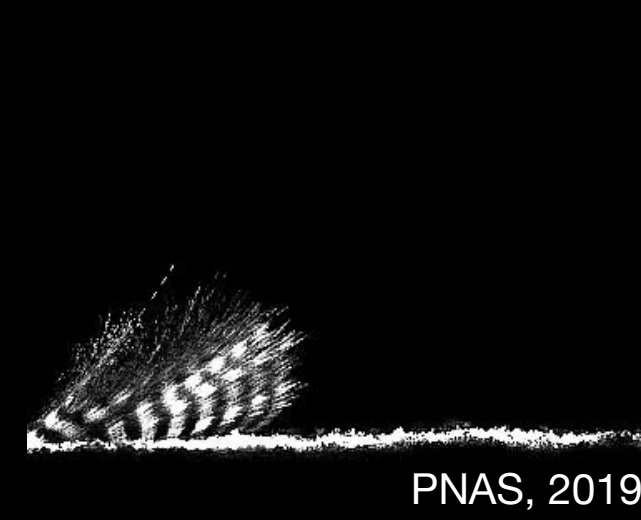


Locomotion



## Particles

Microtornado



Particle capture

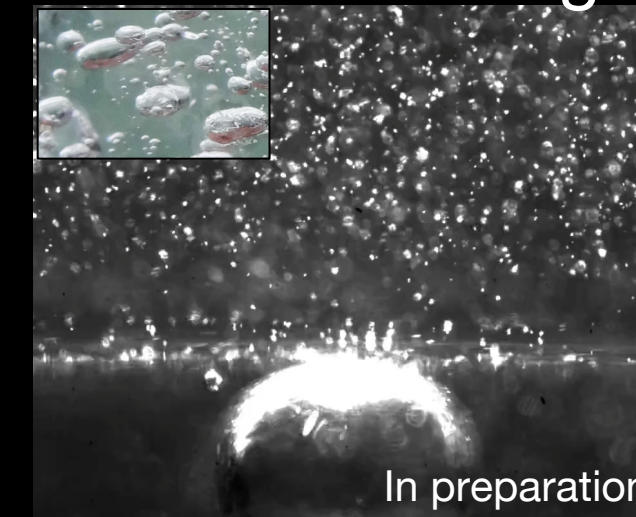


Marangoni assembly



## Ices

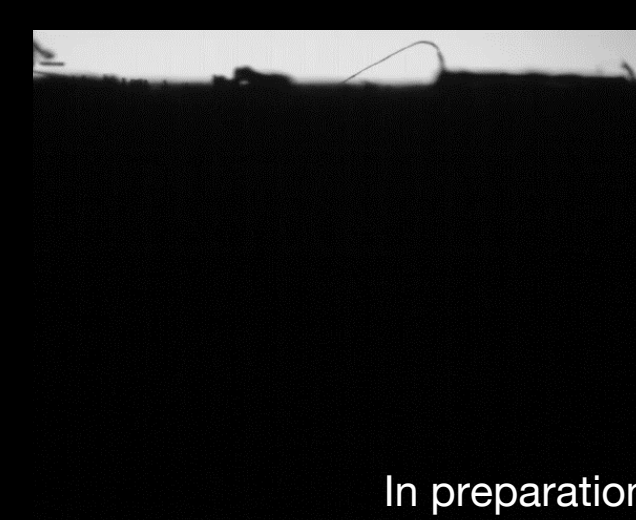
Glacier melting



Ice droplet



Ice adhesion

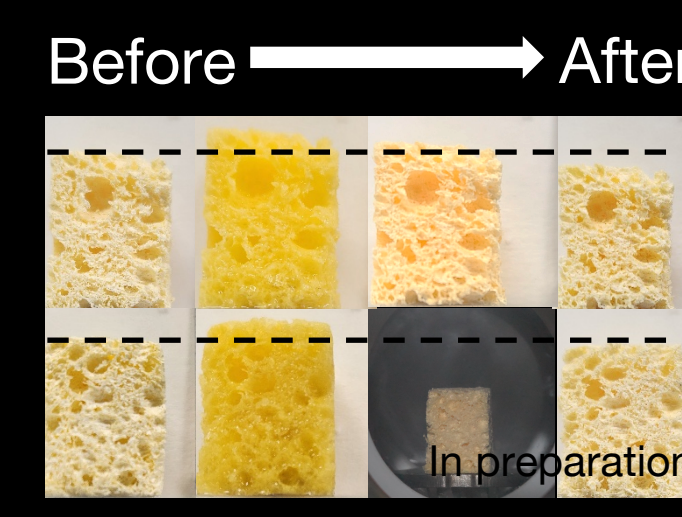


## Extreme conditions

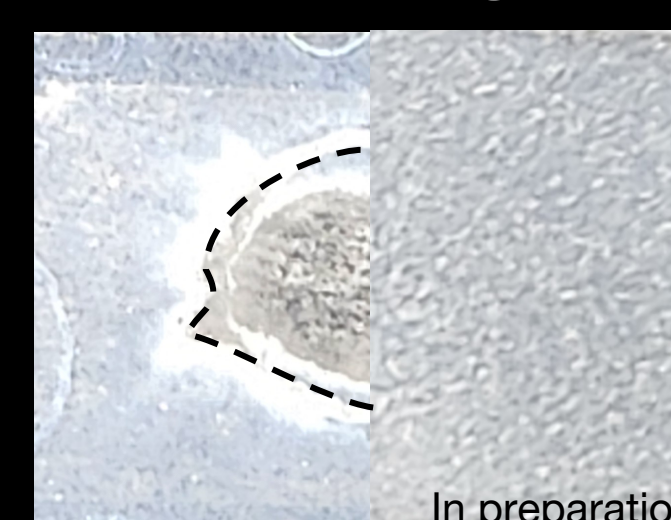
Zero interface



Microfabrication



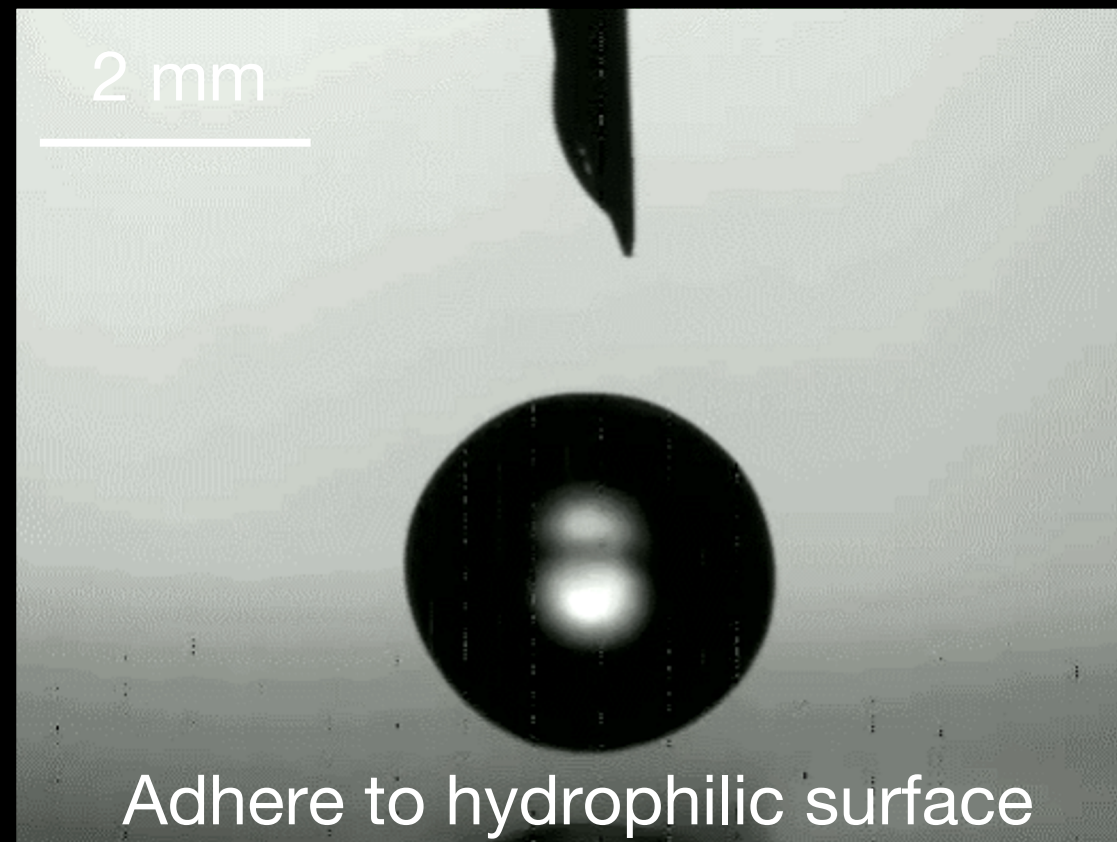
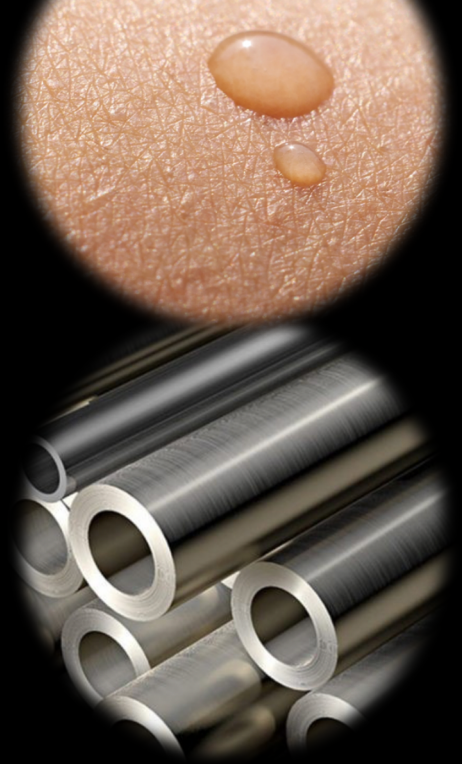
Coffee-ring-free



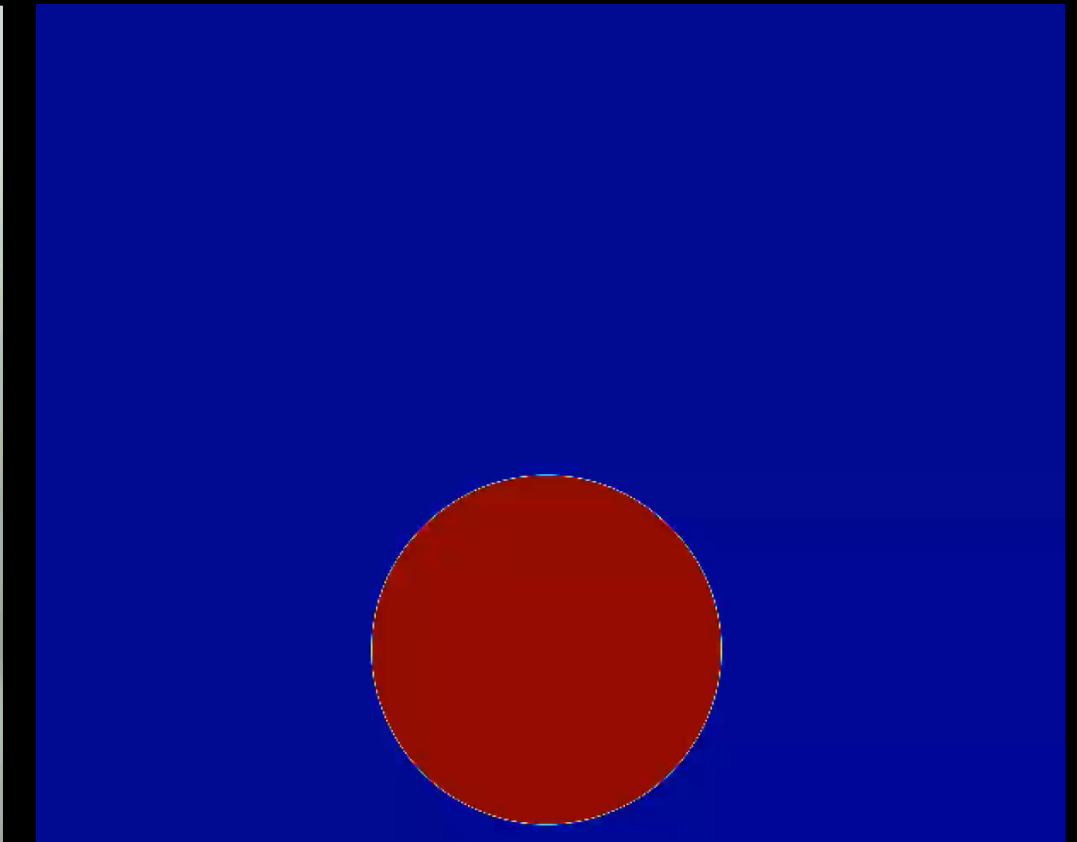
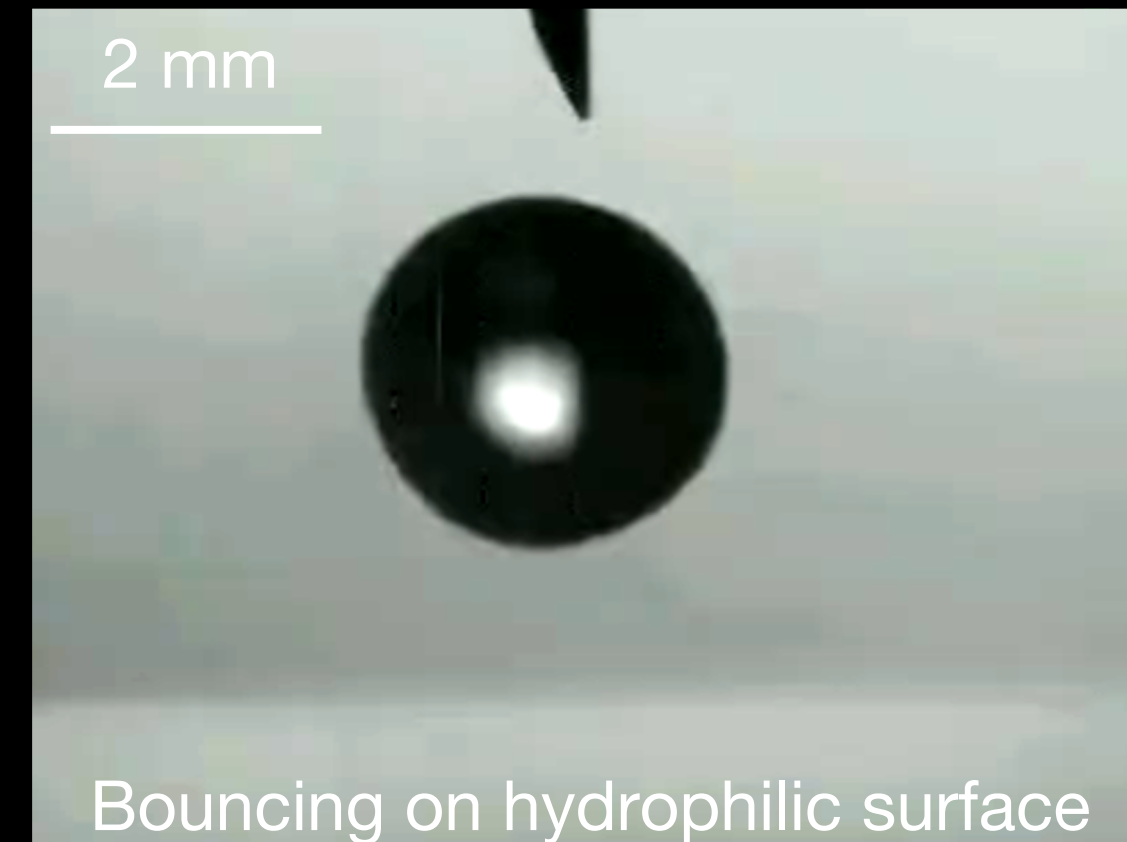
# Recent research (after PNU)

## Anti-wetting

Many surfaces:  
hydrophilic



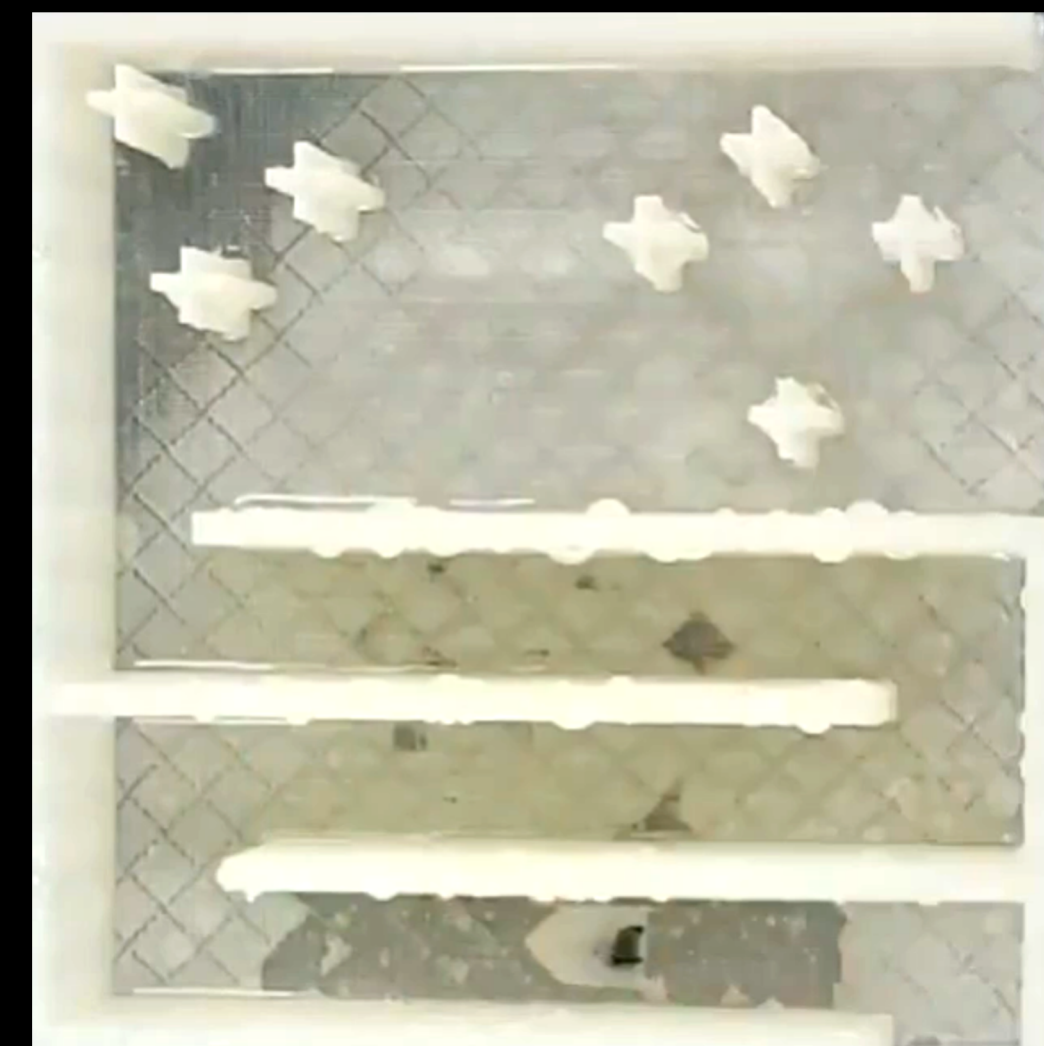
By supplying  
alcohol vapor



## Self-propelled actuator



Biomimetic

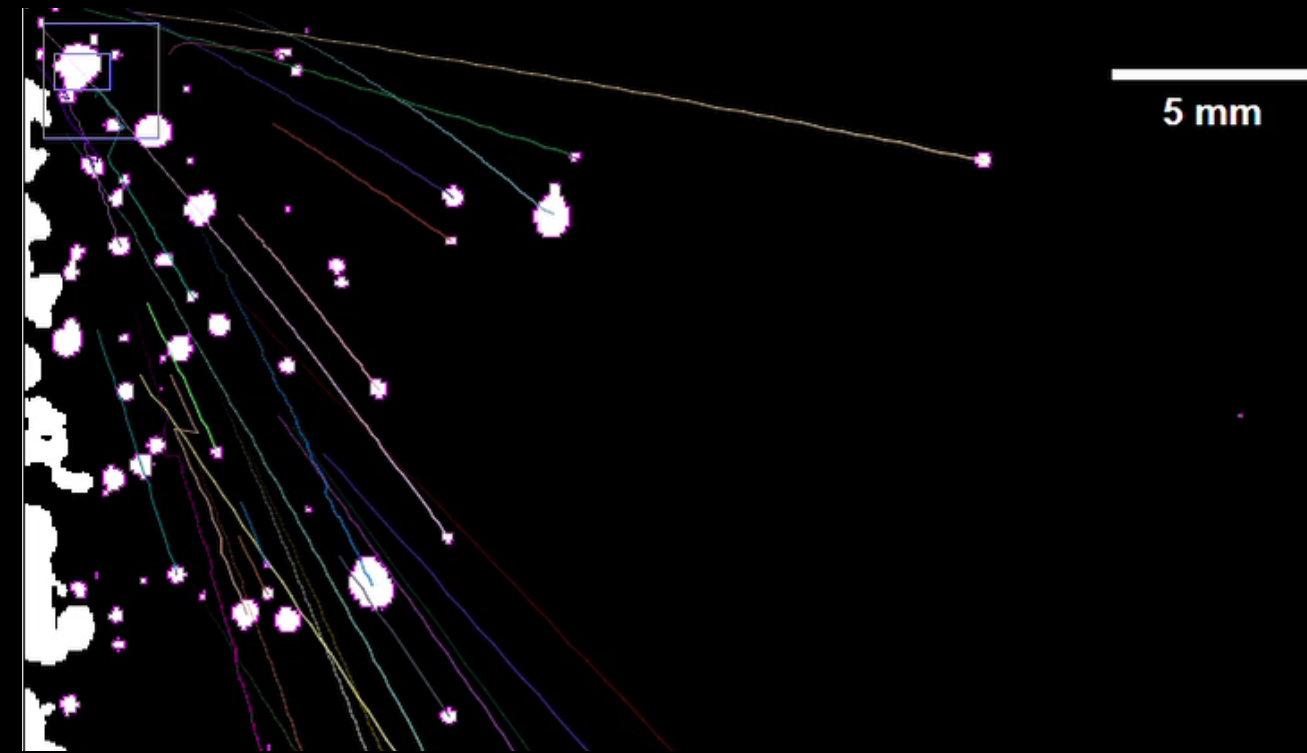


# Recent research (after PNU)

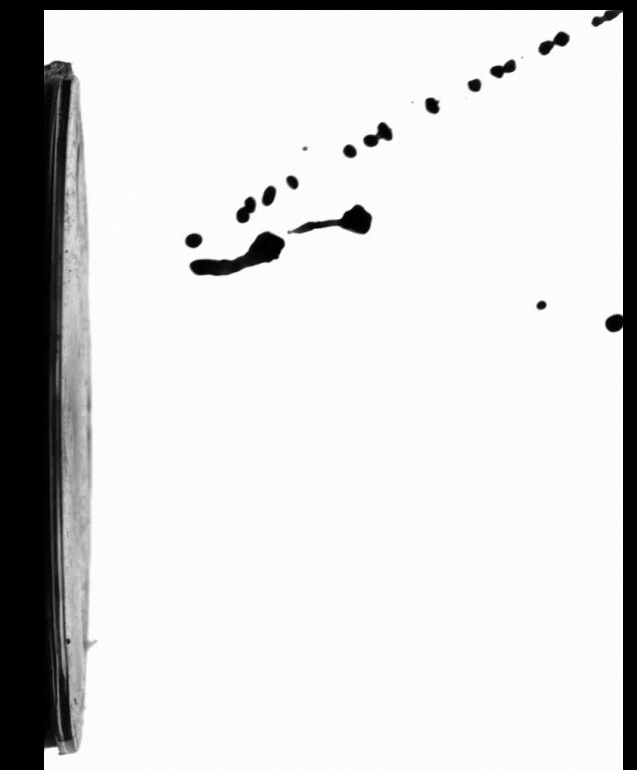
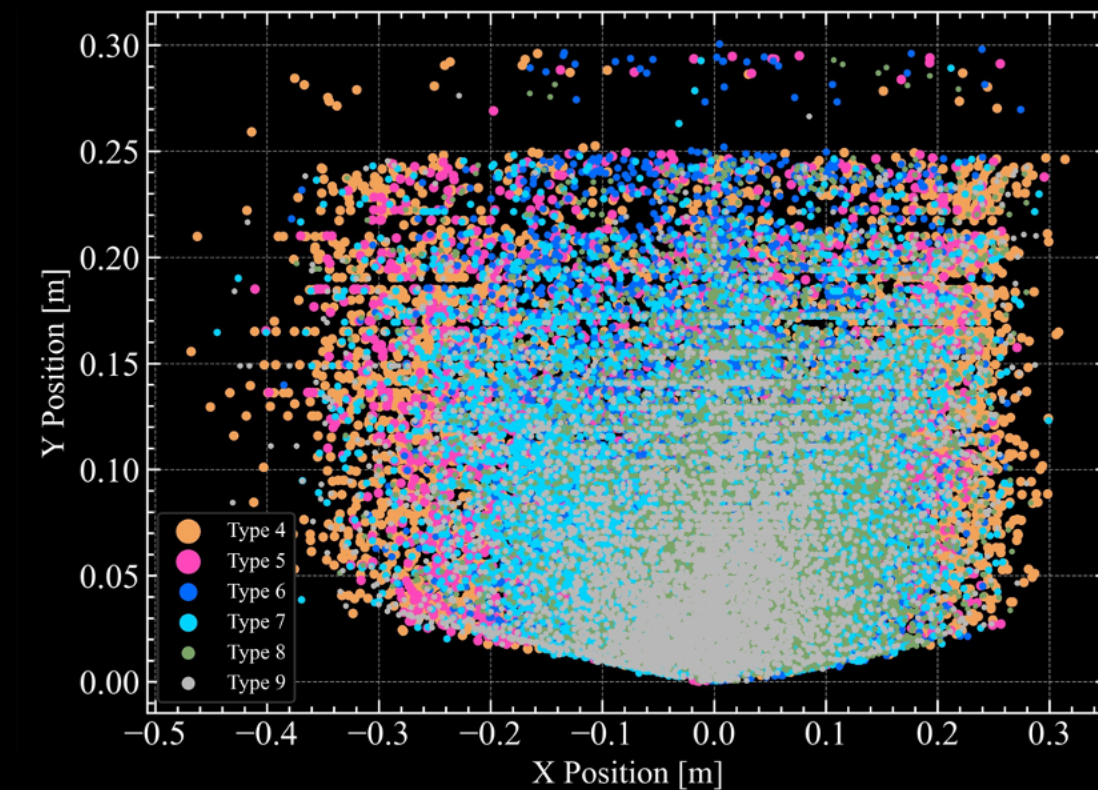
## Splash-free urinal



Urine Droplet Dispersion

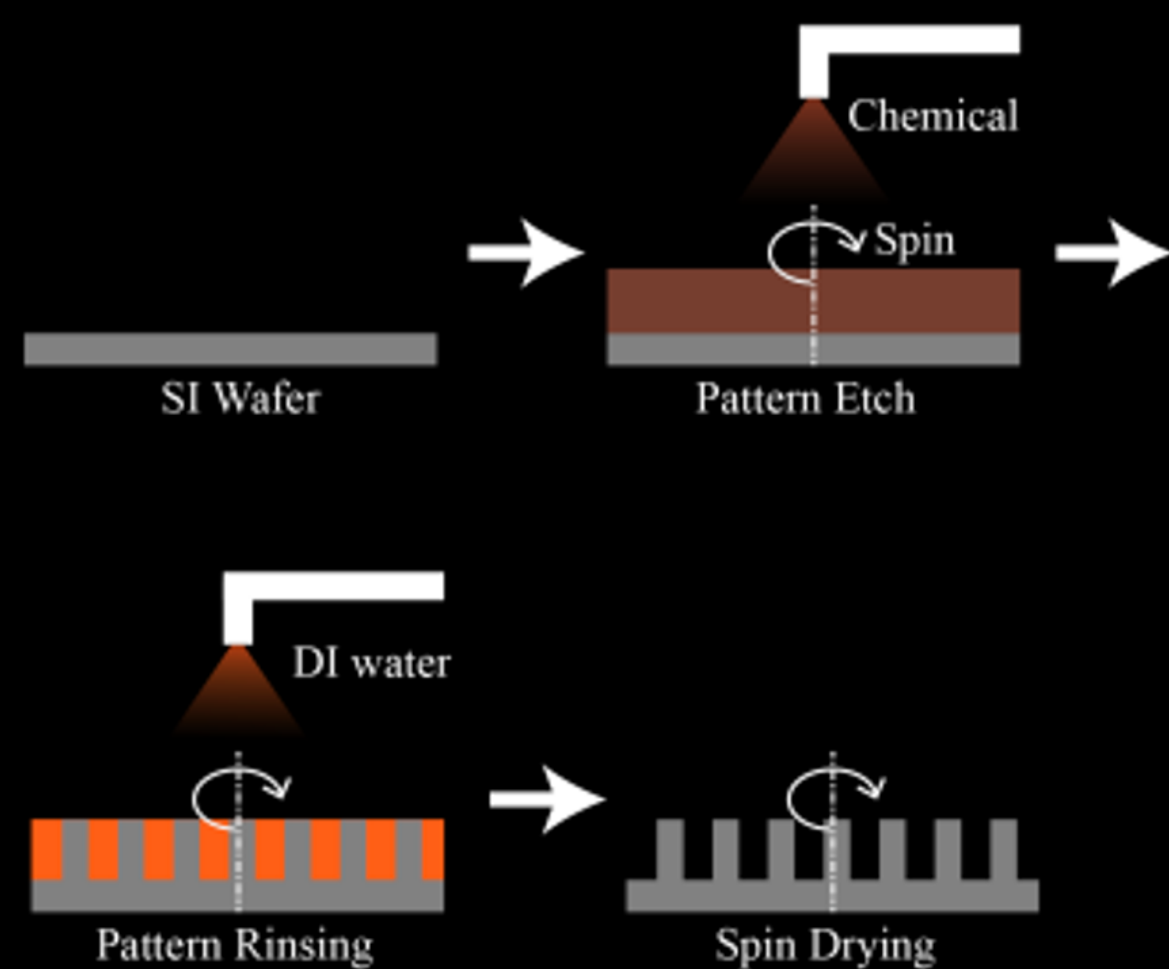


Fine-Droplet Tracking Algorithm and Quantification of Dispersion

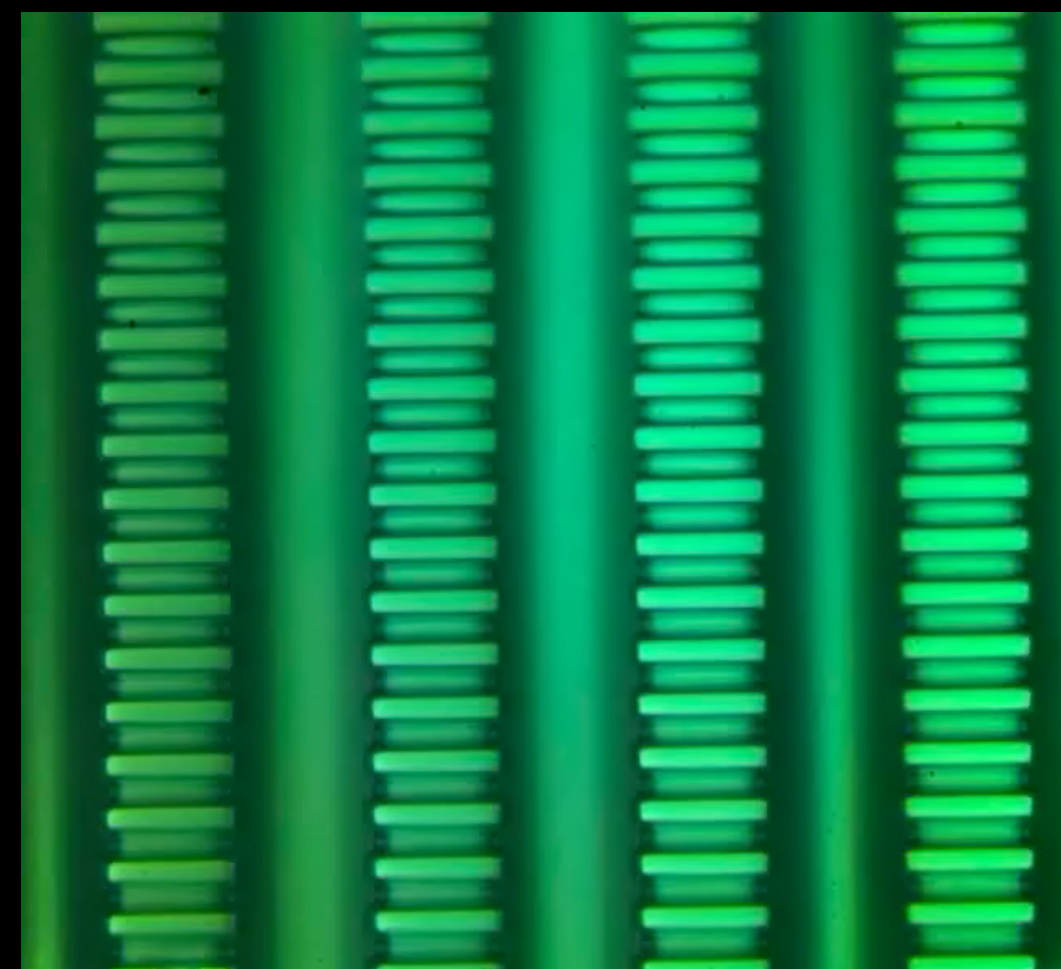


Splash-Reducing Urinal

## Semiconductor pattern fabrication



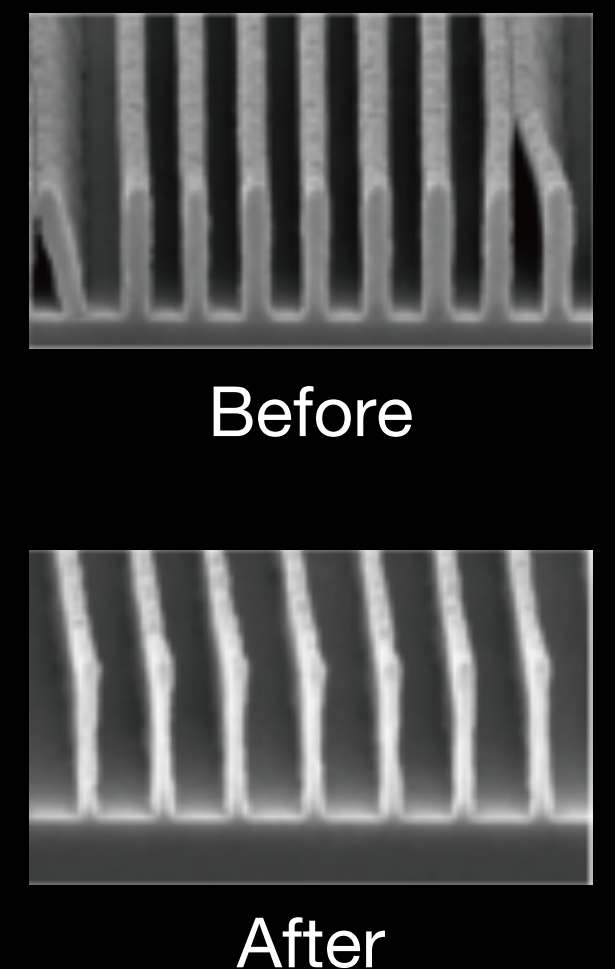
Wet etching schematic



Pattern collapse during rinsing



Implementation of supercritical drying



# Achievements

## Members

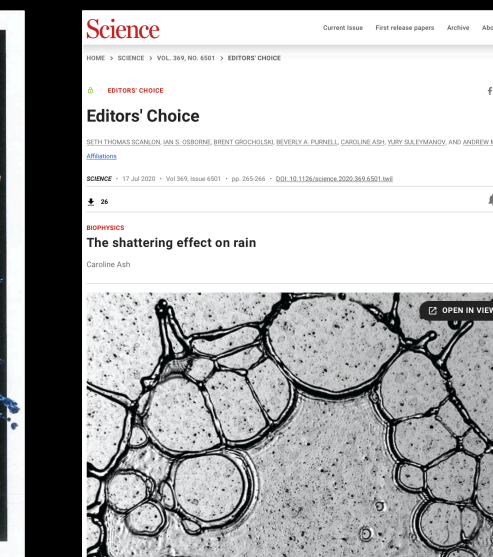
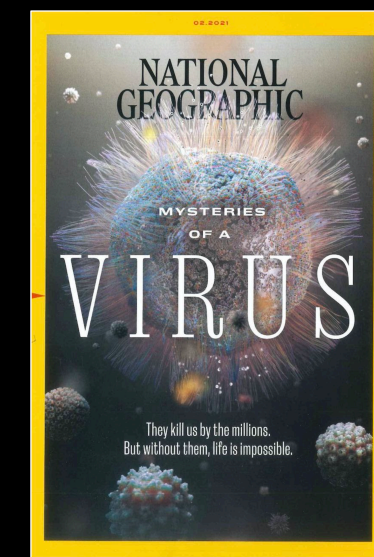
- PhD candidates: Jongsu Jeong, Taeyeong Park, Hyungjun Jung, Jaehyeok Bae
- Msc candidates: Keonwoo Jung, Jihyun Kim, Sangyoon Seong, Dogyun Oh
- We are recruiting undergraduate interns who are interested in pursuing graduate studies.

## Representative publications

- Coherent spore dispersion via drop-leaf interaction, *Science Advances*, 10 (2024)
- Mechanics of removing water from ear canal: Rayleigh-Taylor instability, *Journal of Fluid Mechanics*, 963 (2023)
- Experimental and numerical study on the thermal and hydraulic characteristics of porous-media heat exchangers in cryogenic conditions," *Applied Thermal Engineering*, 216 (2022)
- From an elongated cavity to funnel by the impact of a drop train," *Journal of Fluid Mechanics*, 921 (2021)
- Liquid spreading along nanostructured superhydrophilic lanes, *Physical Review Fluids*, 6 (2021)
- How a raindrop gets shattered on biological surfaces, *Proc. Natl. Acad. Sci. U. S. A.*, 117 (2020)
- Vortex-induced dispersal of a plant pathogen by raindrop impact, *Proc. Natl. Acad. Sci. U. S. A.*, 117 (2019)
- Dewetting of liquid film via vapour-mediated Marangoni effect, *Journal of Fluid Mechanics*, 872 (2019)
- Formation, growth and saturation of dry holes in thick liquid films under vapor-mediated Marangoni effect, *Physics of Fluids*, 31 (2019)

## Research funds

- Outstanding Young Researcher Program, NRF, 2025–2030, KRW 1.5 billion
- Regional Leading Research Center (RLRC), NRF, 2022–2027, KRW 0.6 billion
- SME Technology Innovation Development Program, TIPA, 2025–2027, KRW 110 million
- Industry-Academia Collaborative Research, LG Electronics, 2026–2027, KRW 60 million



# Many thanks!

