부산대학교 기계공학부
PUSAN NATIONAL UNIVERSITY
SCHOOL OF MECHANICAL ENGINEERING

Micro & Complex Fluids (MCF) Lab.

Mar. 19, 2024

Seungho Kim
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https://sites.google.com/view/skimpnu/

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

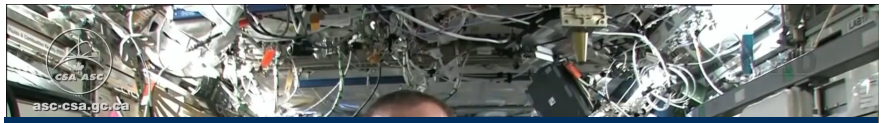
1 μm — Drop and thin film mechanics — 1 mm — 1 m

$F_{surface} > F_{body}$: Fluid interfaces ↔ liquid/air/solid

Surface tension

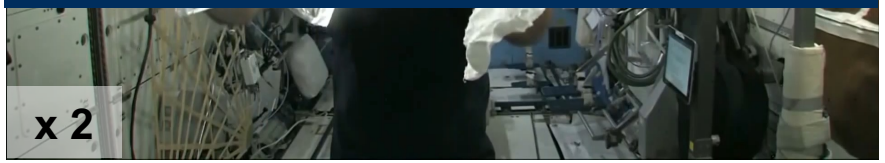
Tensile state like a stretched rubber band

Wringing out a wet washcloth in spaceship



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

You must handle liquids differently!



Capillary length $(l_c) = \sqrt{\frac{\text{Surface tension}}{\text{Density} \times g}}$

: Length scaling factor that relates gravity and surface tension

For water → 2.7 mm

Applications of microfluid mechanics

■Biological examples

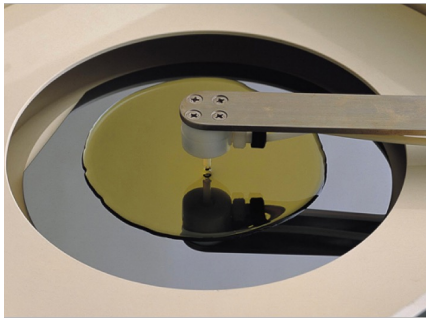
Underwater house

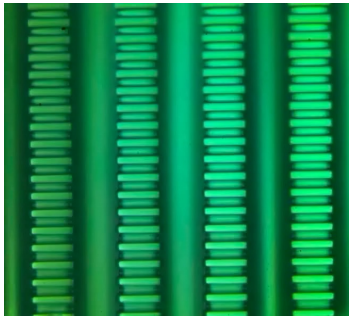
Walking on water

Water drinking to overcome gravity

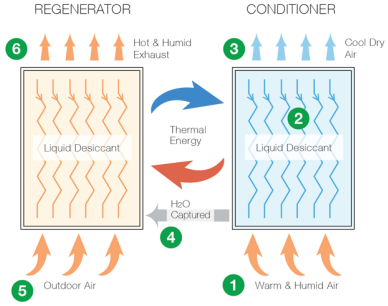
■Industrial examples

Semiconductor pattern drying

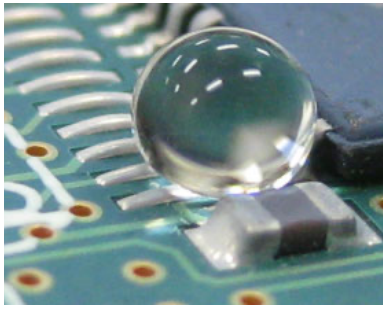




Liquid desiccant air conditioner

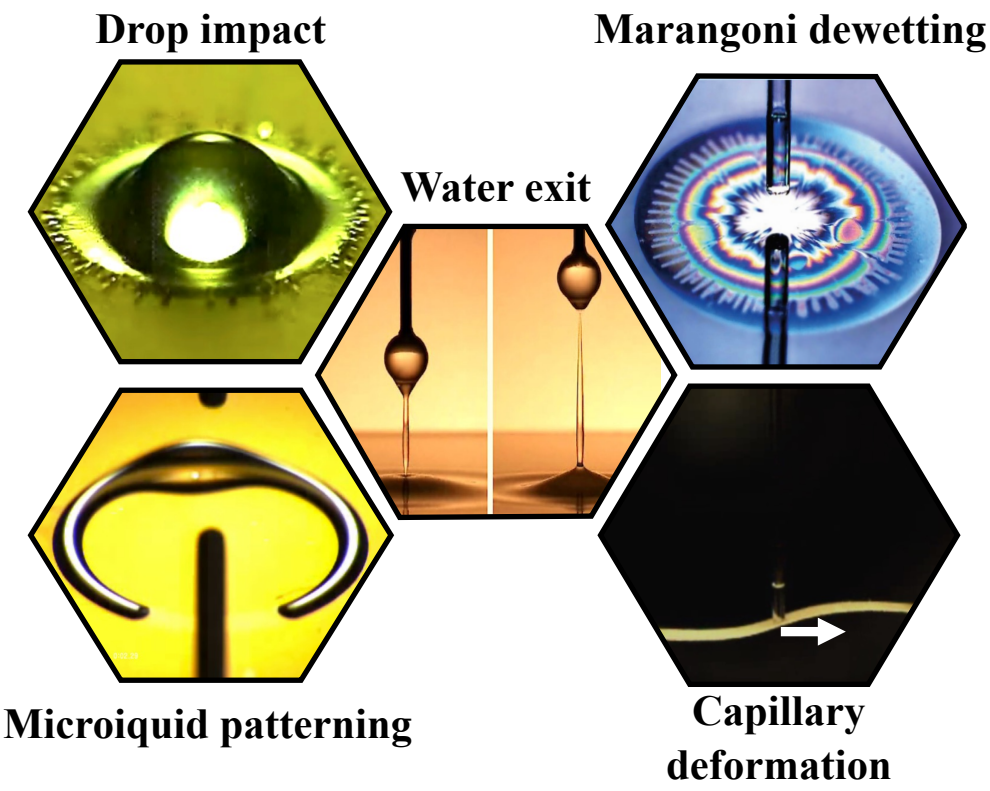


Water/oil-proof surface



Research interests

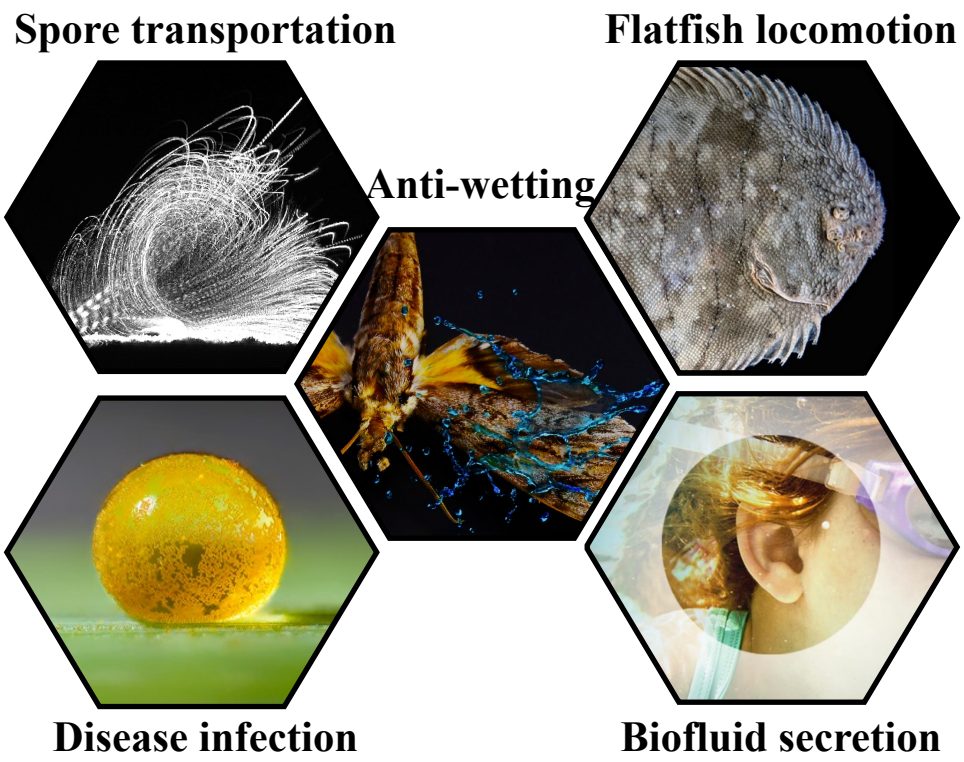
■ 미세스케일에서 새로운 유동 현상 가시화 및 수학모델 개발



- 미세 액적 충돌 역학 해석
- 기능성 액체 패터닝 기술
- 액체-기체 계면 거동 해석
- 최신 마랑고니 현상 연구
- 액체-고체 상호작용 역학

Research interests

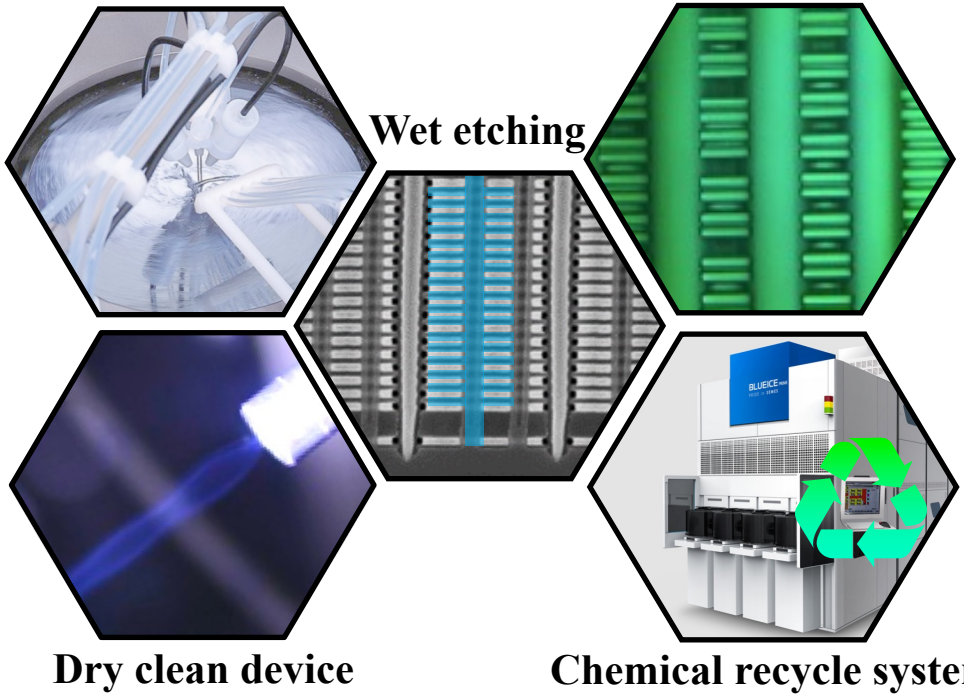
■ 동식물 생존전략을 유체역학 관점에서 해석, 자연모사기술 개발



- 비 의한 병균입자수송 메커니즘 해석
- 액적-생체표면 상호작용 역학 해석
- 물고기 수상 움직임 해석
- 체내 미세액적 분비 역학

Research interests

■ 반도체 패턴 세정 공정/장비개발



- 반도체 패턴 위 미세입자 세정기술
- 습식세정 공정기술 개발
- 웨이퍼 건조 중 패턴 붕괴방지 기술
- 고가 케미컬 재활용 기술 개발

Recent research (before PNU)

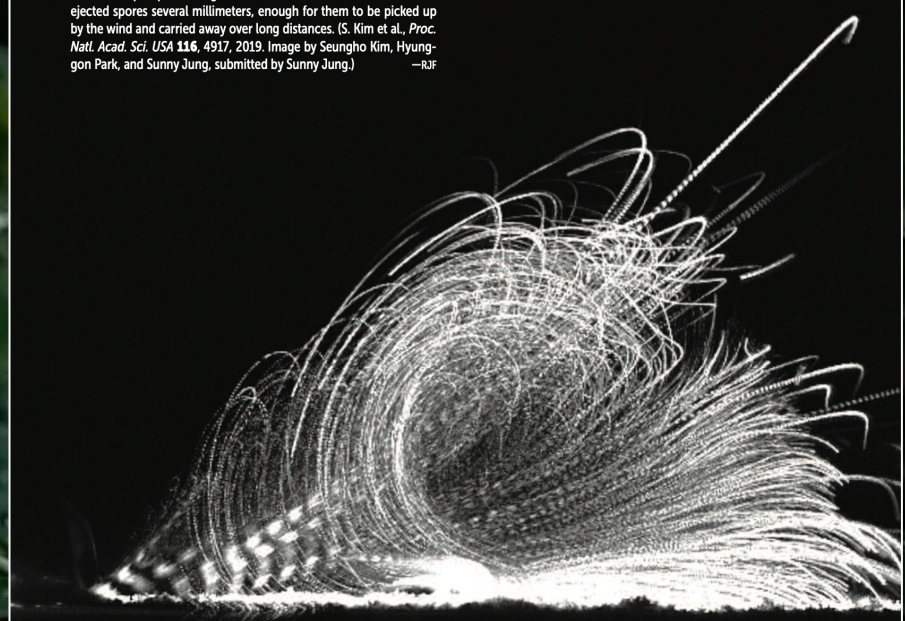
I. How do biological spores (<10 μm) get increased by rainfall?

BACK SCATTER

Spore vortex

The spreading of plant and fungal spores is of great importance to plant and animal health. Once lofted by the wind, the particles can travel anywhere from a few kilometers to thousands and even cross continents. Rainfall can goad the dispersal. When raindrops land on a spore-laden leaf, they spawn droplets that envelop some of the particles and carry them short distances. Cornell University's Sunghwan Jung and colleagues have now shown that raindrop-triggered transport is dominated by a second mechanism: dry-spore dispersal.

This image, created from several superposed high-speed video frames, captures raindrop-induced trajectories of glass beads, which the researchers used as surrogates for actual spores. After a raindrop hits the leaf surface, it starts to spread, and spores that get trapped at the advancing meniscus will collide with and eject other dry spores. The raindrop impact also generates an air vortex, which can lift the ejected spores several millimeters, enough for them to be picked up by the wind and carried away over long distances. (S. Kim et al., *Proc. Natl. Acad. Sci. USA* **116**, 4917, 2019. Image by Seungho Kim, Hyungon Park, and Sunny Jung, submitted by Sunny Jung.) —RJF



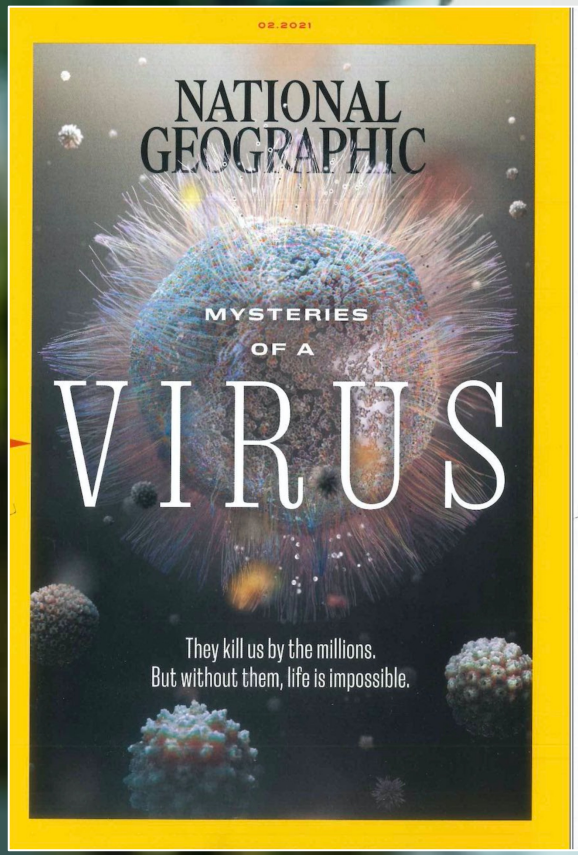
TO SUBMIT CANDIDATE IMAGES FOR BACK SCATTER VISIT http://contact.physicstoday.org.

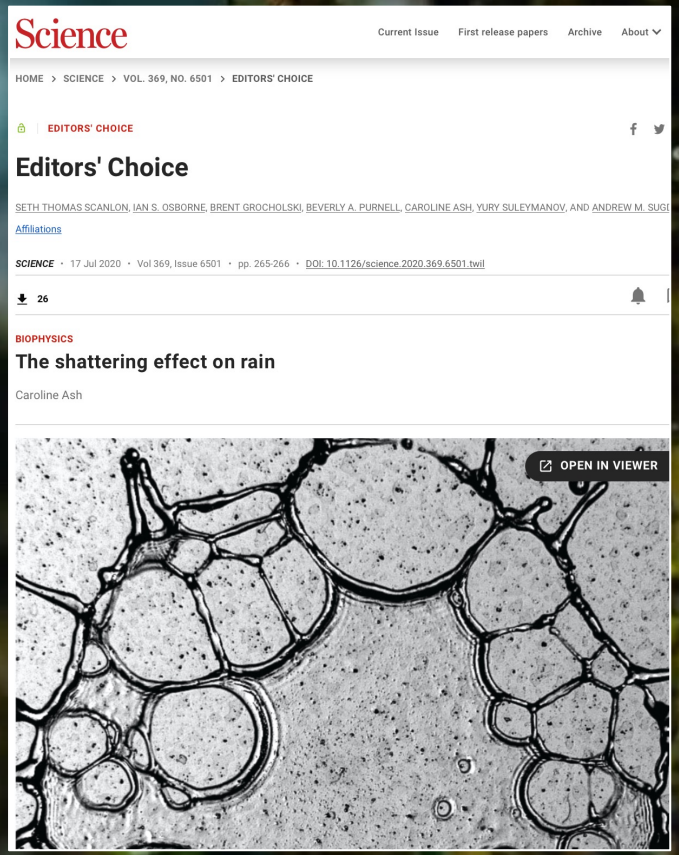
72 PHYSICS TODAY | JUNE 2019

S. Kim et al., *PNAS*, 2019

Recent research (before PNU)

II. How do biological species shed cold raindrops to avoid hypothermia risk?



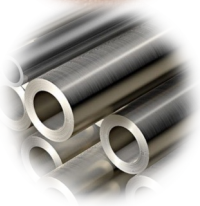


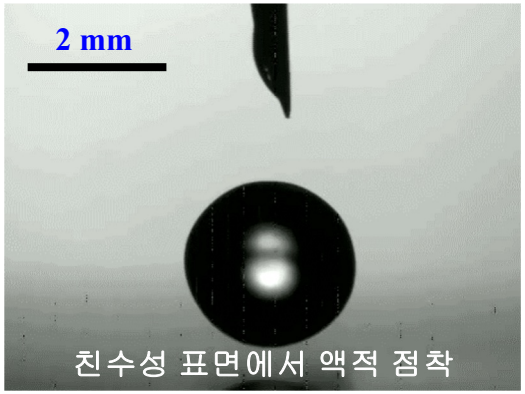
S. Kim et al., *PNAS*, 2020

Recent research (after PNU)

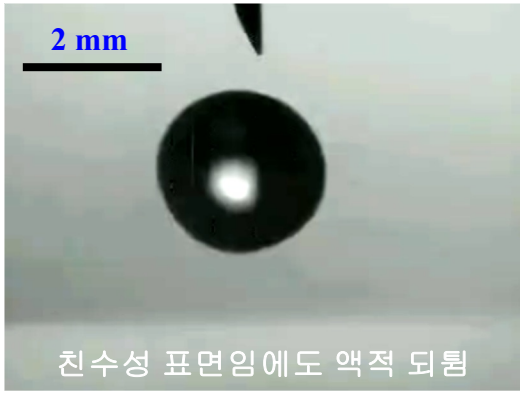
- **Anti-wetting coating**

대다수 표면
: 친수성





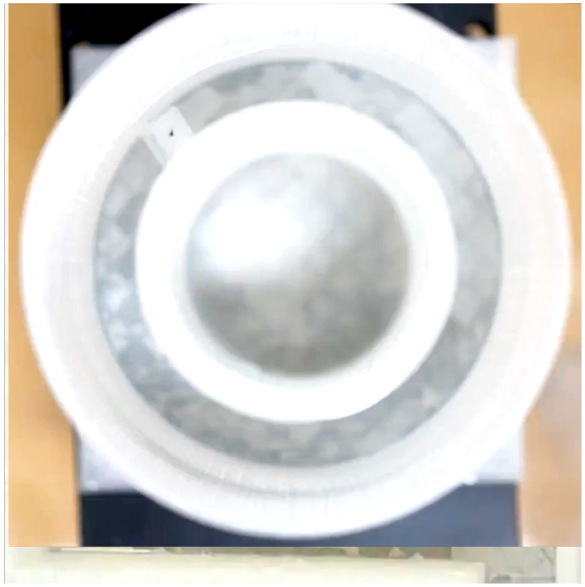
알코올
증기 공급



응용분야
: 젖음 및 얼음 방지

- **Self-propelled actuator**

생체모방

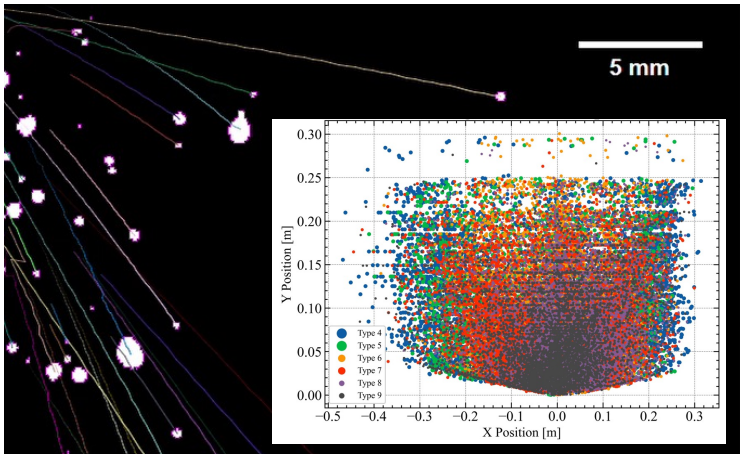


응용분야
: 소형탐사정, 수질측정

Recent research (after PNU)

- **Splash-free urinal**

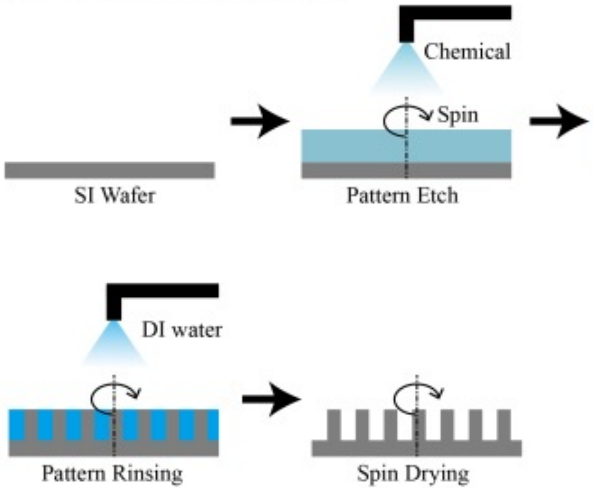
소변액적비산 가시화



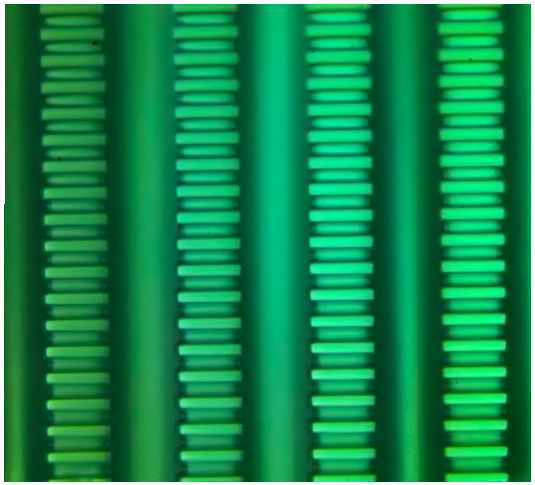
미세액적 추적알고리즘 개발 및 표면 별 비산정량화

비산억제 소변기 실증

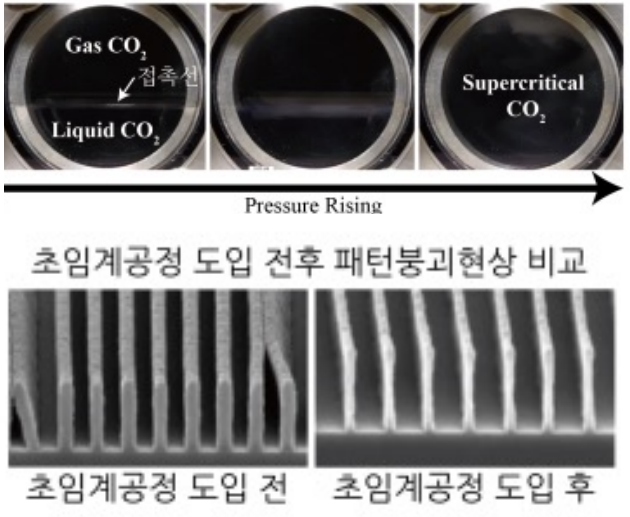
- **Semiconductor pattern drying using supercritical CO_2**



Wet etching 모식도



Pattern rinsing 과정 중 패턴붕괴



초임계 건조공정 도입

Achievements

■ 대표 연구 실적 (최근 5년)

- 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)