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## Education

- \* 2011.03 – 2014.02 Dongyang High School
- \* 2014.03 – 2018.02 Yonsei University, B.S. in Physics
- \* 2018.03 – 2025.02 **Seoul National University (SNU), Ph.D. in Physics**

## Publication List (First Author)

A progressive wafer-scale approach for sub-10-nm nanogap structures

Cha, Jongjin, et al., *Scientific Reports* (**under minor-revision**)

: Development of a large-area fabrication method for sub-10 nm nanogaps with advantages including compatibility with various metals, enhanced structural stability, avoidance of advanced equipment, and flexible patterning.

High-throughput single-molecule imaging system using nanofabricated trenches and fluorescent DNA-binding proteins

Kang, Yujin, et al., *Biotechnology and Bioengineering* 117.6 (2020): 1640-1648.

: Development of a novel DNA curtain assay platform featuring nano-fabricated trenches on a quartz substrate. **[Co-first author]**

A novel high-throughput single-molecule technique: DNA curtain

Cha, Jongjin, and Ja Yil Lee., *Journal of the Korean Physical Society* 78 (2021): 442-448.

: A review of the working principles, technical details, and applications of the DNA curtain technique, a type of single-molecule approach aimed at elucidating the detailed mechanisms underlying DNA metabolic processes.

## Publication List (Co-Author)

Defining the zerogap: cracking along the photolithographically defined Au–Cu–Au lines with sub-nanometer precision

Kim, Sunghwan, et al., *Nanophotonics* 12.8 (2023): 1481-1489.

: Development of a novel zero-gap fabrication method on flexible substrates.

## Ongoing research

Redox cycling in a nanogap electrochemical cell: As the distance between two electrodes in electrochemical experiments narrows to within tens of nanometers, the behavior of molecules within the electrodes can no longer be explained solely by classical mechanical models. Utilizing advanced nanogap fabrication techniques, I am making an electrochemical cell with a precisely defined gap of less than tens of nanometers.

Optical rectification in near-IR bands using nanogap rectenna: Demonstration of rectenna operation in the near-infrared region, paving the way for next-generation energy harvesting devices that overcome the limitation of solar power generation through the straightforward implementation of sub-5 nm nanogap.

Mass production of optical sensors featuring ultra-narrow nanogap: Demonstration of the fabrication and operation of diablo nanoantenna arrays incorporating sub-5 nm nanogap for chemical molecule detection. The study highlights the potential for mass production of sensors incorporating positive antennas operating across various spectral ranges.

## Experience in Nanofabrication

Process Design: Determining specific fabrication processes, designing optimization strategies, troubleshooting errors, and finding related literatures to realize target devices within the constraints of limited infrastructure. I contributed to projects such as large-area, high-yield sub-10 nm nanogap fabrication, a reusable DNA curtain assay platform with nano-fabricated trenches, and zerogap fabrication on flexible substrates.

Optimization of Individual Process Parameters:

- Photolithography: Optimization of parameters through cross-sectional analysis - Suitable resist type and specific model, spin-coating conditions, heating protocols, exposure energy, and development conditions.
- Atomic layer deposition (ALD): Ensuring uniformity through wafer-scale ellipsometry measurements - Chamber temperature, purge time, TMA and H<sub>2</sub>O source exposure times, and Ar gas pressure.
- Argon (Ar) ion beam etching: Optimization of parameters through cross-sectional

analysis - Etching angle and duration, plasma generation conditions including RF power, sample cooling temperature, post-etch cooling protocols, and sample fixing methods.

List of Available Equipment for Direct Use:

- Measurement Equipment: Atomic force microscope (AFM), ellipsometer, electron microscopes (FE-SEM/Compact SEM), energy dispersive spectroscopy (EDS) elemental analysis, Terahertz time-domain spectroscopy (THz-TDS)
- Processing Equipment: Reactive ion etcher (RIE), Ar ion beam etcher, O<sub>2</sub> plasma etcher, i-line contact-type mask aligner, atomic layer deposition (ALD), electron beam (e-beam) evaporator, Au/Pt sputtering coater, e-beam and ion-beam direct writing

## Presentations

### Oral

Advanced Method for Scalable Fabrication of Sub-10 nm Nanogaps with High Yield

2023 KPS Fall Meeting, Changwon, Korea

**[Best oral presentation award]**

### Poster

Fabrication of reusable diffusion barriers for DNA curtains assay using H-SiQ negative tone EBL resist and its cleaning method

2022 KPS Fall Meeting, Busan, Korea

SU-8 photoresist processing for freestanding nanogap structure fabrication

BUG 2022 (KPS), Korea

Improvement of DNA Curtain Assay Using Concave-Barrier Slide and Fluorescent Protein-DNA Binding Protein (FP-DBP)

2019 KPS Fall Meeting, Gwangju, Korea

**[Best poster presentation award]**