The Role of National Nano Fab Center

- Advancing nanotechnology research, Education and commercialization in Korea

The 19th Korea-U.S Forum on Nanotechnology

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NANO 나노종합기술원
NATIONAL NANOFAB CENTER

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Who We Are

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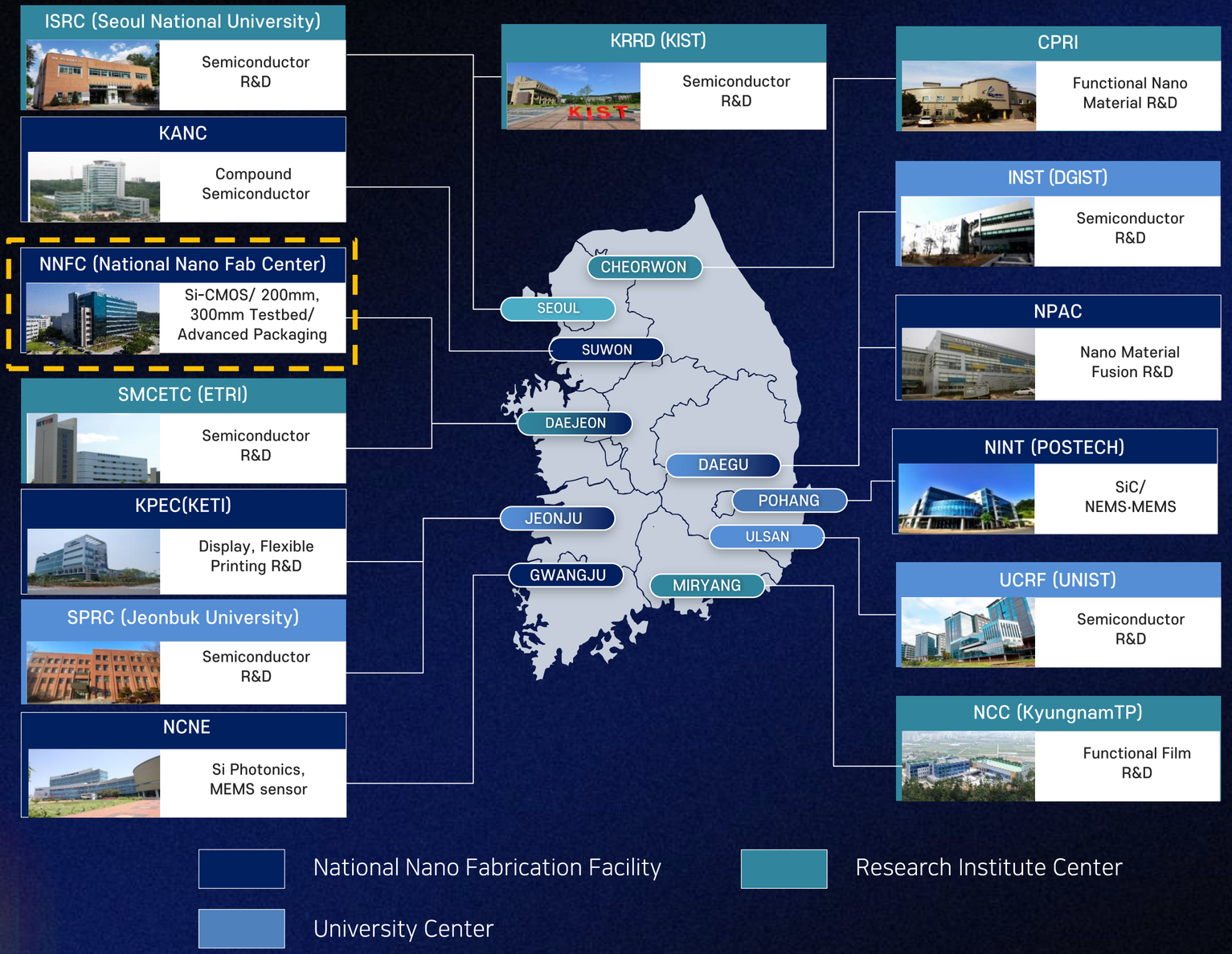
01

"Who We Are"

Public and University Nanofabrication Facilities in Korea

[Korea Infrastructure Organization for Nanotechnology]



01

"Who We Are"

National Nano Fab Center(NNFC)

- Basis of Establishment
. Nano Technology Development Promotion Act (Article 11, 2002)

- Established in 2004
. Affiliated with Korea Advanced Institute of Science and Technology

- Affiliated with the Ministry of Science and ICT in 2014
. Became a national R&D facility for advancing nanotechnology

- Expanded the testbed platform from 200mm to 300mm
. Invested in 12-inch Fab equipment investment (~50B ₩) in 2019
. Designated as Advanced Packaging Development Hub (~50B ₩) in 2024

- Collaboration with Top global R&D centers
. Joint technology MOU with NY CREATES (2024)
. Memorandum of Cooperation with imec (2025)

2002. 7 Establishment of the NNFC @ KAIST Campus

2004. 5 Affiliated Institution of KAIST

2014. 1 Inclusion under the Ministry of Science, Technology & ICT

2019. 12 Designation as N-Facility (in the Nano-Semiconductor Field)

2021. 2 Established 12inch Testbed for nano-semiconductor

2024. 3 Signed the Joint Technology Collaboration MOU with NY Creates(USA)

2024. 5 NNFC cele-bration of 20th anniversary & international forum

01

"Who We Are"

National Nano Fab Center(NNFC)

Enabling Act

Article 11 of Nano Technology Development
And Promotion Act(Korea)

Mission

"The Service Provider for Advancing Nanotechnology"

① Promoting the joint use of nano-facility between industry, academia, and institutes

② Fostering engineers & college students through training programs in cutting-edge facilities

③ Commercializing research outcomes & Supporting small and venture companies

Main Service Domain

- ❖ Testbed Service (8-inch 12-inch) and Logic CMOS Fabrication (0.18um 8-inch MPW)
- ❖ Nano-biosensor/chip fabrication
- ❖ Semiconductor and Display convergence technology platform
- ❖ MEMS sensor fabrication
- ❖ Analysis and measurement service
- ❖ Semiconductor-Micro Solid State Battery Interfacing Platform
- ❖ Silicon Quantum Device fabrication

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02

What We Have

02 "What We Have"

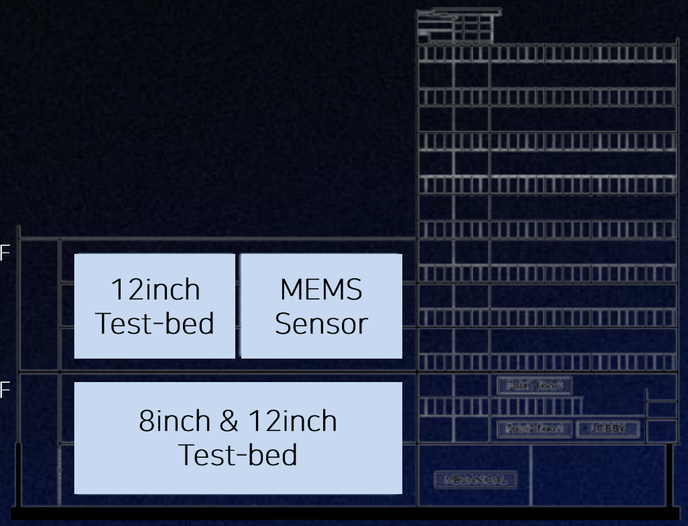
NNFC's Facility

Total Area 26,446㎡

Research Building
B1~ 9F(16,585㎡)

Fab Building
2F(4,989㎡)

Central Utility Building
B1~ 4F(4,620㎡)



Fab(1 floor) 2,500㎡

Area
- 12-inch test-bed : 248㎡
- 8-inch test-bed : 2,231㎡

Fab(2 floor) 2,500㎡

Area
- 12-inch test-bed : 992㎡
- MEMS Sensor (8-inch) : 992㎡

Equipment

8-inch

- Contact aligner, I-line stepper, KrF, ArF, E-beam patterning
- ArF Dry Scanner : Twinscan Dual-stage 70nm resolution(NA 0.85)
- Providing highly efficient processes through Mix & Match techniques

12-inch

- ArF Immersion(40nm for line & space) and its double patterning(20nm)
- Stitching for large area covering & its application ; Wire Grid Polarizer
- Hole patterning with only 1 mask(40 ~ 18 nm)

Semiconductor manufacturing service

- Fully equipped 8-inch processes and partially equipped 12-inch processes
- High quality support and collaboration by a well-experienced in-house experts
- Equipment open to use by qualified engineers from customers

02

“What We Have” – Fab Layout

‘The First Floor’

- Mainly 8-inch full process(180nm),
- 12-inch patterning(ArF I-Scanner), Inspection
- Testbed, MEMS, etc.

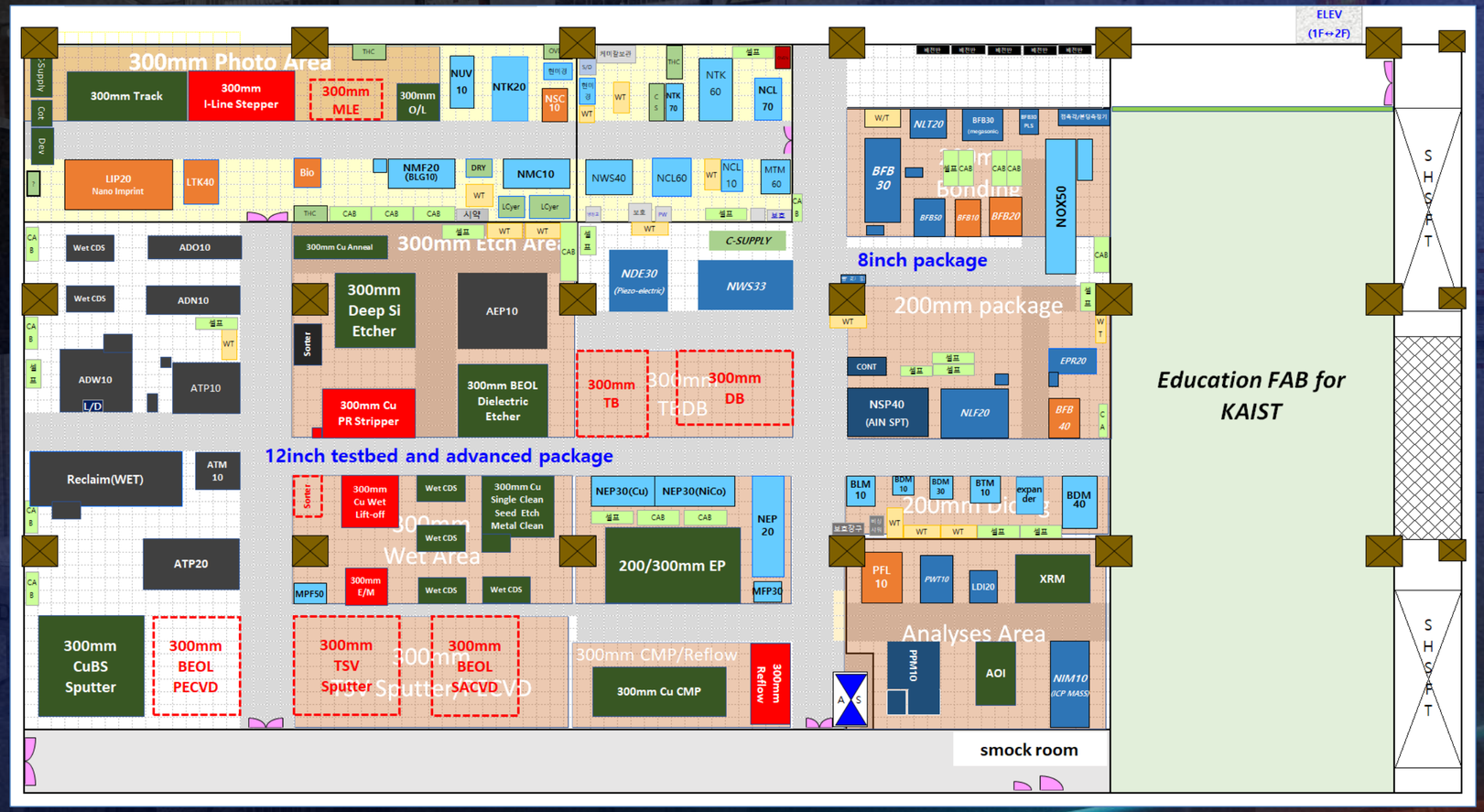
As of 30 June 2025

02 “What We Have” – Fab Layout

‘The Second Floor’

- Testbed for 12-inch Equipment (Etch, Diffusion, T/F, etc.)
- 12-inch-based Advanced Packaging(in preparation)
- 8-inch-based Sensor

As of 30 June 2025



✓ Expansion to 12-inch advanced packaging by 2029

02 “What We Have” – Equipment

8-inch Semiconductor Manufacturing Service

Total Equipment : 171 units

Photolithography & Etch

1x Lithography
- Contact Aligner (EV Group)
- Mask Generator (Heidelberg)

Contact Aligner, Mask Generator

4x(5x) Lithography
- ArF Scanner (ASML)
- KrF Scanner (ASML & Nikon)
- I-line Stepper (Nikon)

ArF Scanner, KrF Scanner, I-line Stepper

Metrology
- CD SEM (Hitachi)
- Overlay (KLA-Tencor)
- Particle Counter (KLA-Tencor)
- Defect Inspection (NEXTIN)

CD SEM, Overlay, Defect Inspection

Oxide Etcher
- Dielectric Etch
  - SiO2, Si3N4, SION...
  - HM, Spacer, Contact, SAC...
- PR Stripper
  - O2 Plasma PR Strip

Dielectric Etcher [Lam Research, TEL]

PR Stripper [PSK]

Poly & Metal Etcher
- Poly Etcher
  - Si Substrate, Poly-Silicon Etch
- Metal Etch
  - Ti, TiN, Al, W, TaN
  - Ni, Au, Pt, W, Al...

Metal Etch System [Lam Research, AMAT]

Metal Etcher [Oxford]

DRIE
- DRIE (Deep Reactive Ion Etch)
  - Bosch Process, TSV Etch

Deep Si Etcher [Gigalane, SPTS]

Diffusion

Diffusion Furnace
- Wet Oxidation
- Dry Oxidation
- Forming Gas Anneal (H2)
- High & Low Temp. Anneal

Furnace System [Centrotherm]

Ion Implantation & RTP
- High Energy Ion Implantation
- High Current Ion Implantation
- Medium Current Ion Implantation
- Spike Rapid Thermal Process
- Rapid Thermal Process

Ion Implantation & RTP [Axcelis, AMAT & Metron]

Cleaning Process
- Pre-metal Cleaning
  - HF, BOE, SC1, SPM, H3PO4...
- Post-metal Cleaning - Solvent...
- MEMS Wet Process
  - SC1, BOE, SPM,NH4OH, KOH...

Wet Station [HIT]

Laser Anneal System
- Laser Source : Nd:YAG Green laser
- Wavelength : 532nm
- Max Pulse : 400mJ
- Pulse Stability : ±3%
- Beam Size : 5*5㎟

Laser Anneal System [DIT]

LP-CVD System
- LPCVD TEOS/Nitride
- LPCVD Poly-Si & a-Si
- LPCVD Doped Poly-Si (Ph3)
- LPCVD Low Stress Nitride

LP-CVD System [Centrotherm]

CMP System
- Oxide/Poly-Si CMP
- Cu Barrier & Seed Metal CMP
- W Barrier & Seed Metal CMP
- CMP Brush Cleaning / Chemical Cleaning

CMP System [Doosan DND & CTS]

Thin-film

Thin-Film @ PECVD
- PECVD
  - SiO2, SiN, SiON
  - PE-TEOS
  - BPSG, PSG, BSG
  - a-Si, ACL (Amorphous Carbon Layer)

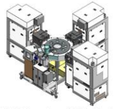
PECVD System [Lam Research, AMAT, TES]

Thin-Film @ Metal
- Sputter
  - Al & Cu Metal Interconnection
  - Multi-Target Sputter & Evaporator
- Tungsten(W) CVD Plugging
- Electroplating – Cu, NiCo...

Sputter & W CVD [AMAT, Sorona, KVT]

Electroplating [EEJA]

Thin-Film @ ALD
- ALD (Atomic Layer Deposition)
  - High-k Materials
    Al2O3, HfO2, ZrO2, TiO2, Ta2O5
  - Dielectric : SiO2 ...
  - Metal & Nitride : TiN ...



Multi-Chamber ALD System [CN1]

Sawing @ Package
- Stealth Laser Dicer
  - Only Si wafer ≤ Ø200mm
  - Dynamic focal point system
  - Completely dry process
- Blade Dicer : Si & Glass Saw

Stealth Laser & Blade Dicer [DISCO]

Die Separator
- Die Separator
  - DAF / UV Film applicable
  - Cooling Chamber : Min.-15℃
  - Heating Module : Max. 250 ℃
  - 300mm wafer available

Die Separator [DISCO]

Multi-Chamber CVD
- PECVD
  - Multi Frequency TEOS USG
  - ACL(300℃,400℃.550℃)
- SACVD
  - BPSG, PSG, USG

Multi(PE & SA)CVD System [AMAT]

- 8-inch-based CMOS integrated device platform – 180nm Logic CMOS technology
- Unit, module, and integrated process services based on 180nm CMOS full process

02 “What We Have” – Equipment

12-inch Semiconductor Manufacturing Service Total Equipment : 21 units

Photolithography

ArF Immersion Scanner

TWINSCAN XT1900Gi @ ASML

- Single-Wafer Processing with In-Line Track
- 1.35-NA 193nm Projection Lens
  - Resolution down to 45nm(annular)
- Immersion Dual-Stage Technology
- AERIAL XP Polarized Illuminator
- 6-kHz ArF Laser Technology

Auto Track System

Lithius-Pro-i @ TEL

- 4 Loadports, Process coater / developer
- Immersion Top-coat Process
  - ITC & ITR (Top-Coat Coater & Remover)
- Develop Process (Alkali soluble)
- Wafer Rinse process (SRS & PIR)
  - SRS/PIR : Pre/Post Exposure Rinse

CD-SEM

CG6300 @ Hitachi

Thickness Measuremen

Spectra FX 200 @ KLA

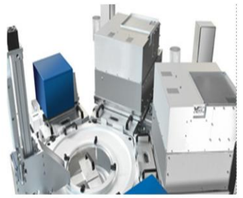
Defect Inspection

AEGIS @ NEXTIN

Dry Etch

Dry Etcher @ Oxide/Poly

2300e5 Platform Flex GX @ Lam Research



- 2 Loadports, TCP type plasma source
- Dielectric dry etch system
  - Low-k and ultra low-k dual damascene
  - Self-aligned contacts
  - Capacitor cell, Mask open
  - 3D NAND H/R hole, trench, contact

PR Stripper

SUPRA N @ PSK

- 3 Loadports, Single-Wafer Processing
- 2 PM with FCIP R3 Plasma source
  - High strip rate by ATM wafer heating
  - PR removal with low plasma damage
- End point detector with 309nm wavelength
- Process gas : O2 / N2 / H2(4%)N2

Diffusion/Thin-film /Wet Clean

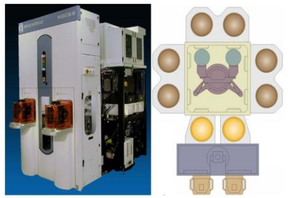
Oxidation/LPCVD Furnace

WIDAS @ WONIX IPS QUIXACE @ KEK

- 2 Loadports
- Batch Process (125ea Wafers/batch)
- 1 Tube / System
  - Oxidation System, LPCVD System
- Vertical Type Furnace
- Vacuum Load Lock Type (N2 Purge)

Multi-Chamber PECVD

Producer SE System @ AMAT



- 2 Loadports, Single-Wafer Processing
- 3 Twin Process Chamber / 1 System
  - TEOS USG
  - SiH4-Based SiO2/SiNx/SiON
  - Amorphous Carbon Layer
- RPS Clean

Single Wafer Cleaner

300mm Single Wafer Processor

- 2 Loadports, Single-Wafer Processing
- 2 Process Chamber / 1 System
  - 2 Dispensers/Chamber
  - Pre-Dep. Clean : DHF, SC-1
  - Post-Etch Clean : LAL15, DSP
  - IPA-DI/N2 Spin Dryer

✓Pattern/Blanket Wafer Service

- Minimum Line/Space Pitch ≥ 20nm half-pitch (using double patterning)
- Deposition of various thin/thick films(e.g. oxide, nitride, multiple layers etc.)

✓Testbed Service for Performance Assessment

- New materials(e.g. Photoresist etc.) , gas, slurry…
- Equipment parts/modules

“What We Have” – Equipment

Analysis “Deliver high-quality data with speed”

Structural Analysis

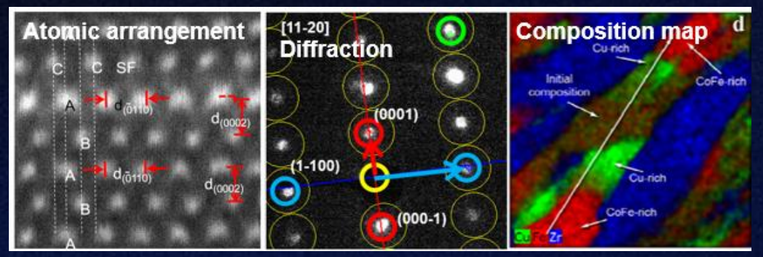
1. Atomic resolution
2. Microscopy (HRSTEM)
3. Crystallography (4D STEM)
4. Spectroscopy (EDS, EELS)
5. Cooling, heating, biasing and air-free

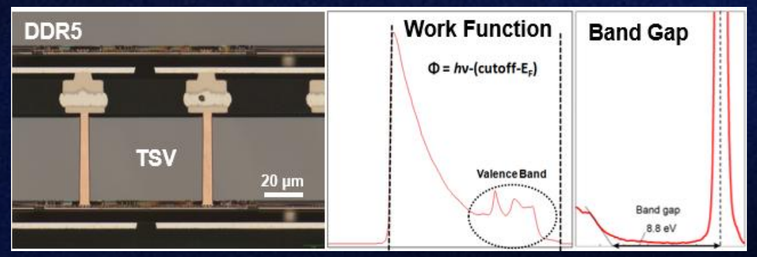
Product Analysis

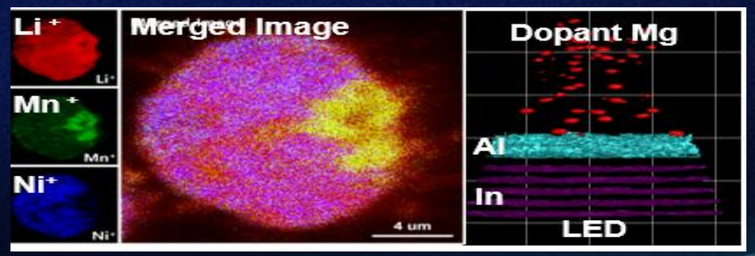
1. Reverse engineering
2. Process analysis
3. Failure analysis
4. Intellectual property analysis
5. Electrical characterization

Surface Analysis

1. Composition analysis
2. Doping profile
3. 1D/2D/3D analysis
4. Electronic structure
5. Bonding structure







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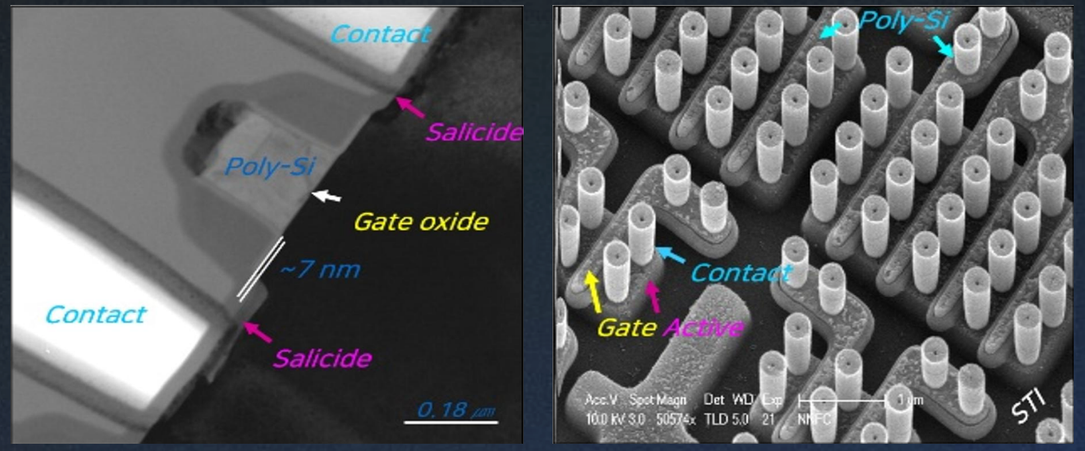
03

What We Offer

8-inch CMOS Integrated Device Platform



NNFC's 180nm Standard CMOS Process

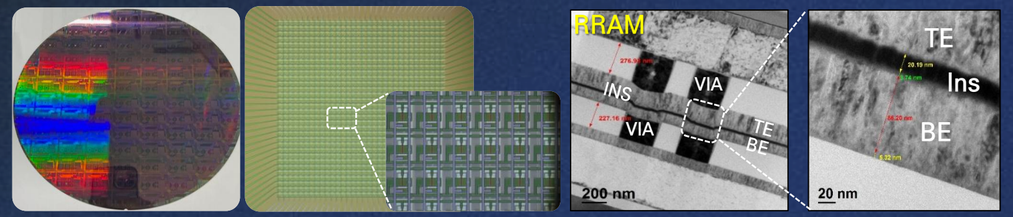
MPW support using 8-inch Platform

- Establishment and technical validation of an 8-inch, 180nm CMOS Integrated Device Platform via MPW
- NNFC is expanding 180nm CMOS design capabilities and advancing 130nm CMOS technologies

NNFC's 180nm CMOS Standard Process

CMOS-compatible Specialized Process for Intelligent Devices

NNFC's R&D Support for Intelligent Semiconductors



NNFC's Intelligent Device : 32 X 32 (1Kb) CMOS + RRAM (1T1R)

Support for Intelligent Semiconductor R&D

- Growing demand for R&D support for intelligent semiconductors
- Supporting commercialization through CMOS-based intelligent semiconductor libraries

03 "What We Offer"

12-inch Semiconductor Testbed Platform

Materials

Photoresist, Underlay, Etching Gas, etc.
- Process performance, Defects, Etch Resistance, Etch rate, etc.

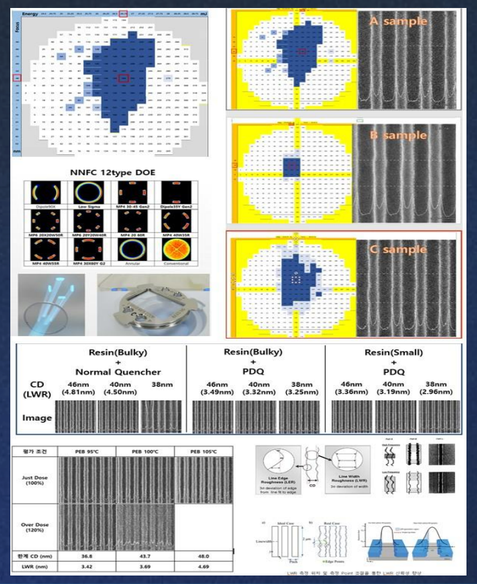
ArF Immersion Photoresist

ArF immersion Scanner
ASML_XT1900Gi

Track
TEL_Lithus Pro i

CD SEM
Hitach_CG6300

Energy, Focus Margin Evaluation

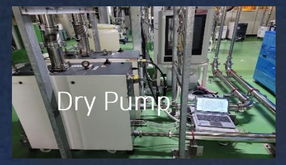


Parts

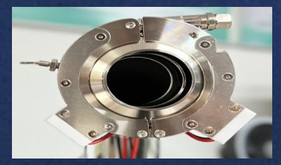
Board, Pump, Generator, Sensor, etc.
- Sensitivity, Reliability, Longevity Error verification, etc.

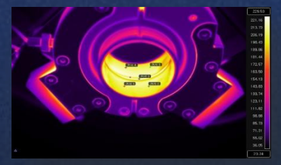
Demonstration of a process by-product suppression heater

Dry pump exhaust section



Carbon Film Clamp Heater





Before & after Clamp Heater

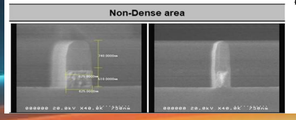
Equipment

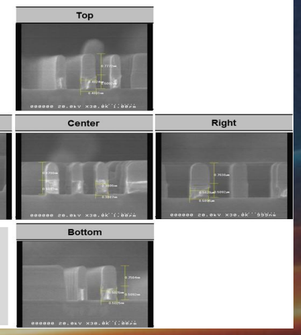
Etcher, Deposition, Analysis system, etc.
- Performance evaluation of prototype equipment

12-inch Deep Reactive Ion Etcher (DRIE)
Etch rate, Uniformity, Etch Profile, etc.

Etch depth, dense CD, Angle

Position	Etch Depth	Etch Width Top	Etch Width Bottom	Angle
Top	510㎚	482㎚	489㎚	89.6°
Center	510㎚	388㎚	388㎚	89.9°
Bottom	510㎚	502㎚	502㎚	90.0°
Left	510㎚	529㎚	542㎚	89.2°
Right	510㎚	582㎚	589㎚	89.6°
Average	510㎚			89.7°
Angle UniF.				0.44%





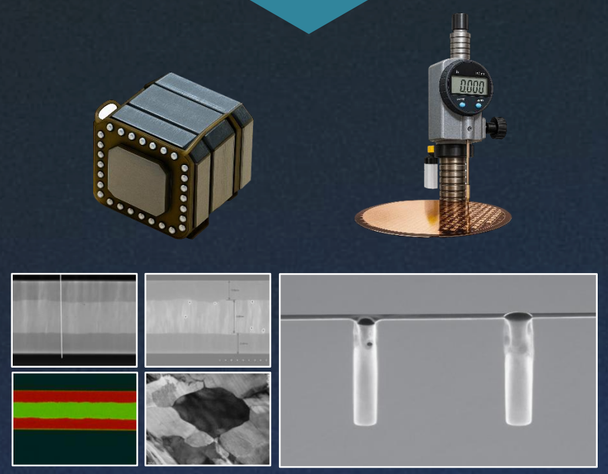
*** Non-dense Result**
- Etch depth : 510nm
- Etch width
  Top : 625nm
  Bottom : 625nm
- Angle : 90°

03 "What We Offer"

Advanced Packaging

※ 12-inch-based Advanced Packaging is under preparation

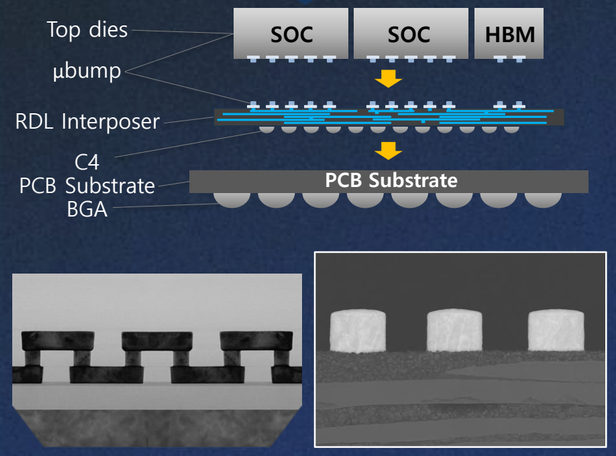
8-inch Heterogeneous Integration



Hetero Sub. PKG in NNFC

· Wafer bonding
· TSV & Cu damascene
· Thin wafer process
· Test & Inspection

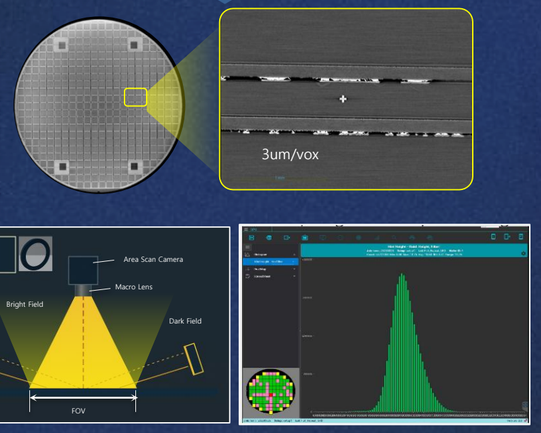
8-inch Interposer



Inorganic Si Interposer

. RDL
. TSV
. BUMP
. Material Evaluation

Failure Analysis (Destructive, Non-D)



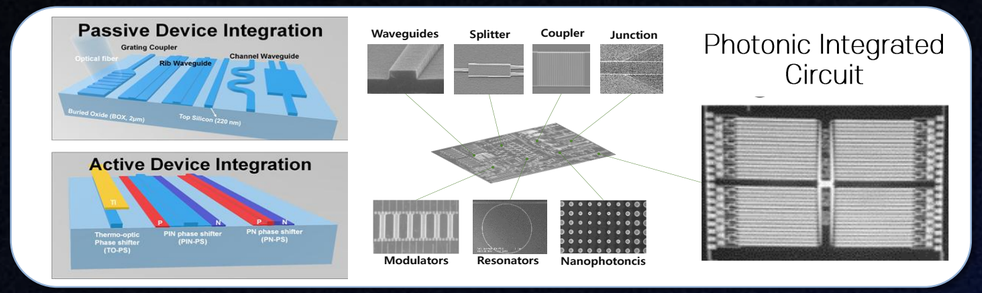
Inspection & Metrology

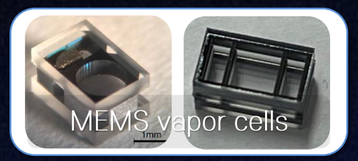
. X-ray Computed Tomography
. 3D non-destructive analysis
. Automated Optical Inspection
. TSV/Trench Depth
. Inner Crack Inspection

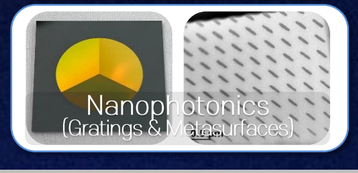
"What We Offer"

Quantum on Silicon Technology Platform

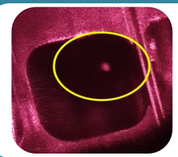
Quantum Technology Toolbox







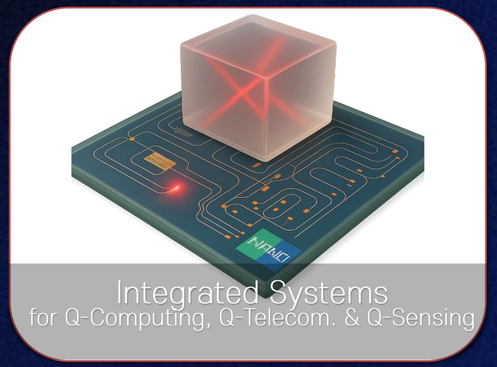
Chip-Scale
Atomic Clocks
(Transferred to Industry)



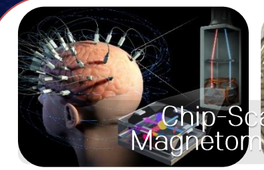
Cold Atoms
(with KRISS)

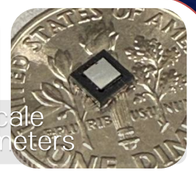
Vertical
Evolution
(Integration)

Horizontal
Evolution
(Application
Expansion)

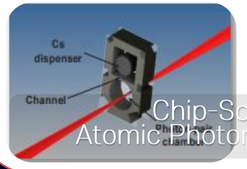


Integrated Systems
for Q-Computing, Q-Telecom. & Q-Sensing





Chip-Scale
Magnetometers



Chip-Scale
Atomic Photon Sources

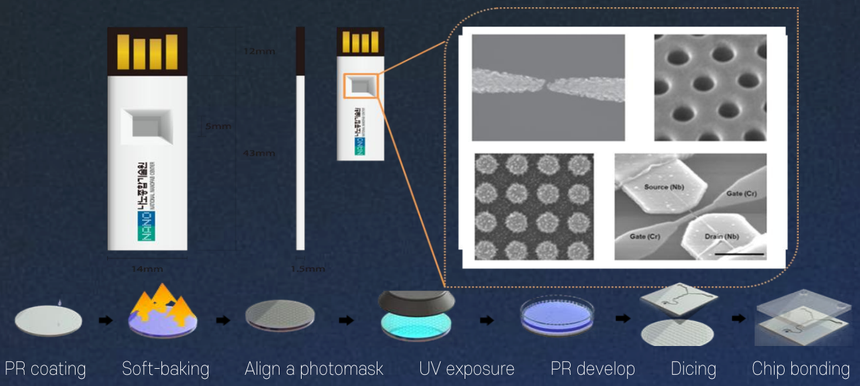
Since 2014 Present Future

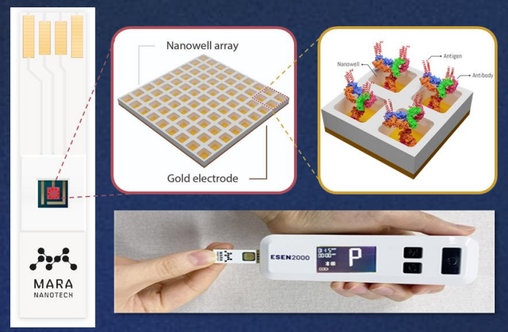
Leading Nanotechnology and Driving Innovation for the Future

Nano-medical Device Platform

Integration of nanostructures into a USB platform

- Biosensors with nanostructures fabricated using semiconductor processes

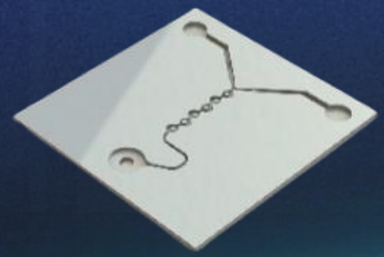




- Development of biosensor-based point-of-care devices using semiconductor fabrication technologies

Microfluidic Platform for Drug Delivery Device

- Development of microfluidic devices through bonding of silicon and glass wafers containing micropatterns

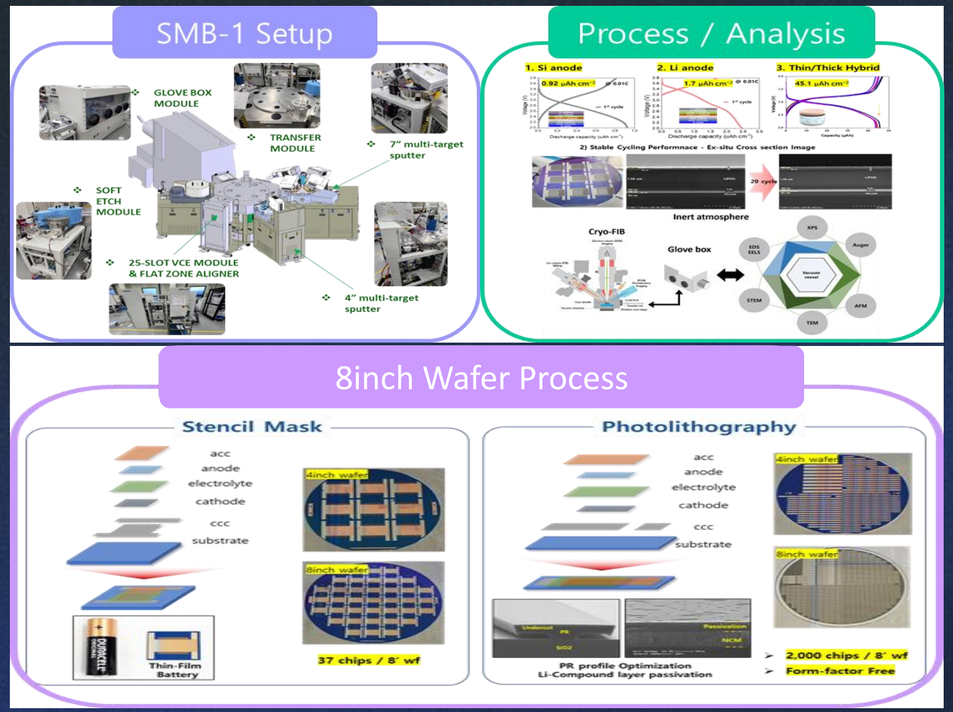


03 "What We Offer"

Nano Device Materials Platform

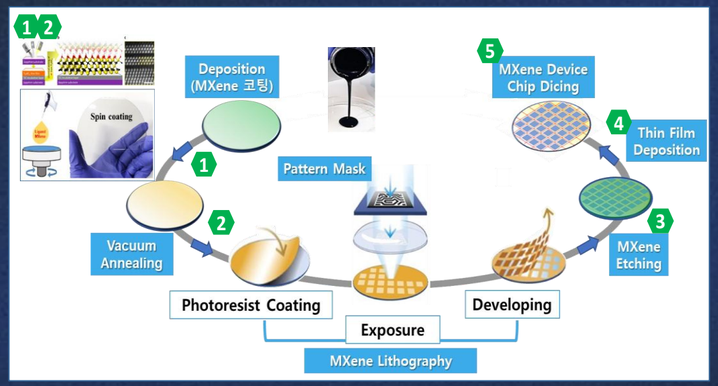
From Li Compound Material to Micro-Battery Devices

Semiconductor-Nano Process



From Nanomaterial to Nano-Device

2D MXene, 2D Graphene(CVD, Coating),
Nano-Fiber(Polymer), Thin Film,
3D Nanostructure(SiO_2, Si, Polymer, Metal)



03 “What We Offer”

Workforce Development

We provide world-class workforce development programs based on the following strengths:

#1 : Hands-on training programs delivered through cutting-edge FAB infrastructure and XR-based learning equipment

#2 : Dynamic coaching and mentoring led by experts from both industry and academia (internal/external)

Connecting Talent with Opportunity

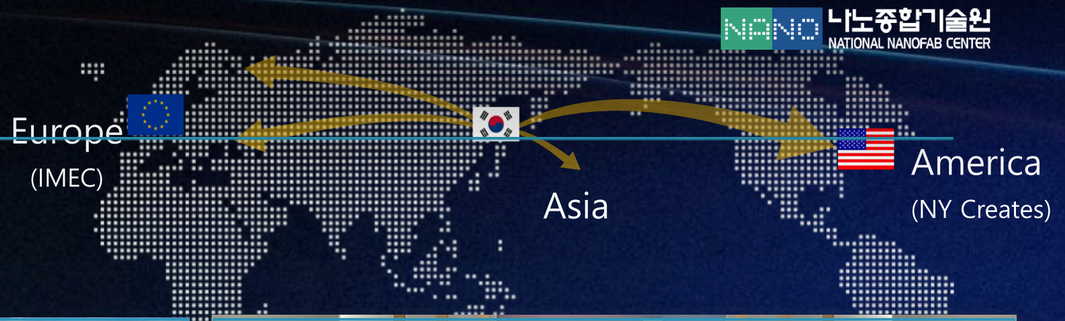
Comprehensive programs for educations, skills training and workforce development

Training Platform Using XR/Digital Twin

Simulation-based equipment troubleshooting and process optimization training

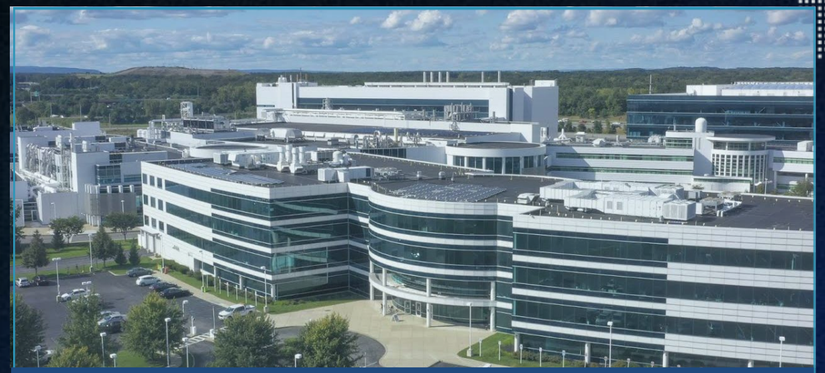
03 "What We Offer"

Global Collaboration



Joint R&D Project (NY CREATES, US)

- **Objective**
  Supporting International Joint R&D to commercialization core semiconductor technologies in collaboration with NY CREATES and National NanoFab Center
- **Beneficiaries**
  Consortia composed of Korean and US researchers, including universities, and government-funded research institutions



Testbed Project (NY CREATES, US)

- **Objective**
  Support demonstration and evaluation through the NY CREATES 300mm front-end/back-end infrastructure, including EUV facilities
- **Supported Areas**
  Semiconductor materials(e.g. photoresists), Equipment(e.g. test wafer fabrication), Device processing, Advanced packaging
- **Beneficiaries**
  Korean companies involved in semiconductor materials, parts, and equipment

Internship Program (imec, Belgium)

- **Objective**
  Foster global R&D talent by supporting internships at leading international semiconductor R&D institutions
- **Beneficiaries**
  Graduate students (Master's or Ph.D level) in Korea
  * A total 24 students were selected for 2024-2025
- **Scope of support**
  Operational costs for conducting internship program

04

Future Direction

Vision

Global Leader in Nano-Semiconductor R&D Support

NNFC, We "Represent" Korea

Strategy

- Building Nano-Semiconductor Ecosystem
- Service Provider
- Driving Global Growth
- Ensuring Safety First

❖ Enhancing collaboration and cooperation between domestic and international public semiconductor facilities and the private sectors

❖ Upgrading in-house capabilities to keep up with future technologies such as advanced packing technology, quantum sensor technology and AI

❖ Maintaining sustainability with 'safety first' principle and improving energy efficiency while following green chemistry principles

- 12-inch Materials & Parts& Equipment Testbed
- 12-inch Advanced Packaging Testbed
- Nano-Semiconductor Convergence Platform
- Next Generation Neuromorphic Semiconductor
- Global Collaboration

NNFC,
We Are Always Here for
Your Success

Nano-semiconductor R&D Service Provider,
NNFC, We "Represent" Korea

Thank you

나노종합기술원
NATIONAL NANOFAB CENTER