<Professor Kyounghoon Yang's Lab.> (양경훈 교수 연구실)

HIGH SPEED NANOELECTRONICS LAB
HSNL
High Speed Nano Electronics Laboratory

■ **Contact information**

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■ **Current state of the Lab. (in 2025 Fall Semester)**

Postdoctoral Fellows : 1 PhD Students: 1 Master's Student: 0

■ **Research Areas**

● III-V HEMT / Nano-CMOS RF Device Modeling & mm-Wave IC Design

Mm-wave wireless T/R Front-end phased-array ICs have been developed at the frequencies ranging from 28GHz, 60GHz up to W-band (77GHz, 94GHz). With the increase of frequencies, it has been widely known that the resolution of beam-forming and the capacity for signal data rates are enhanced, which is a major research focus for the next-generation wireless system development. **The research on D-band (110-170GHz) RF-ICs** is in progress and **sub-THz bands (170-300GHz)** will be also pursued.

● Wide-bandgap High-power Semiconductor Devices

For power electronics application, the wide-bandgap semiconductors such as gallium nitride (GaN) and silicon carbide (SiC) have benefits of high breakdown voltage, lower on-resistance, and higher current. In particular, **GaN-based HEMTs are ideal for the next generation of high-frequency, high-power power electronics applications** because the GaN HEMTs generate a high concentration of two-dimensional electron gas (2-DEG) owing to the strong polarization difference and high conduction band offset at the interface and have on-resistance lower than SiC devices. Our current focus is on **enhancement-mode (E-mode) GaN HEMTs grown on Si substrate with Vds,max>150 V and Ids>25 A.** The enhanced GaN HEMT is safer and more energy efficient because the device is in the off state at zero bias.

● Quantum-effect High-speed Nanodevices/Integrated Circuits

A **resonant tunneling diode (RTD),** which is a semiconductor nonlinear diode with a double-barrier quantum-well structure for electrons to resonantly tunnel through, has been regarded as one of the most mature quantum-effect devices for practical low-power integrated circuit (IC) applications. The resonant tunneling diode (RTD) which is the fastest electronic device has inherent negative differential resistance (NDR), nonlinearity, and multifunctional/bistable characteristics, so it has been actively researched in signal sources, detectors, and mixed-signal circuits for various mmW and THz applications.

For upcoming THz applications and the development of THz monolithic integrated circuits (TMICs) using the RTD and high-speed **heterojunction bipolar transistor (HBT)** technologies, further optimization techniques based on the previously developed HBT technologies and their monolithic co-integration of RTDs with HBTs are highly required.

■ **Recommended courses**

- Basic Physical Electronics, Semiconductor Devices, Electronic Circuits, Microwave Engineering, etc.

■ **Career after graduation**

- Samsung Electronics/SK Hynix/ADD/ETRI/KIST/Academia

■ **Introduction to other activities besides research**

- Laboratory workshop & picnic / Casual group meetings with sandwich or coffee

■ **Introduction to the Lab.**

- HSNL is currently getting into the 2nd-phase of lab research activities, moving towards ***more integrated & converged co-research with other laboratories to develop mmW/THz Wireless Comm-Radar Core System IC/Modules*** from high-speed/high-frequency nano devices to full-scale IC/Systems based on enhanced mutual-lab collaboration, which will ***provide students with more in-depth & broader research opportunities from device to circuit & system levels.***

■ **Recent research achievements ('23~'25)**

[1] X. Yang, et al., "Impact of Gate Field Plate on Kink Phenomenon in S22 of AlGaN/GaN HEMTs for RF Applications: A Comparative Study," KCS, 2025.

[2] X. Yang, et al., "Direct Extraction Methods for RF Characterization of Extrinsic Parasitic Parameters in 28 nm FDSOI MOSFETs Up to 110 GHz," IEEE J-EDS, 2024.

[3] J.-H. Yoo, et al., "Single-power-supply compatible cryogenic $In_{0.8}Ga_{0.2}As$ quantum-well HEMTs with record combination of high-frequency and low-noise performance for quantum-computing applications," IEEE VLSI, 2024.

[4] W.-S. Park, et al., "Characterization of AlGaN/GaN HEMTs on 4-inch SiC substrate at Cryogenic temperature," CS MANTECH, 2024.

[5] I.-G. Lee, et al., "Improved thermal reliability in base contact of full 3-inch InP Double-HBTs with f_T and f_{max} in excess of 300 GHz," CS MANTECH, 2024.

[6] M. Park, et al., "200-mm Si CMOS Process-Compatible Integrated Passive Device Stack for Millimeter-Wave Monolithic 3-D Integration," IEEE TED, 2023.

[7] X. Yang et al., "Systematic characterization for RF small-signal parameter extraction of 28 nm FDSOI MOSFETs up to 110 GHz," Microelectronics Journal, 2023.

[8] K. Yang, "Status and Perspective of Resonant Tunneling Diode Technology for Future mm-Wave and Terahertz (THz) Electronics," CSW, 2023.