

# Group Leaders & Members

Research Area	Tohoku Univ.		NCTU	
	Group Leader	Team Members	Group Leader	Team Members
② Nano-Devices and System (5G mm-Wave Smart Radar System)	Prof. Seiji Samukawa (IFS/AIMR)	Prof. Nobuaki Teramoto (Niche) Prof. Takahito Ono (SE) Prof. Qiang Chen (SE) Prof. Takashi Matsuoka (IMR) Prof. Noriharu Suematsu (RIEC)	Prof. Yiming Li (李義明教授/ECE)	Prof. Jenn-Hwan Tarng (唐震寰教授/ECE) Prof. Chao-Hsin Chien (簡昭欣教授/EE) Prof. Tien-Sheng Chao (趙天生教授/EP) Prof. Tuo-Hung Hou (侯拓宏教授/EE) Asso. Prof. Zuo-Min Tsai (蔡作敏副教授/ECE) Asst. Prof. Tian-Li Wu (吳添立助理教授/ICST) Dr. Niraj Man Shrestha (尼洛齊博士後研究員/ECE) Dr. Yao-Jen Lee (李耀仁研究員/TSRI)

➤ Tohoku Univ.

IMR: Institute of Material Research, IFS: Institute of Fluid Science, AIMR: Advanced Institute of Material Research, RIEC: Research Institute of Electrical Communication, SE: School of Engineering, SS: School of Science, GSES: Graduate School of Environmental Studies, GSBE: Graduate School of Bio-medical Engineering, Niche: New Industry Creation Hatchery Center

➤ NCTU

ECE: Department of Electrical and Computer Engineering, EE: Department of Electronics Engineering, ME: Department of Mechanical Engineering, AC: Department of Applied Chemistry, MSE: Department of Materials Science and Engineering, EP: Department of Electrophysics, ICST: International College of Semiconductor Technology, TSRI: Taiwan Semiconductor Research Institute

# 5G and Beyond-compliant mm-wave Smart Radar Systems and Technologies

Harvard University

*Radar Signal Deep Learning*



University of California

Los Angeles

*CMOS Technologies*



Karlsruher Institut

für Technologie

*AI Technologies*

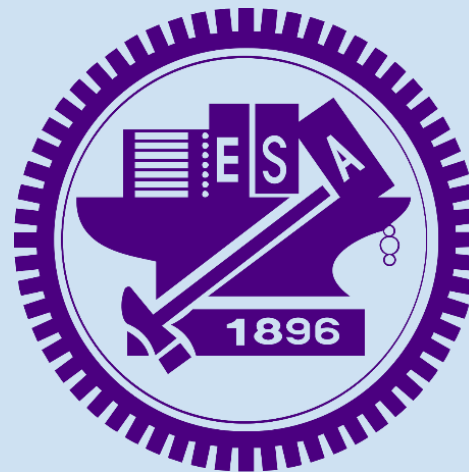


Karlsruher Institut für Technologie

**NCTU**

毫米波智慧雷達系統與技術研究中心

國外學術合作夥伴Gr



*GaN HEMT Technologies*

2018~2022 (5 Years)



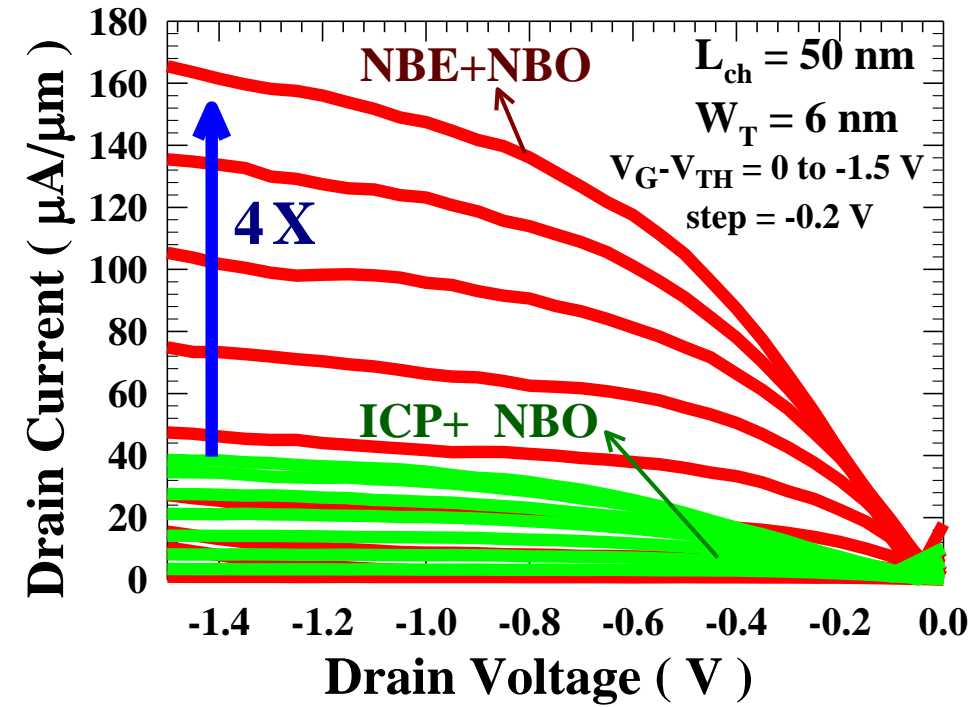
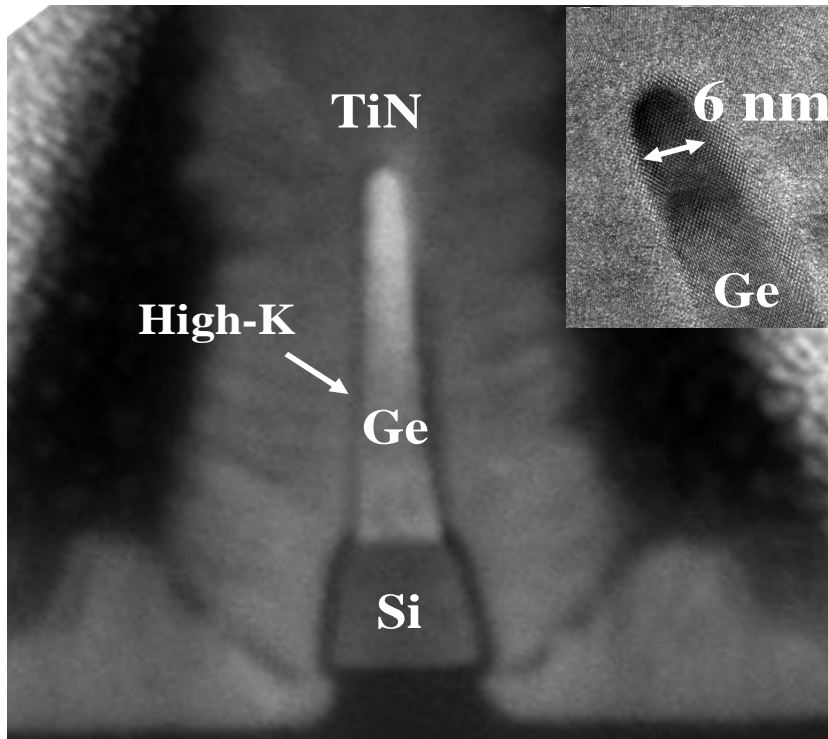
**MOST and Industries**

Tohoku University

*Defect Control Process  
(Neutral beam, ALD, Epi)*

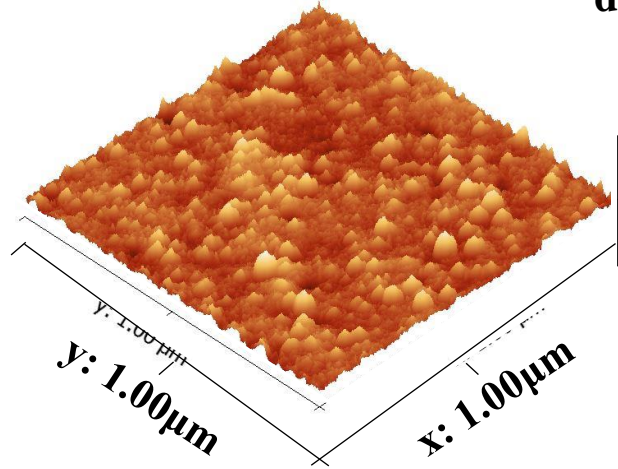


# Sub-6nm Ge Fin MOSFET

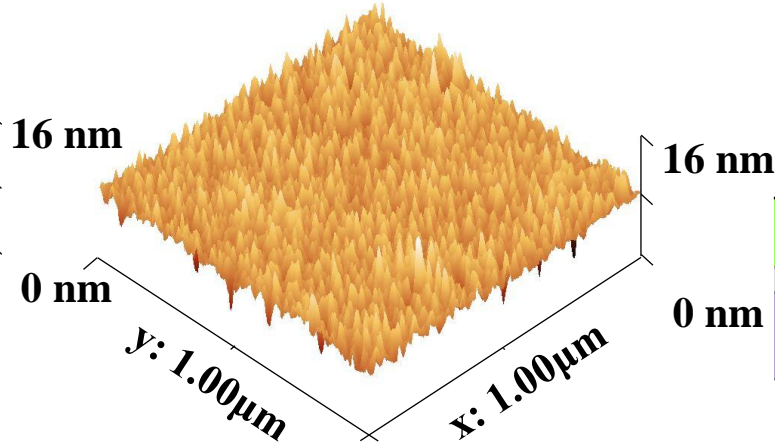


Y.-J. Lee, et. al., *IEEE International Electron Devices Meeting, 33.5* (San Francisco, 2016/12/07).

# AlGa<sub>x</sub>N/GaN Gate Recess Neutral Beam Etching Surface and Pulsed I<sub>d</sub>-V<sub>ds</sub> Characteristics (Tohoku Univ.)

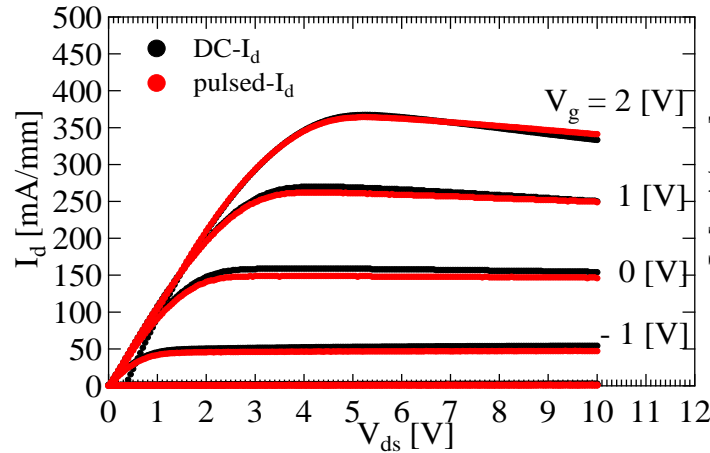
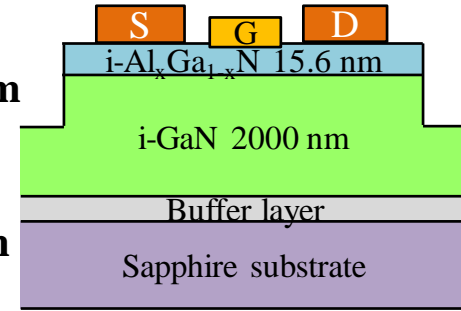


(a) NB-etched surface  
RMS= 0.452 nm

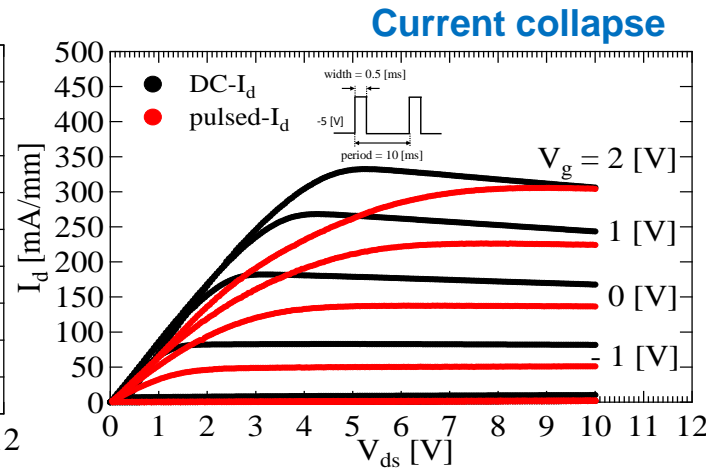


(b) Plasma-etched surface  
RMS= 1.024 nm

RMS: Route Mean Square



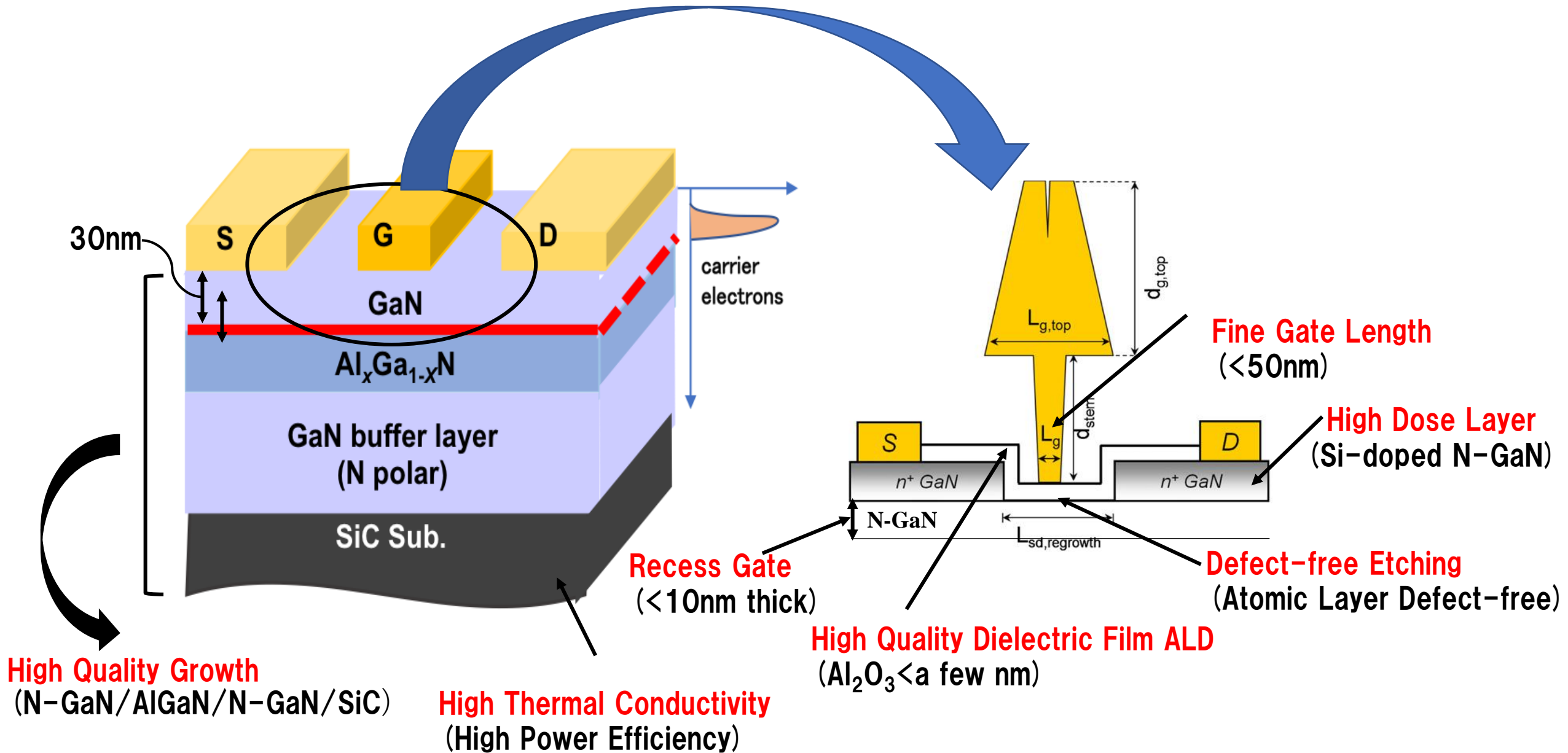
(a) NB recess etching



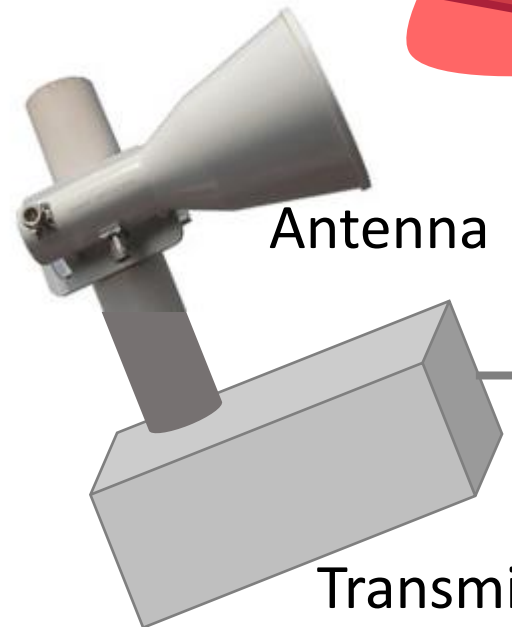
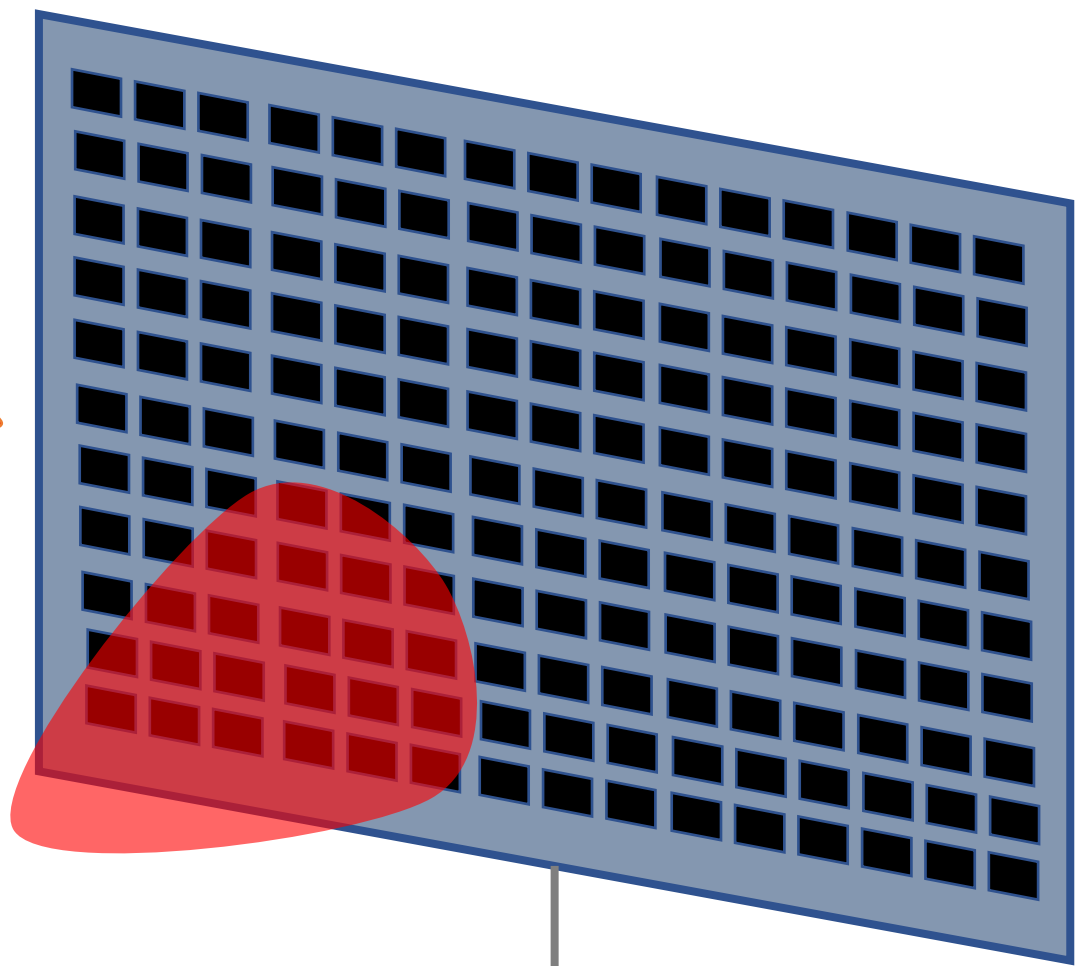
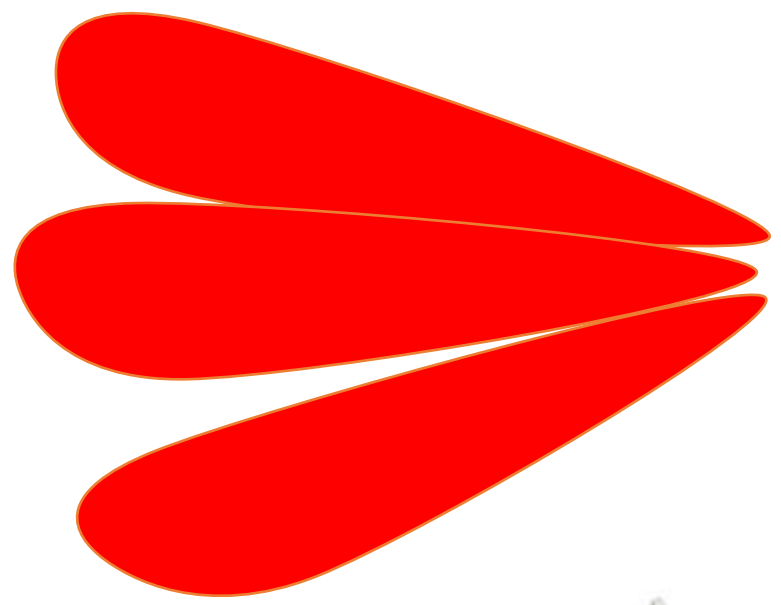
(b) Plasma recess etching

The neutral beam (NB) etching is applicable for the GaN gate recess with suppressing the **current collapse** (caused by surface defects). As a result, **higher speed AlGa<sub>x</sub>N/GaN HEMT** can be achieved by using NB etching.

# Research Items for N-polar GaN HEMT



Beam steering



Antenna

Transmitter and Receiver

2 Dimensional Planar Reflectarray with  $N \times N$  Scatterers of MEMS Switches