Research Center for Integrated Quantum Electronics (RCIQE)

Hokkaido University

September, 2025

Overview

At RCIQE, we conduct research on eco-friendly, power-efficient, integrated quantum electronics, with focus on the following topics:

- Fabrication of semiconductor-based quantum nanostructures by atomically controlled crystal growth and low-energy nanofabrication process. Characterization of their physical properties and application to efficient solar cells, telecommunication, and magnetic devices.
- Formation and characterization of magnetic semiconductors and application to ultra-low power IC and low-loss ultrahigh-frequency devices.
- Development of high-performance wide-gap semiconductor devices based on the nano-scale control of hetero interface. Application to the next-generation high-efficiency power inverter systems.
- Design of ultra-low power and high-functional IC based on novel architecture for advanced information processing.

Organization

Director: Professor Junichi Motohisa


Prof. S. Kasai Assoc. Prof. T. Sato

Prof. F. Ishikawa

Project: Green semiconductors


Specially appointed Prof. K. Kumakura
Specially appointed assoc. Prof. F. Inoue

Research Area for Advanced Electronic Nanomaterials

Nanoscale interface control
III-V compounds
Semiconductor / oxides composites

Research Area for Quantum Intelligent Devices

Nature- & bio-inspired devices
Artificial Intelligence
Photo-electro-chemical energy conversion

Quantum integrated electronics

Research Area for Functional Communication Devices and Circuits

Ultralow-power communication devices
THz devices /Metamaterials
III-N power devices

Research Area for Integrated Electron Devices

Semiconductor nanowires
Electron & optoelectronic nanodevices
Functional electron devices


Prof. M. Ikeba Assoc. Prof. M. Akazawa


Prof. J. Motohisa Prof. K. Tomioka

Visiting Professors, Research Institute Fellows, Technical staffs, Secretaries

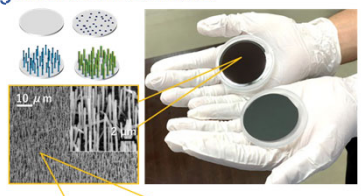
Research Area for Advanced Electronic Nanomaterials

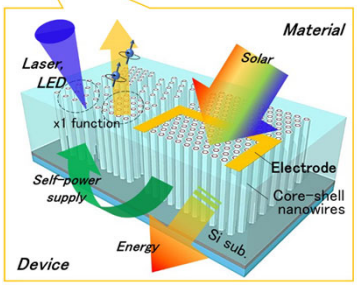
Professor: Fumitaro Ishikawa (Ph. D)

Based on the epitaxial growth of III-V compound semiconductors, we explore new electronic nanomaterials and hetero-structure. We thus try to establish materials of heterogeneous junction nanowires, high-efficiency electronic and photonic energy conversion, new-generation communication devices, and high-performance nano-electronics/photonics.

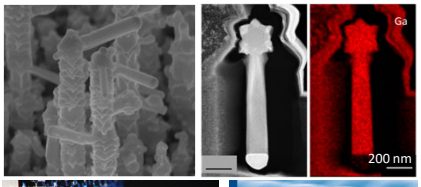
1) Exploration of novel electronic nano-materials with interface control
2) Pursue electronic devices with performance overcoming present limitation
3) Semiconductor/Oxide nano composites and their application to novel devices

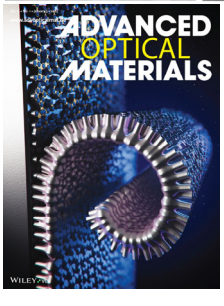
Self assembled nanostructures showing a prospect for new generation devices

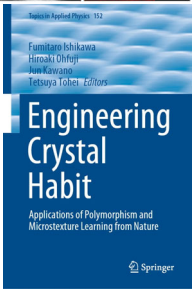




Novel bottom-up fabrication technologies of hybrid nanostructures between semiconductor and oxides.







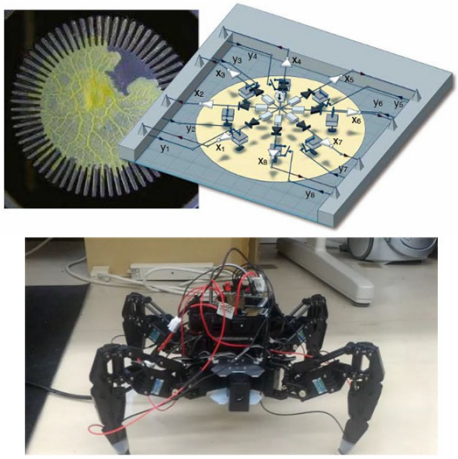
Research Area for Quantum Intelligent Devices

Professor: Seiya Kasai (Ph. D) Associate Professor: Taketomo Sato (Ph. D)

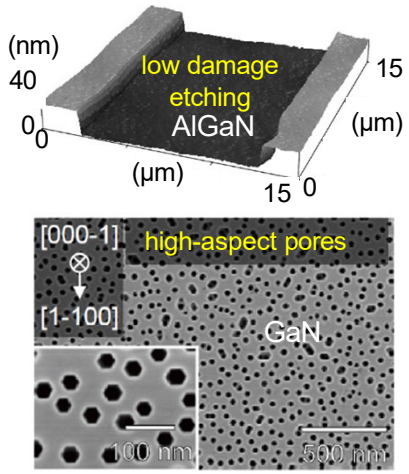
We investigate nature- and bio-inspired technologies for novel function material and devices, including high-efficient solar cells, stochastic resonance devices, and amoeba-inspired artificial intelligence. We are aiming nature and environment friendly semi-conductor technologies for SDGs.

1) Bio-inspired electron devices exploiting fluctuation and their applications
2) Amoeba-inspired non-von Neumann computer
3) “Photo-”, “electro-”, “chemical-” energy conversion and application to nitride semiconductor processing

Electronic amoeba and its application to autonomous walking robot



Damage-free etching by photoelectro-chemical process and formation of high-density nanostructure



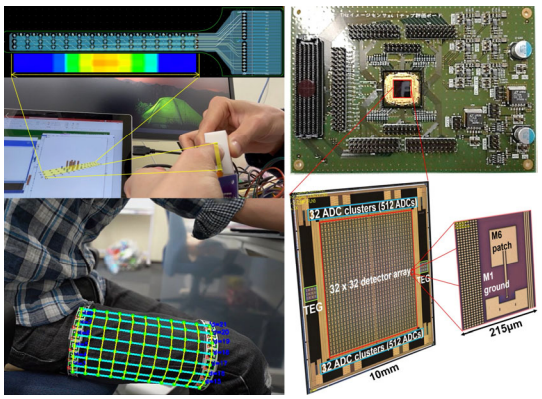
Research Area for Functional Communication Devices and Circuits

Professor: Masayuki Ikebe (Ph. D) Associate Professor: Masamichi Akazawa (Ph. D)

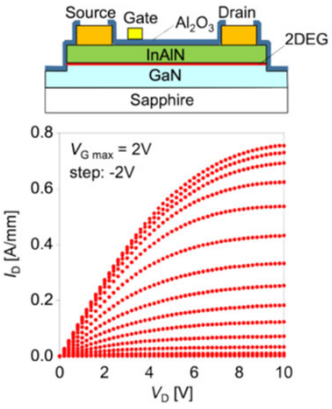
This research area covers systems, circuits and devices for functional communication and sensors towards IoT society. We are investigating THz devices utilizing low-cost CMOS technology, fabrication process of III-nitride power devices, ultra-low-power CMOS circuits operating at subthreshold regions, and intelligent sensing technologies with high sensibility and sensitivity.

1) Novel materials and devices for THz waves
2) Sensor LSIs with micro-Watt power
3) III-nitride power devices
4) Intelligent sensing/information processing

Remote tactile transmission sensor systems and THz imaging sensors that capture invisible light



InAlN/GaN heterostructure field-effect transistor



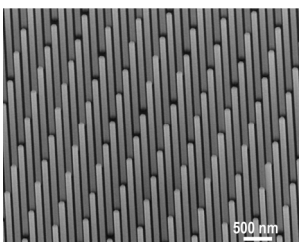
Research Area for Integrated Electron Devices

Professor: Junichi Motohisa (Ph. D) Professor: Katsuhiro Tomioka (Ph. D)

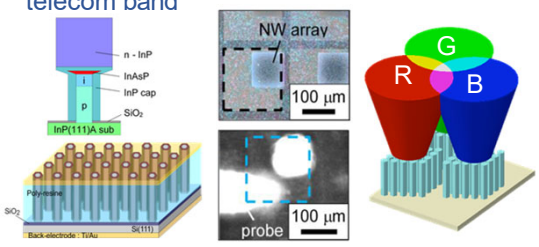
We pursue the research on nanowire-based integrated devices towards energy-efficient electronics. Semiconductor nanowires enable efficient control of carriers utilizing unconventional heterostructures and materials. Based on the selective area epitaxy and nanofabrication techniques, we aim at the application for high-performance and energy-efficient nanodevices, and their integration.

1) Integration of III-V semiconductor nanowires using selective-area epitaxy
2) High performance and energy-efficient nanodevices
3) Nanowire photonic devices

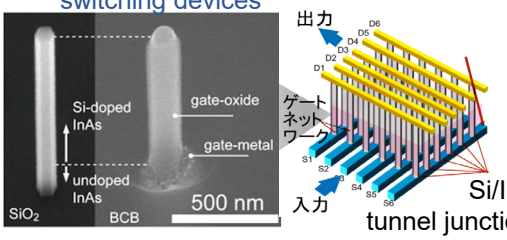
Epitaxially grown nanowires



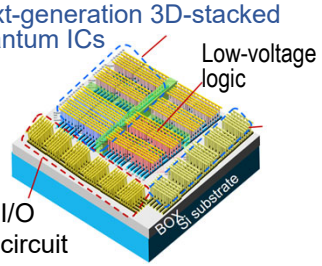
Nanowire-based light emitter & receiver for telecom band



High-performance & low-voltage switching devices



Next-generation 3D-stacked quantum ICs

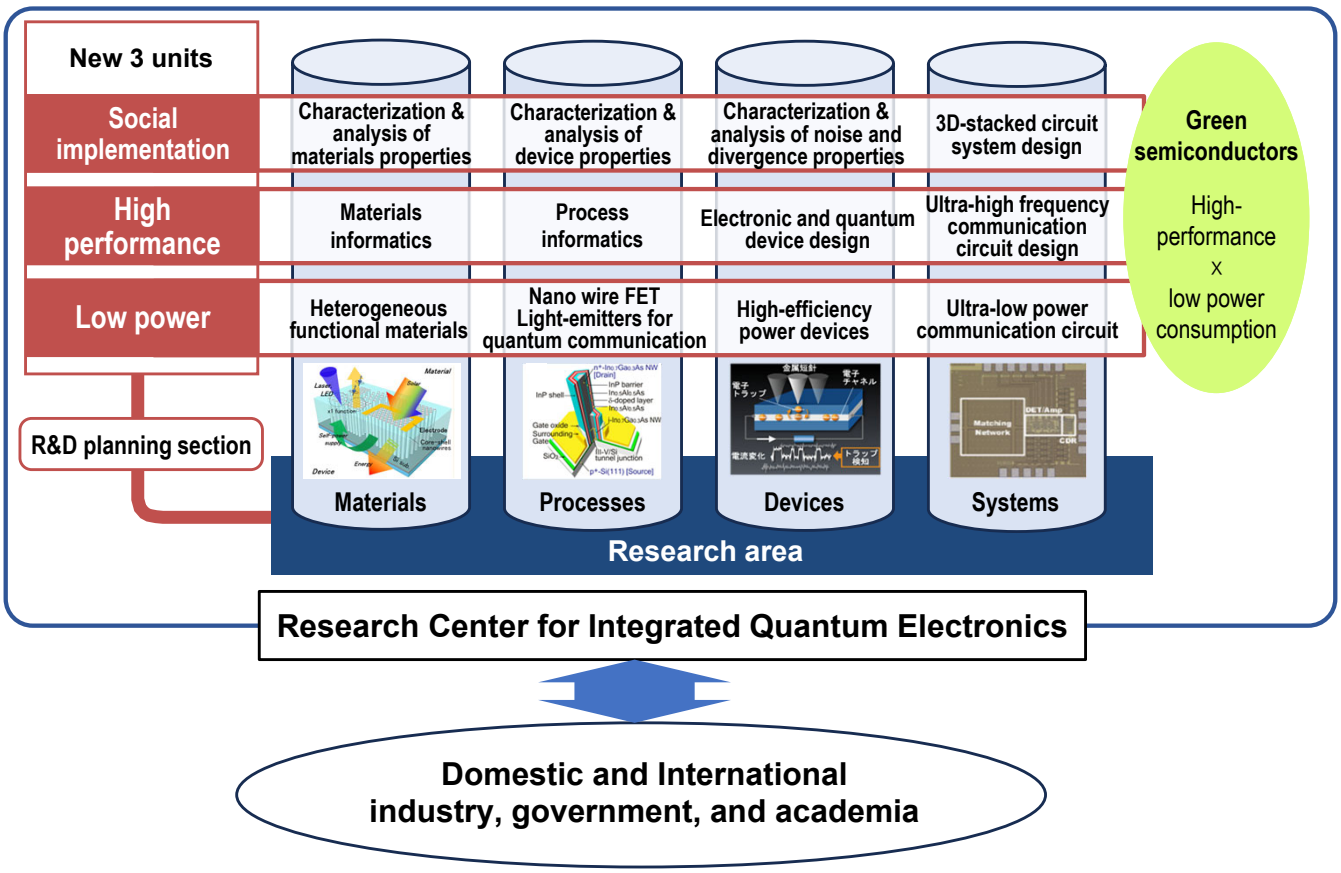


Establishment of Green Semiconductor R&D Hub

From FY2024, strengthening our capabilities have been started as a five-year project. With this expanded structure, we are working to establish heterogeneous integration technologies that integrated diverse materials and devices. This enables us to promote research on next-generation green semiconductor technologies that achieve both high performance and energy efficiency. This enhanced framework allows us to more powerfully advance the research goals of our center.

Support for research and education organization reform by MEXT※ (FY2024-FY2028)

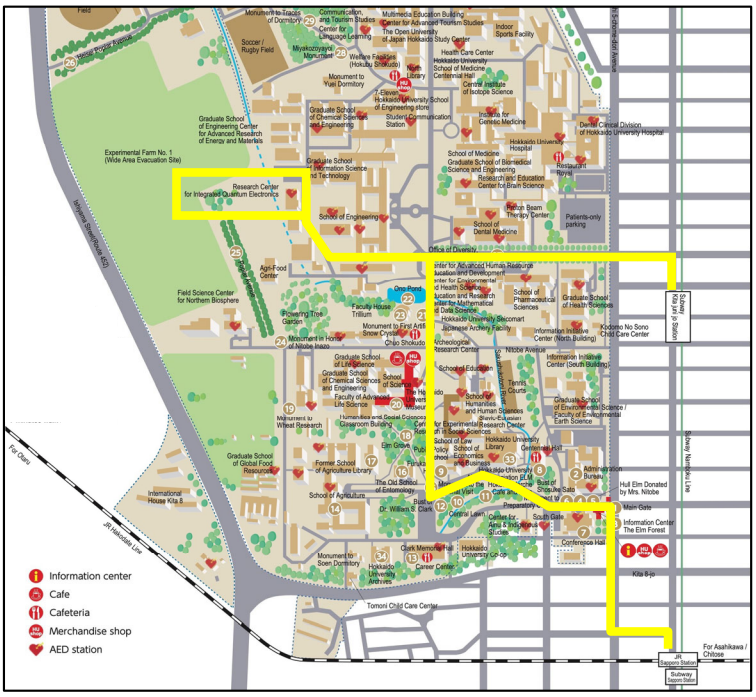
※ Ministry of education, culture, sports, science and technology-Japan



Access

By JR line:
Get off at Sapporo Station,
20 minutes walk to RCIQE.

By Sapporo subway:
If you take Namboku line or Toho line,
get off at Sapporo Station,
25 minutes walk to RCIQE.
If you take Namboku line,
get off at Kita Juni jo Station,
15 minutes walk to RCIQE.



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