北海道大学
HOKKAIDO UNIVERSITY

Research Center for Integrated Quantum Electronics (RCIQE)

Hokkaido University

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

Research Area for Advanced Electronic Nanomaterials

Nanoscale interface control
III-V compounds
Ferromagnetic/semiconductor composites

Professor 1
Associate Professor 1

Research Area for Quantum Intelligent Devices

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

Professor 1
Associate Professor 1

Quantum integrated electronics

Research Area for Functional Communication Devices and Circuits

Ultralow-power communication devices
THz devices
Metamaterials

Professor 1
Associate Professor 1

Research Area for Integrated Electron Devices

Semiconductor nanowires
Electron & optoelectronic nanodevices
Functional electron devices

Professor 1
Associate Professor 1

Staff

Visiting Professors	2
Research Institute Fellow	1
Technical Staff	1
Secretaries	1

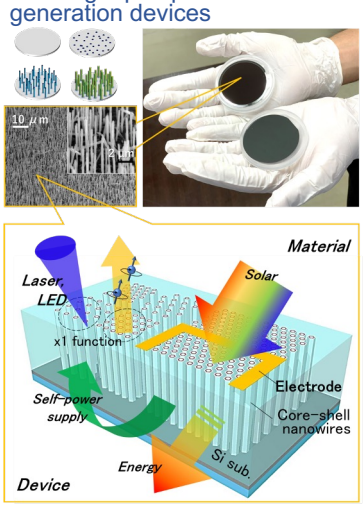
Research Area for Advanced Electronic Nanomaterials

Professor: Fumitaro Ishikawa (Ph. D) Associate Professor: Shinjiro Hara (Ph. D)

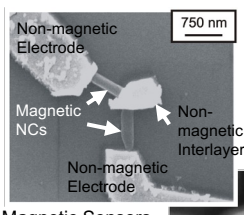
Based on the epitaxial growth of III-V compound semiconductors, we explore new electronic nanomaterials and hetero-structure. We thus try to establish materials of heterogeneous junction nanowires, high-efficiency electronic and photonic energy conversion, new-generation communication devices, and high-performance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

- Exploration of novel electronic nanomaterials with interface control
- Pursue electronic devices with performance overcoming present limitation
- Bottom-up ferromagnetic/ semiconductor nano composites and their application to magnetic devices

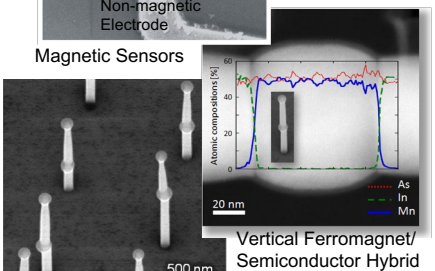
Self assembled nanostructures showing a prospect for new generation devices



Novel bottom-up fabrication technologies and magnetic device applications of hybrid nanostructures between ferromagnet and semiconductor



Magnetic Sensors



Vertical Ferromagnet/ Semiconductor Hybrid Nanowires

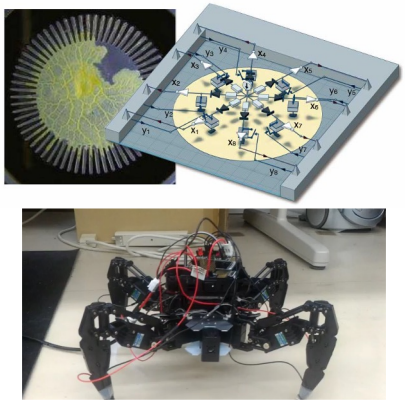
Research Area for Quantum Intelligent Devices

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

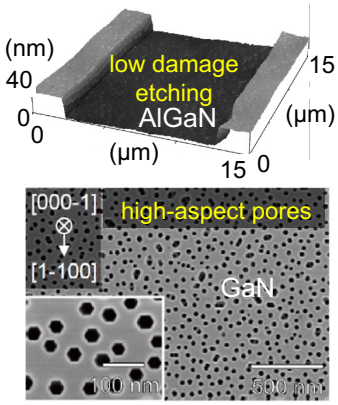
We investigate nature- and bio-inspired technologies for novel function material and devices, including high-efficient solar cells, stochastic resonance devices, and amoeba-inspired artificial intelligence. We are aiming nature and environment friendly semiconductor technologies for SDGs.

- Bio-inspired electron devices exploiting fluctuation and their applications
- Amoeba-inspired non-von Neumann computer
- “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



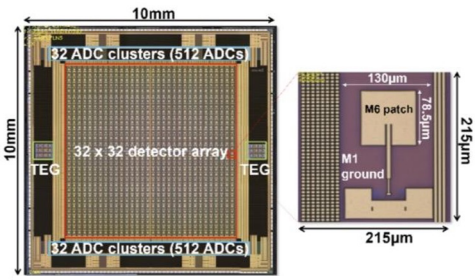
Research Area for Functional Communication Devices and Circuits

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, electronic properties of InAlN/GaN heterostructures, ultra-low-power CMOS circuits operating at subthreshold regions, and intelligent sensing technologies with high sensibility and sensitivity.

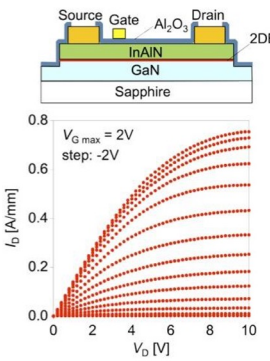
- Novel materials and devices for THz waves
- Sensor LSIs with micro-Watt power
- Properties of InAlN/GaN heterostructures
- Intelligent sensing/information processing

THz image sensor with global shutter based on the column-parallel ADC



Power cosumption per pixel : 4.5 μW
Frame rate: 400 fps

InAlN/GaN heterostructure field-effect transistor



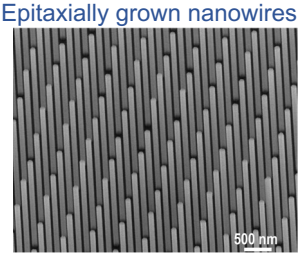
Research Area for Integrated Electron Devices

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

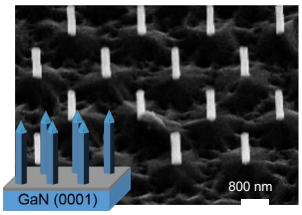
We pursue the research on nanowire-based integrated devices towards energy-efficient electronics. Semiconductor nanowires enable efficient control of carriers utilizing unconventional heterostructures and materials. Based on the selective area epitaxy and nanofabrication techniques, we aim at the application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

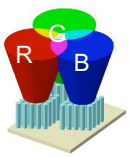
- Integration of III-V semiconductor nanowires using selective-area epitaxy
- High performance and energy-efficient nanodevices
- Nanowire photonic devices

Epitaxially grown nanowires



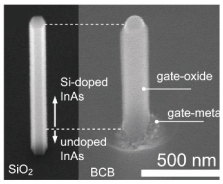
GaN-based nanowires utilizing top-down technology

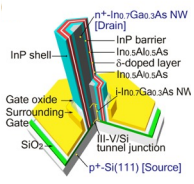




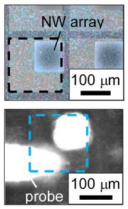
Full-color nano LEDs

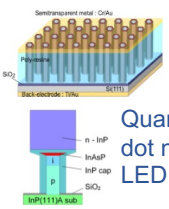
High-performance & low-voltage switching devices





Nanowire-based light emitter & receiver for telecom band





Quantum dot nanowire LED

Access

https://www.global.hokudai.ac.jp/about/access-maps/

Research Center for Integrated Quantum Electronics (RCIQE), Hokkaido University

Address: North 13, West 8, Sapporo 060-0813, JAPAN
Tel: +81-11-706-7171, Fax: +81-11-716-6004
HP: https://www.rciqe.hokudai.ac.jp/en/

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