

National Institute of Advanced Industrial Science and Technology (AIST)
Department of Energy and Environment

Research Institute for Energy Conservation



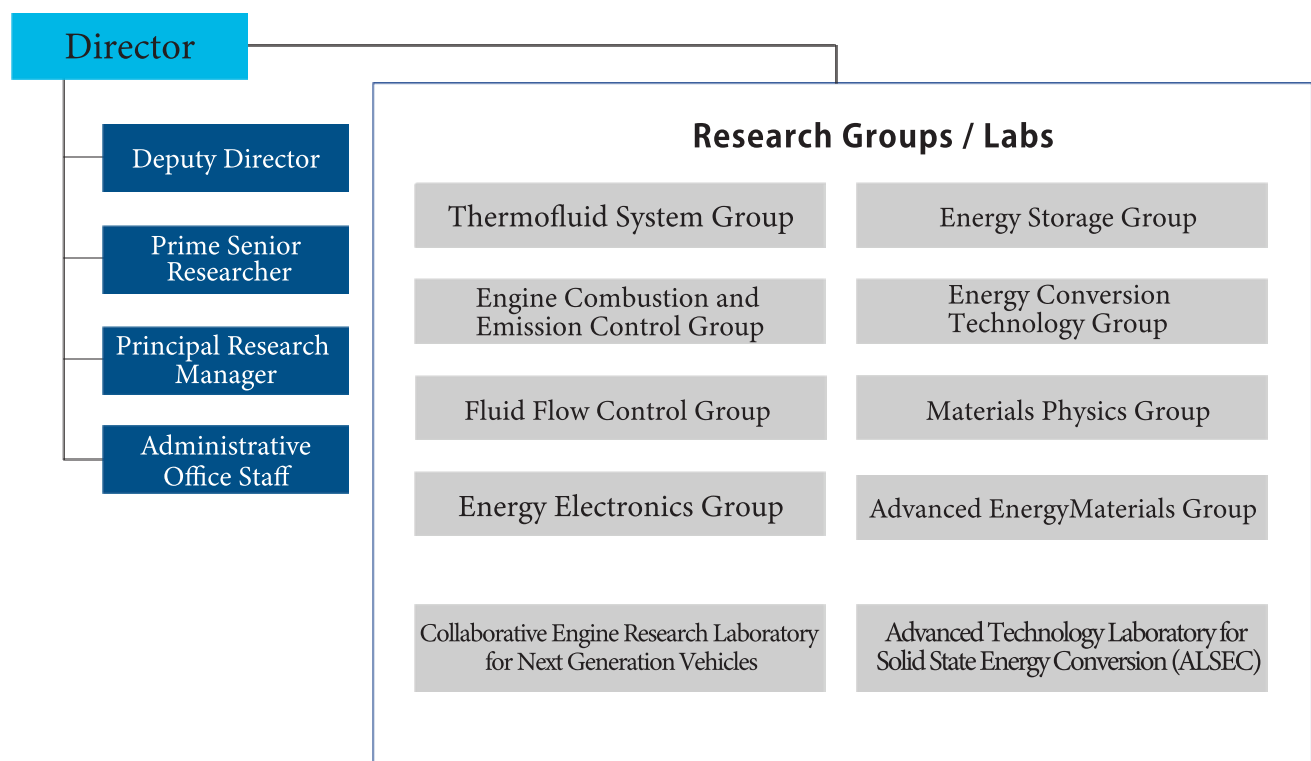
Outline of iECO

It is an urgent and global issue to utilize the limited energy resources and reduce the emission of greenhouse gases. The research institute for energy conservation (iECO) is promoting fundamental research for significant reduction of greenhouse gas and applied R&D on mobility energy for enhancement of industrial competitiveness.

In eight groups and two collaboration laboratories, we are conducting the following four main topics; (1) High conversion technology for hydrogen and ammonia gas turbine, fuel cells/electrolysis, and thermoelectric, (2) High efficient transport, storage and utilizing technologies for heat/electricity/light, (3) R&D on optimization of mobility energy and highly efficient propulsion system applied to automobiles and aircraft, and (4) Fundamental studies on thermos-fluid measurement technology and numerical simulation technology that support the above R&D.

We widely collaborate with other organizations, universities, and private companies by utilizing the above activities.

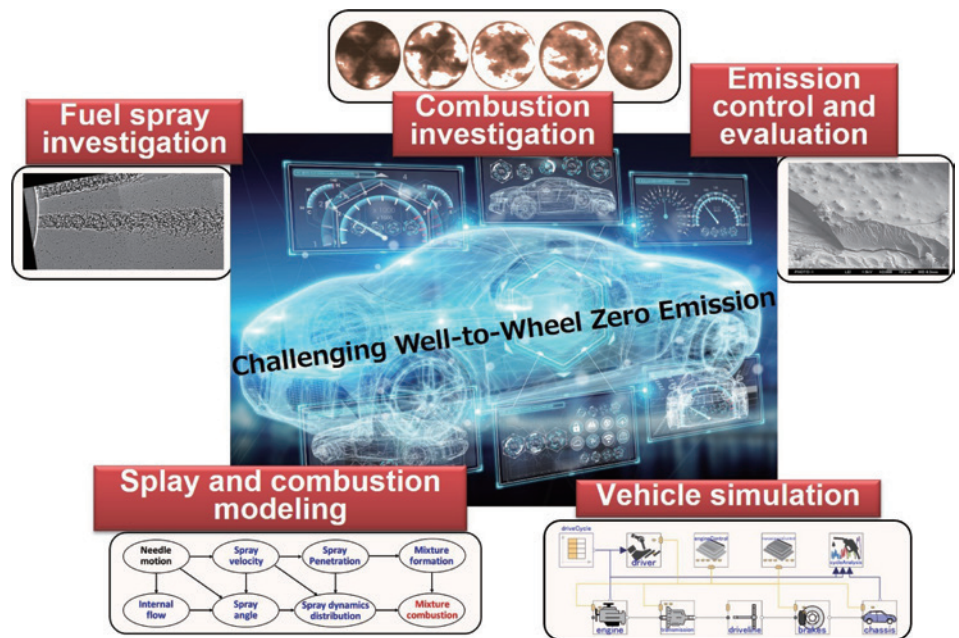
Organization of iECO



Tenured Researchers 44 / Contracted Staff 46
(As of October 2023)

Collaborative Engine Research Laboratory for Next Generation Vehicles

Electrifying cars, including hybrid cars, is essential for a sustainable mobility society. On the other hand, the combination of power trains is wide-ranging, the development process has become extremely complicated, and development in the automobile industry is shifting to Model-based development (MBD). In this lab, an MBD platform for evaluation as an automobile system is building with open source software, then, linked the results of various phenomena elucidation research and device development research undertaken by AIST. to. We are taking on the challenge of R&D on the ultimate (dream) automobile "zero-emission vehicle" with the comprehensive strength of AIST.



Model-based research image for zero-emission vehicles

Keywords :

Internal combustion engine, Electrification, Automotive fuel, Fuel spray, Engine combustion, Emission catalyst, Standardization, Vehicle simulation model, Well to Wheel, Zero emission

Advanced Technology Laboratory for Solid State Energy Conversion (ALSEC)

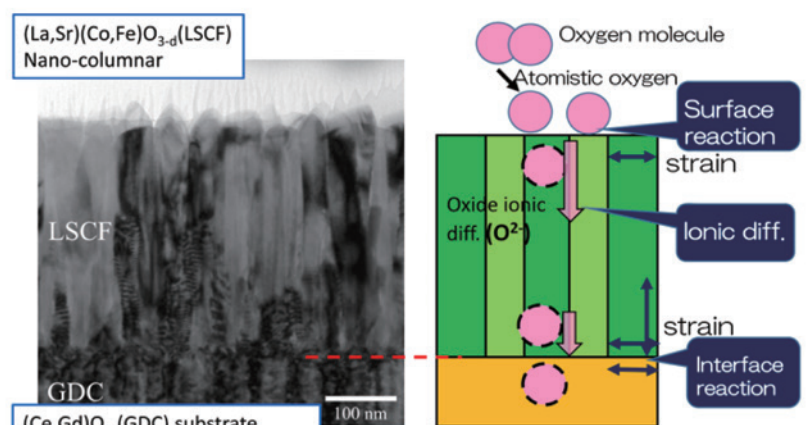
Advanced Technology Laboratory for Solid State Energy Conversion (ALSEC)

The ALSEC focuses the study for developing the cutting edge technology on Solid Oxide Fuel Cells (SOFCs) and Solid Oxide Electrolysis Cells (SOEC). Also, the activities cover all solid-state ionic conducting devices as well as the technological support of the Advanced Technology Consortium for Solid State Energy Conversion (ASEC-2).

1. Investigation of cutting edge technology for SOFCs, such as new materials, cell-stack fabrication methods, and evaluation methods
2. Investigation of new and efficient energy conversion technology using ionic conducting solid-state electrolytes
3. Combining the research scientists' activities with different fields to induce a synergy effect
4. Establishment of Innovation-Hub for SOFC-SOEC technology with companies, universities, and research institutes.

High Performance SOFC Cathode

TEM image of cathode (left) and oxide ion diffusion path (right)



K. Develos-Bagarinao et al., *Solid State Ionics*, 288, 6-9 (2016)

Keywords :

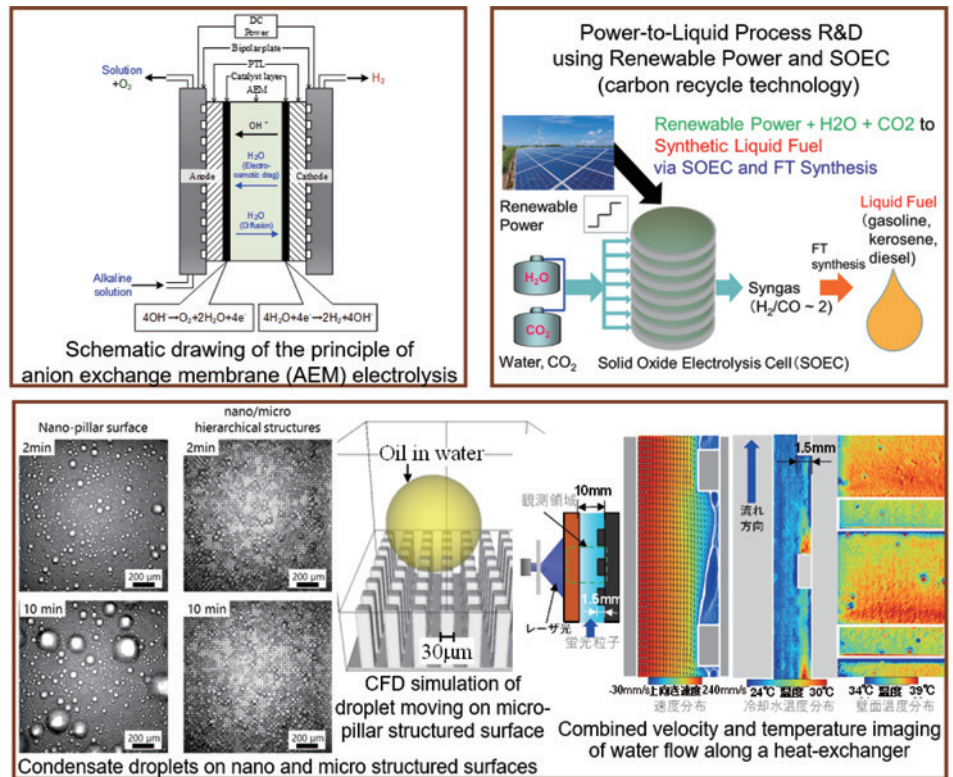
SOFC, SOEC, solid-electrolyte, electro-chemistry, ceramic processing

Thermofluid System Group

Our main mission is to construct a technical foundation for the approaching of the “sustainable society”. Our research topics include visualization and numerical simulation technologies related to the phase-change heat transfer, heat-pumps, or power generation cycles. In addition, our research covers the electrochemical energy conversion devices such as fuel cells, water electrolyzers, and co-electrolyzers.

Keywords :

Water electrolysis, Solid oxide cell, Latent heat technology (Thermal storage, Boiling, Heat exchanger), Heat and flow visualization, CFD (Computational fluid dynamics)

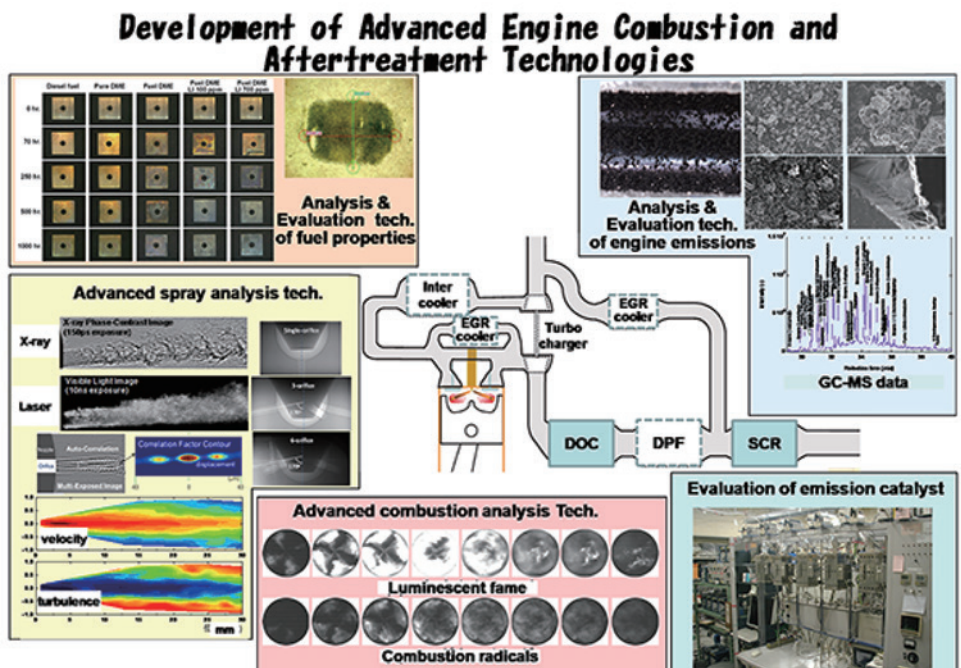


Engine Combustion and Emission Control Group

We perform the fundamental and advanced researches associated with the engine combustion and after-treatment technologies to resolve the common problems that automotive manufacturers have encountered. On the other hand, we also develop the practical technologies that can be used for improvement of engine thermal efficiency to contribute to the significant reduction of fossil fuel use and CO₂ emissions. In the meantime, we endeavor to establish the domestic and international standard of automotive fuels.

Keywords :

Simulation, Internal combustion engine, Fuel, Spray, Combustion, Emission catalyst, Standardization



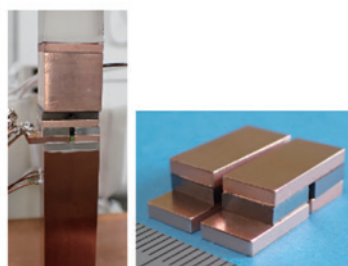
Materials Physics Group

As a sustainable low-carbon society, it is strongly desired to develop technologies for efficient use of energy and for reducing carbon dioxide emissions. In order to respond the need of society, Materials Physics Group investigates physicochemical phenomena of thermoelectric materials, developing new materials, and development and evaluation of thermoelectric modules.

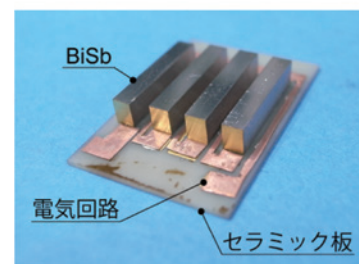
Furthermore, our group develops the post lithium-ion batteries with high capacity and power, which is considered a promising next-generation storage system.

Keywords :

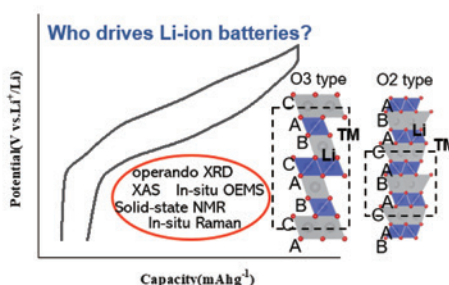
Thermoelectric materials, Thermoelectric power generation, Thermoelectric modules, Perovskite solar cells, Electrode materials, Lithium-S battery, Lithium-ion battery



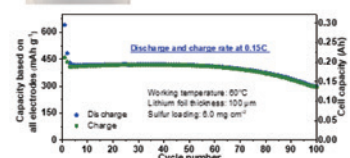
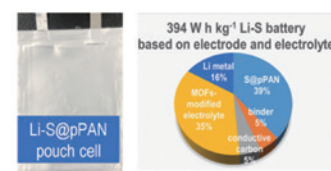
Development and evaluation of thermoelectric modules



Nernst effect modules



Toward high energy density Lithium ion batteries through developing of materials



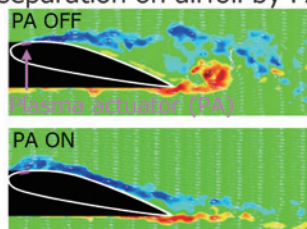
Development of high-performance lithium-S batteries

Fluid Flow Control Group

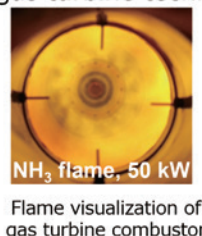
In order to improve the aerodynamic characteristics and efficiency of fluid machinery, it is necessary to develop advanced flow control devices such as sensors/actuators and to build control systems integrated them. This research group is engaged in the following research topics with the aim of realizing green innovation with the Sustainable Development Goals (SDGs) and strengthening industrial competitiveness.

1. Improvement of vehicle aerodynamic characteristics and fuel efficiency by using flow control devices
2. R&D of novel aircraft and flight control technology to improve flight performance and flight efficiency
3. R&D of ammonia and hydrogen gas turbine combustion technology

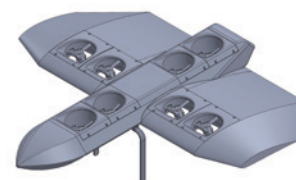
- Feedback control of flow separation on airfoil by PA



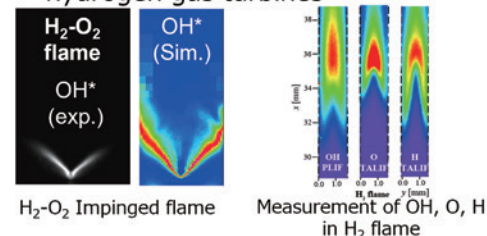
- Ammonia combustion gas turbine technology



- Fixed wing VTOL UAV



- Combustion technology for hydrogen gas turbines



Keywords :

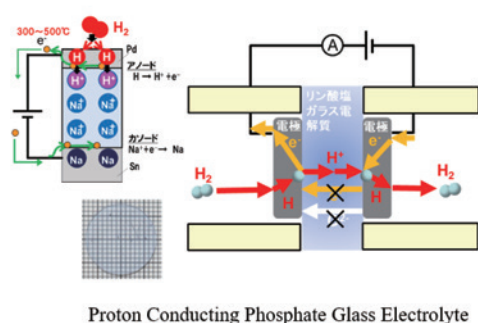
Automotive aerodynamics, Drone, Gas turbine, Active flow control, Plasma actuator, Plasma fluid simulation, Data science, Flight control, Combustion, Hydrogen, Ammonia

Energy Conversion Technology Group

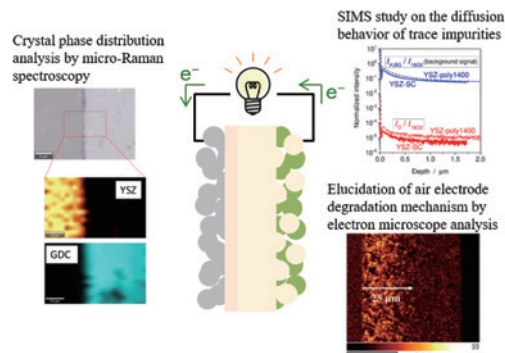
Research and development of highly efficient energy conversion technology is indispensable in meeting the increasing demands for electrification of energy. Our group is focusing on research and development of energy conversion devices operated at high temperatures – solid oxide fuel cells (SOFC) for converting with high efficiencies diverse types of fuels such as fossil and biomass fuels into electric power, and solid oxide electrolysis cells (SOEC) for converting surplus power from renewable energies into highly efficient and high-value added fuels. In particular, we play an important role as a public research institute in the ongoing efforts for the enhancement of SOFC durability/reliability through collaboration with companies and universities. As a future endeavor, even more highly efficient energy conversion devices based on solid state ionics phenomena are envisaged by carrying out comprehensive research and development including the development of evaluation technology, and thus further contribute to the realization of a low carbon society.

Keywords : Energy Conversion Devices, Solid Oxide Fuel Cell (SOFC), Solid Oxide Electrolytic Cell (SOEC), Solid State Ionics

Development of next-generation fuel cells



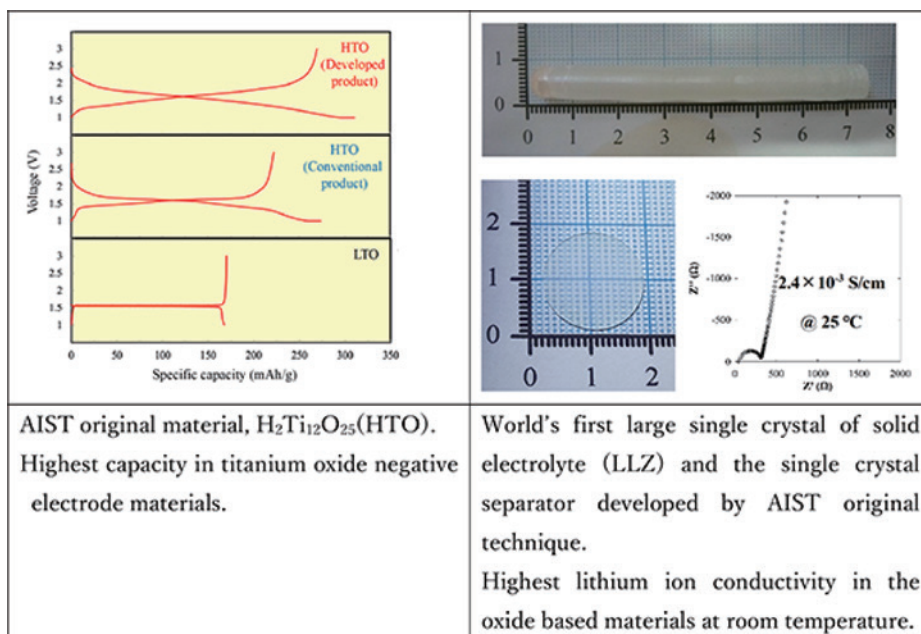
Solid Oxide Cell (SOC) Analysis



Advanced Energy Materials Group

Lithium secondary battery is expected as devices for future low carbon society by widely use and development for large power supplies of automobiles, stationary, IoT etc. Therefore, it is important to be safety, long life, higher capacity, and low cost.

In our group, advanced oxide based materials, such as new electrode materials and solid electrolyte materials, have been developed for next generation liquid type lithium secondary battery and all solid lithium secondary battery. In addition, advanced material design has been promoted by development of new synthesis processes, and application of techniques such as crystal structure analysis and physical properties evaluation.



Keywords :

Inorganic material synthesis, Single crystal growth, Crystal structure analysis, Lithium secondary battery, All-solid lithium secondary battery

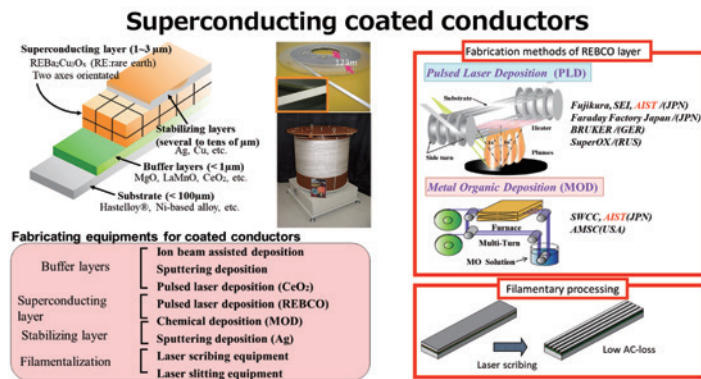
Energy Electronics Group

For effective utilization of energy resources and efficient use of energy, we are engaged in the research and development of following subjects.

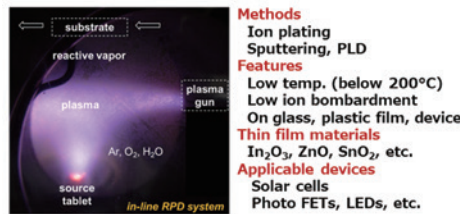
1. R&D of basic technologies related to superconducting coated conductors for the promotion of electrification of mobility such as aircraft and automobiles
2. R&D of new materials and evaluation of new structures of chalcogenide and oxide semiconductor for solar cell applications and opto-electronic applications

Keywords :

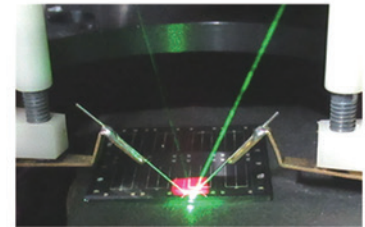
superconductivity, wire, aircraft electrification, solar cells, chalcogenides, transparent conductive oxide, photoelectron spectroscopy



High-mobility broadband TCOs Optoelectronic Devices



Fabrication and evaluation of low cost and earth abundant CZTS solar cell

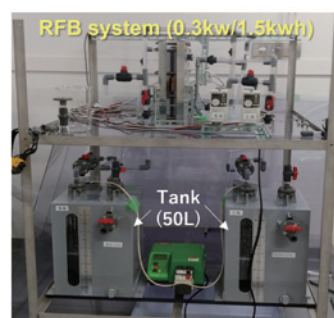


Energy Storage Group

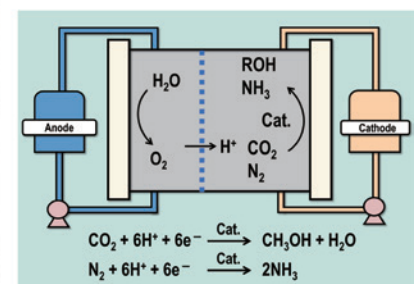
Our group aims to develop highly efficient energy storage technologies that contribute to the reduction of greenhouse gases and the effective use of energy resources. Specifically, we are engaged in research on various elemental technologies (material and cell development, evaluation of stability and performance, and development of reaction system) that make up energy storage systems, including in addition of redox flow batteries (RFBs), lithium ion batteries (LiBs), and all-solid-state batteries, the development of new storage technologies using hydrogen and CO₂ or N₂ based on chemical/electrochemical reactions.

Keywords :

Redox Flow Batteries, Lithium-ion Batteries, All-Solid-State Batteries, CO₂ electroreduction, NH₃ electrosynthesis



Development of novel high-performance RFBs



CO₂ electroreduction
NH₃ electrosynthesis



Fabrication and evaluation of all-solid-state batteries



Stability evaluation for LiBs

Website

- **Research Institute for Energy Conservation** <https://unit.aist.go.jp/ieco/en/>
 - Collaborative Engine Research Laboratory for Next Generation Vehicles
<https://unit.aist.go.jp/ieco/en/groups/index.html#cerlab>
 - Advanced Technology Laboratory for Solid State Energy Conversion (ALSEC)
https://unit.aist.go.jp/ieco/alsec/index_en.html
 - Thermofluid System Group
<https://unit.aist.go.jp/ieco/tfs/>
 - Engine Combustion and Emission Control Group
<https://unit.aist.go.jp/ieco/ec2/en/index.html>
 - Materials Physics Group
<https://unit.aist.go.jp/ieco/ieco-mp/>
 - Fluid Flow Control Group
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 - Energy Conversion Technology Group
<https://unit.aist.go.jp/ieco/ect/>
 - Advanced Energy Materials Group
<https://unit.aist.go.jp/ieco/en/groups/index.html#ademat>
 - Energy Electronics Group
<https://unit.aist.go.jp/ieco/eeg/>
 - Energy Storage Group
<https://unit.aist.go.jp/ieco/est-2021/>

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