



Faculty of Engineering  
Reactive Gas Dynamics Laboratory

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▶ <http://www.mech.kyushu-u.ac.jp/~rgd/index-j.html>

➤ Towards Smart Utilization of Combustion Energy

"Reactive Gas Dynamics" is a study field of gas dynamics that deals with reactive flows, such as combustion. Combustion phenomena are studied in our Reactive Gas Dynamics Laboratory. Huge amount of energy is utilized by combustion of fuel in the world. And the demand for energy is still growing. It is very important to understand combustion properties of fuels for the global warming and energy issue.

Combustion properties of fuel affect the performance of combustors, such as engines. We investigate the fundamental and practical aspects of combustion properties and techniques by experiments using an apparatus unique in the world and numerical simulation towards the smart utilization of combustion energy. Our interests include not only conventional fuels but also alternative and next-generation fuels such as carbon neutral biomass, coal gasification gas and hydrogen. Our studies contribute to the developments of automobile engines, electric power plants and combustors in industries.

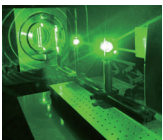
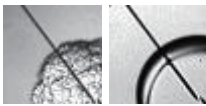
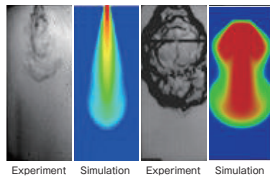


Fig. 1 Flame Visualization by Laser Tomography



Hydrogen flame Propene flame  
Fig. 2 Comparison of Hydrogen Flame with Hydrocarbon Flame



Experiment Simulation Experiment Simulation  
Hydrogen Jet Combustion of Jet  
Fig. 3 Hydrogen Jet and its Combustion



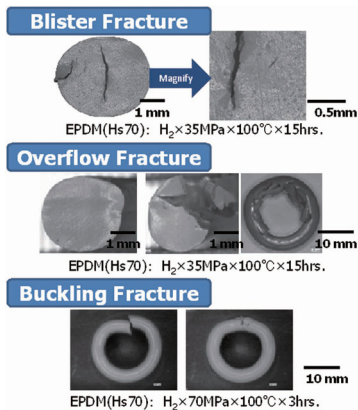
Faculty of Engineering  
Advanced Hydrogen Materials Laboratory

Shin NISHIMURA  
(Professor)

➤ Influence of High Pressure Hydrogen Gas on Rubber and Polymeric Materials.

Rubber and polymeric materials are used as sealing devices of high-pressure hydrogen gas in equipment for hydrogen energy systems. For example, rubber O-rings for hydrogen gas sealing can be broken by high-pressure hydrogen exposure, as shown in the figure below.

In our laboratory, we are going to clarify the fracture phenomenon of rubber and polymeric materials exposed to high-pressure hydrogen gas. In order to clarify the influence of dissolved hydrogen on the fracture behavior of the materials, we have been performing thermal desorption analyses and nuclear magnetic resonance measurements of the dissolved hydrogen gas in the materials. To establish material design guidelines for high-pressure hydrogen sealing materials, we are continuously discussing the relationship between fracture behavior of the materials and their composition or molecular structure.



Three fracture modes of rubber O-ring after repeating high-pressure hydrogen gas exposure.



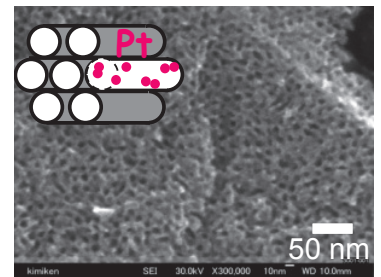
Graduate School of Engineering  
Advanced Hydrogen Energy System Lab

Akari HAYASHI  
(Professor)

➤ Fuel Cell Research for Vehicles

In our laboratory, fuel cells and related technologies for FCVs are focused on. We have been particularly working on novel electrocatalysts, which play a most important role for fuel cell performance, with following approaches.

- Encapsulation of Pt into nano-channels to suppress Pt aggregation, leading to high activity and durability
- Graphitization of carbon surface, leading to increased tolerance to carbon oxidation
- Investigation of electrode degradation at higher temperature operation
- Investigation of degradation mechanism by In-situ SEM/TEM



Carbon Materials with Nano-channels



International Institute for Carbon-Neutral Energy Research (iCNER)  
Electrochemical Energy Conversion Research Division

Hiroshige Matsumoto  
(Professor)

➤ Hydrogen production and energy conversion via electrochemistry

Electrochemistry plays an important roles for conversion between electric and chemical energies, e.g. fuel cells and electrolysis. Research on solid state ion conductors have been conducted. Namely, proton-conducting oxides that operate at  $400 \sim 800^\circ C$  and metal oxide nanoparticles which conducts protons on the surface are studied for the fundamental understanding as well as for technological applications. Water/steam electrolysis is one of the major topics from a view point of utilizing renewable energies.



Proton conducting oxides



Surface-proton conducting nanoparticles