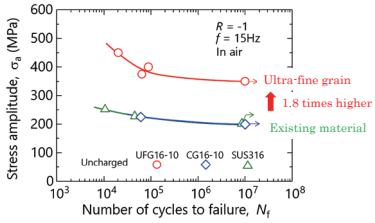
International Institute for Carbon-Neutral Energy Research
Hydrogen Compatible Materials and Interfaces Division

Masanobu KUBOTA
(Professor)

Studies on hydrogen-induced degradation of materials strength enables optimization of the cost, performance, and safety of hydrogen systems

Hydrogen is one of promising solutions to realize sustainable and environmental-friendly society. However, hydrogen can degrade material strength. Therefore, it is very important to study how to safely use materials in hydrogen environment. For this objective, we carry out a variety of material testing under the effect of hydrogen. Based on the experiments, we are aiming at elucidation of mechanisms that hydrogen reduces material strength. Ultimately, predictive model of hydrogen-induced degradation of material strength will be established in collaboration with computation. When considering practical design of hydrogen equipment, many kinds of material properties are required such as high-cycle fatigue, fretting fatigue, tensile properties, crack growth properties, fracture toughness, etc. Through these evaluations, we take a part in a development of new hydrogen equipment such as pressure gauge, strain gauge, hydrogen packing, etc. Furthermore, a next-generation high-strength steel is also studied. The figure shows the result of fatigue test of an ultra-fine grain stainless steel, which crystal grain size is roughly 1/30 of that of common engineering steels (1 μm). As the result of grain refinement, the material has 1.8 times higher fatigue strength. The result clearly indicates a great potential of the ultra-fine grain steel to be next-generation high-strength steel.



Kyushu University Inamori Frontier Research Center
Frontier Energy Research Division

Michihisa KOYAMA
(Professor)

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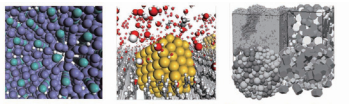
▶http://inamori-frontier.kyushu-u.ac.jp/energy/index-j.html

Frontier Energy Technologies for Sustainable Society

We are conducting research on materials for future energy technologies using theoretical approaches. Understanding phenomena at surface and nano-interface is essential for developing highly functional materials for future energy technologies such as fuel cells, batteries, photovoltaics, biomass utilization, and hydrogen storage materials.



Theoretical Study on Solid Oxide Fuel Cells (SOFC)

SOFC is a highly efficient energy conversion technology. For the higher performance and durability of SOFCs, we are developing platform technologies for designing materials and microstructure of porous electrodes by clarifying multi-scale and multi-physics phenomena in complex porous electrode systems. For this purpose, validations of theoretical approaches collaborating with experimental observations are important.

Theoretical Study on Low Temperature Fuel Cells

We are applying a variety of computational chemistry methods on the practical issues, such as degradation and catalyst design, as well as fundamental issues in polymer electrolyte fuel cell and alkaline fuel cell.

Theoretical Study on Future Energy Technologies

To understand and overcome the issues in future energy technologies such as battery, photovoltaics, biomass utilization, hydrogen storage materials, functional catalysts, we are challenging theoretical materials design collaborating with researchers from other institutes and industries.

Grand Design of Carbon-Neutral Society

We are developing tools for envisioning the carbon-neutral sustainable society with feasible technologies collaborating with researchers from a variety of backgrounds. We are discussing future visions free from a priori bias on specific technologies.

International Research Center for Hydrogen Energy

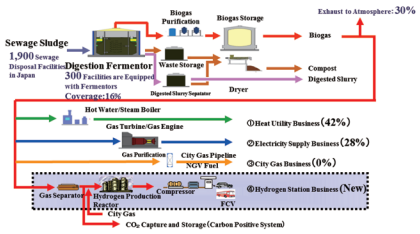
Masaki TAJIMA
(Visiting Professor)

Research on the low-carbon hydrogen production technologies, using renewable energy and town gas, etc.

The laboratory was launched in April 2011 as a Japan Gas Association endowed chair program. The association believes that it can contribute towards the ushering in of a hydrogen-powered society, by further improving its extensive gasification technologies in town gas production. Automakers and energy companies aim to build hydrogen stations, a key factor in realizing a hydrogen-based society, by 2015 when launch of mass-produced fuel cell vehicles begins. The laboratory will be involved in research into hydrogen production technologies indispensable to the creation of a society powered by hydrogen, especially renewable energy sources that offer hope for future commercialization and hydrogen production from low hydrocarbon material such as town gas. Our research into hydrogen production technologies including that into a system for the creation of a hydrogen-based society is will be carried out through collaboration with other laboratories in the Department of Mechanical Engineering, and the International Research Center for Hydrogen Energy.

Main research themes

- Technologies for hydrogen production from biomass that is considered carbon neutral (wood, agricultural residue, sludge, etc.)
- Integration with existing hydrogen production technologies such as those utilizing materials listed above (i.e. wood, agricultural residue, sludge, etc.) and town gas
- Investigation into the introduction of domestic and overseas hydrogen production technologies that use renewable energy in social systems
- Elemental and fundamental technologies in the overall technological development for hydrogen production, transportation and storage systems
- Investigation into systems for the creation of hydrogen-based society



Hydrogen Production System with Biogas from Sewage Sludge