Faculty of Engineering
Fuel Cell System Laboratory

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Electrochemical energy converters, such as fuel cells and electrolyzers, can work at higher efficiency and an excellent reliability with lower noise. These outstanding features of fuel cells and electrolyzers motivate us to utilize them as a main energy converter in the next generation. Although commercialization is already underway, a more cost-reduction, durability and performance are required to be addressed. Against this background, our laboratory conducts R&D for fuel cell and electrolyzer based on a mechanical engineering approach as shown:

- Elucidation of mass, heat and charge transport in cell :
- Development of diagnostic and visualization techniques :
- New proposals :optimization, sophisticated systems :

As a recent topic, our team succeeded to obtain 3D temperature distribution with thin in-line thermocouples (TCs) with fine positioning. It figured out that the temperature under channel was higher than that under rib. This result connects to the understanding of water behavior, leading to appropriate water management.

In addition, humidifier-less technique is being developed for cost-reduction. We built in a gas circulation and humidity recovery system into a cell, with newly designed GDL which contains both hydrophobic and hydrophilic MPL as shown in the photograph. These efforts realize a high performance PEFC without humidifier.

Moreover, our analysis skill of impedance helps to grasp the heat sources in the SOFC during operation. The heat sources obtained is formulated as the thermal modeling, which can estimate temperature and current distribution in unit cell. This result is accessible for the control of thermal stress and the effective use of electrodes. Contact us: kohei@mech.kyushu-u.as.jp

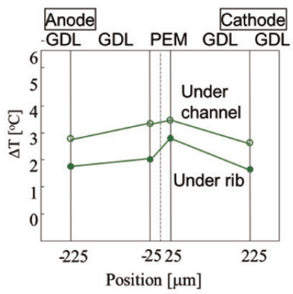

Fig.1 Temp. distribution in a PEEC with thin TCs.

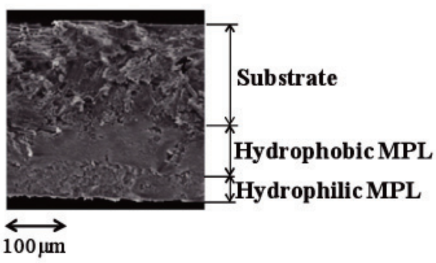

Fig.2 Tailor-made MPLs fabricated on a GDL.

Faculty of Engineering
Tribology Laboratory

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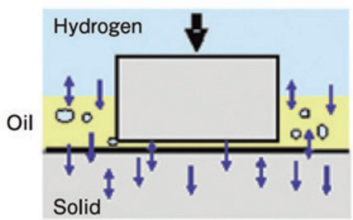
Tribology in High Pressure Hydrogen

Tribology, a term born in the UK in 1966, is a name of the field of "the science and technology of various phenomena occurring between two interacting surfaces in relative motion, and of related subjects and practices*" such as lubrication technology for reducing friction and wear.

We are studying tribology in hydrogen. It is well known that tribological phenomena are often affected by the surrounding gas. If the gas is hydrogen, surface phenomena are quite different from those in air, because it does not contain oxygen and water, or contains only very small amounts of oxidative substances that are known to form protective films on surfaces. It is not only chemical reactions on the surfaces that depend on environmental gas, but a number of physical and chemical processes occurring at or near the surfaces, adsorption, diffusion, deformation, wear and adhesion depends on the gas. Machines to produce, store, transfer and utilize hydrogen have a number of machine elements including bearings, valves and seals which are exposed to hydrogen. In order to ensure their long and reliable operation, it is necessary to establish the methods to understand and design materials and lubrication for hydrogen. However, little is known about effects of gaseous hydrogen in tribology.

Since tribological phenomena include a number of different phenomena according to applications and conditions, our project includes a number of different sub topics. They include sliding friction and wear of materials used in bearings, valves and seals, rolling contact fatigue of materials, fretting wear at contacts under reciprocation with small amplitudes. The materials being tested include steels and other metals and alloys, carbon-based coatings, polymers, elastomers and ceramics. Experiments are conducted in different gas environments including hydrogen, argon, nitrogen and air, and also with materials exposed to high pressure hydrogen. In order to understand tribology in hydrogen, it is necessary to understand the behavior of hydrogen, chemical reactions, and transportation at and near solid surfaces, and the subsequent changes in chemical and mechanical properties of surface layers. We continue to study these fundamental mechanisms in order to contribute to future tribology technology to ensure the reliability of hydrogen systems.

★ from Glossary of OECD



It is necessary to understand mechanisms of generation of hydrogen, its adsorption on solid surfaces, chemical reactions, permeation into and diffusion in solids at tribo-interfaces and the resulting changes in mechanical and chemical properties of surface layers.