Designed for the safe production of hydrogen and its use as an energy source

Public expectations are high for the use of hydrogen energy as a solution to global warming issues, since it is free of carbon dioxide (CO_2) emissions during use. We work on the development of solid oxide fuel cells (SOFC) and other products for the safe production and use of hydrogen.

FC EXPO 2011

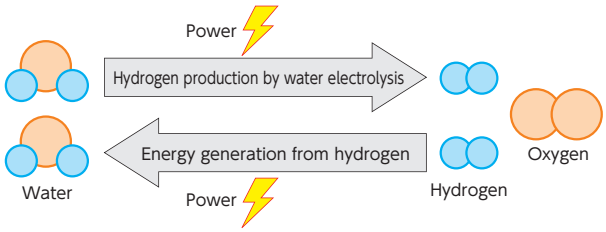
Renewable Energy Sources and Hydrogen

People's lives today are sustained by fossil fuels such as oil and natural gas. However, global warming issues, the depletion of fossil fuels, and power supply instability have increased people's interest in renewable energy sources such as solar, wind, geothermal, and low head hydro power.

Renewable energy sources are present everywhere on the Earth and will be available as long as the Earth exists. However, most renewable energy sources depend on weather conditions. Moreover, it is difficult to adjust the power output they produce. Consequently, hydrogen has attracted attention as a means for the efficient use of renewable energy sources.

Highly Valuable Hydrogen in Wide Applications

Hydrogen is produced by water electrolysis. When excess power from renewable energy sources is used to produce hydrogen by water electrolysis and the produced hydrogen is stored or transported, it becomes possible to use the produced hydrogen during other hours of the day or in other places.



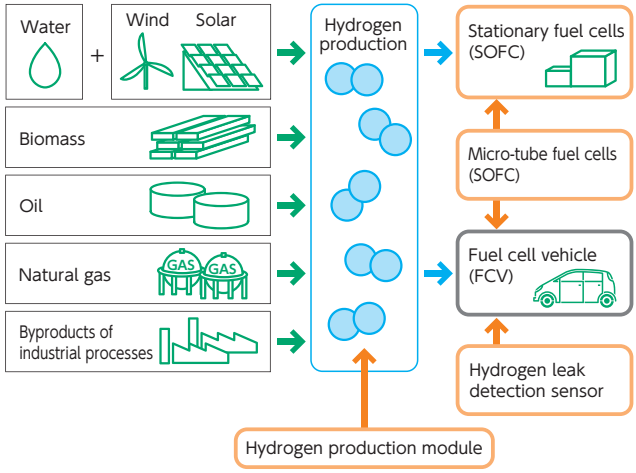
Hydrogen can immediately serve as a fuel. Moreover, by using fuel cells, which we have also developed, electricity and heat can be produced from hydrogen. After generating energy, the element returns to water, without producing carbon dioxide (CO_2), nitrogen oxides (NOx) or sulfur oxides (SOx). It is therefore a clean energy source.

Toward a Society Making the Best Use of Hydrogen

Hydrogen is produced from various resources such as fossil fuels and biomass (wood chips and residues of crops) as well as water. This implies that hydrogen can be produced onsite where it is required, making it useful for the construction of a dispersed energy system. Furthermore, if methods of producing hydrogen from water or biomass become widespread in the future, people's dependence on fossil fuels may decrease.

Before the use of hydrogen becomes popular, it is necessary to solve problems associated with safety, cost, efficiency, hydrogen production involving CO_2 emission, and storage. Researches are actively being conducted to address these problems, so as to build a society that uses hydrogen as an energy source for fuel cell vehicles and for household and commercial purposes. In response to such a situation, we will develop fuel cells and other products/technologies required for the safe and effective use of hydrogen.

■ Types of hydrogen production methods and our product lineup



Voice

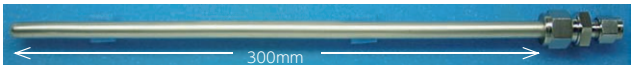
Due to interest in the use of hydrogen as an ultimate clean energy source, a national project commenced some 20 years ago. The idea already existed of converting renewable energy sources to hydrogen and using it for power generation. In 2002, the Japan Hydrogen and Fuel Cell Demonstration Project (JHFC) took over the research, ending it in March 2011 after conducting various demonstration programs. This year, the industry moved toward the commercialization of hydrogen. Domestic automakers have announced scenarios to reduce the prices of fuel cell vehicles by 2020 to a level that permits their widespread use. We have worked for years on hydrogen energy-related development themes, as described in this feature article. The Company intends to make accelerated research efforts in line with the hydrogen energy commercialization trend, in order to contribute to the implementation of a low carbon society.

Takafumi Oshima
Senior Managing Director
General Manager, Engineering R&D Group

Producing Hydrogen Toward Improved Conditions for Hydrogen Production <Hydrogen Production Module>

Fuel cell vehicle (FCV) sales will commence in 2015 to general users. We are working on the development of hydrogen production modules for highly efficient production of high-purity hydrogen as an FCV fuel.

Steam reforming method from natural gas is the most popular hydrogen production method. The conventional method requires high temperatures of 700°C to 800°C to reform natural gas. In contrast, at 500°C to 550°C, the module we have developed achieves a level of reform efficiency comparable to the conventional method. The secret behind the reform at lower temperatures lies in the integrated structure of the reforming reaction section and the hydrogen selective separation membrane. The result is a single module capable of performing both reform (hydrogen generation) and refining (purity improvement) within a compact unit.



Hydrogen production module

The current challenge is to reduce the use of the rare metal palladium (Pd, the main ingredient of the hydrogen separation membrane), which accounts for a large part of the cost of the module. With all our ability, we are working on the development of an environmentally friendly module that will be well received in the market.

Voice

For coming hydrogen energy society in the near future, we all develop the hydrogen production module as one. Although we will face many problems and difficulties in the course of the development, we have to commercialize our module. We want to contribute to construction of hydrogen energy society through the commercialization of the module.

Hideaki Hikosaka
Group Leader, Engineering R&D Group

Using Hydrogen Contribution to Spread SOFCs to Various Applications <Micro-Tubular SOFCs>

SOFCs greatly contribute to reducing CO_2 emissions. We are working on development of micro-tubular SOFCs, which is compact and has robustness for rapid start/stop, with a view to the use of SOFCs in various applications.

The micro-tubular SOFC is the most suitable candidate for low temperature operation and rapid start/stop. However, there are many problems for realization of useful output power. We have to accumulate the large number of micro-tubular cells with electric connection, gas sealing etc, and we have to need manufacturing techniques arising from the miniature parts and complex configuration.

Our palm-sized SOFC module is crammed 360 tubular cells which are 2mm in outer diameter into 150cm³ volume and these tubular cells are arranged using two types of paste for electric connection. This SOFC module can be operated with the power density of 2W/cm³ below 650 °C.

Such as a high-efficiency energy source, we intend to explore the applications in distributed power supply systems, including auxiliary power units for automobile, portable power units, household cogeneration systems and so on.


Micro-tube cell

High-density integration of 360 tubes


SOFC cell module

Voice

We are promoting the development of micro-tubular SOFCs in order to realize the SOFC units with quick start/stop operation, high performance, and high endurance.

In order to achieve a practical level of fuel cell durability, we do need to solve a lot of problems. However, we hope that our products will be used in a wider range of applications as auxiliary or mobile power units in conjunction with secondary batteries.

Development staff

Providing Protection from Hydrogen Early Detection of Slight Leaks <Hydrogen Leak Detection Sensor>

Our efforts are also directed toward the development of an MEMS thermal conductivity hydrogen leak detection sensor that is suitable for the prevention of and safety regarding hydrogen leaks from fuel cells.

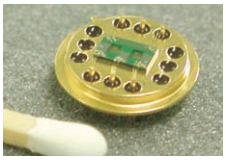
Public expectations are high for fuel cells as a next-generation power generation system. However, one problem they entail is how to ensure safety regarding leaks of the fuel or of hydrogen. Demand is high for a hydrogen leak detection sensor.

We are working on the development of a thermal conductivity hydrogen leak detection sensor. This is a microminiature sensing element comprising a micro heater with a diaphragm structure, which makes use of silicon MEMS technology integrated with a temperature sensor. It detects minute changes in thermal conductivity (the cooling effect of hydrogen), making use of the high thermal conductivity of hydrogen. The detector has electronic circuits incorporating a 16-bit microcontroller provided with an accurate sensing algorithm for micro heater and temperature sensor signals.

Our future efforts will focus on exploring the detector's applications to fuel cell powered forklifts. Furthermore, we plan to install the detector in fuel cell vehicles projected to be mass-produced starting in 2015.


Hydrogen leak detection sensor exterior

Silicon MEMS element



Voice

We want to play our part, even if slight, in helping to solve environmental issues by successfully meeting the remaining challenges and commercializing the detector. One of our development goals is for all automakers to select our detection sensor when their fuel cell vehicles come into widespread use.

Development staff