Research and Development of Polymer Electrolyte Fuel Cells in Japan

Seizo Miyata

Senior Program Manager
New Energy and Industrial Technology Development Organization,
Kawasaki, Japan
miyatasiz@nedo.go.jp

Introduction

New Energy and Industrial Technology Development Organization (NEDO) promotes R&D that individual private sector enterprises can not undertake by themselves. To do this, it utilizes an extensive network that supports cooperation between industries, universities, and public research organizations. NEDO's government-funded R&D budget for FY2005 totals approximately 148.8 billion yen. NEDO is Japan's largest public R&D management organization for promoting the development of advanced industrial, environmental, new energy and energy conservation technologies as well as the introduction of new energy and energy conservation technology.

NEDO uses an efficient and strategic process to coordinate various types of projects involving the industrial, academic and governmental sectors. This has made it possible to achieve superior research results and promote the global level of advanced technology.

NEDO focuses on bringing a professional management approach to such activities as the development of precursor technologies, promotion of mid- to long-term R&D projects, and support of commercial product development.

NEDO is conducting 10 R&D big projects such as biotechnology and medical technology development projects, electronic and information technology development projects and so on.

Fuel cells and hydrogen technology development project is one of them. The budget size was ¥20.8 billion, corresponding to about 60% of annual expenditure of Japanese government for fuel cells in FY2005. These projects consist of 8 programs as follows.

1. Strategic development of PEFC technologies for practical application

This program promotes the development of technology for the practical application at the initial introduction stage, development of elemental technology at the full introduction stage and development of next-generation technology at the full dissemination stage to comprehensively develop highly-efficient, highly-reliable and low-cost polymer electrolyte fuel cells (PEFC).

(1) Development of Technology on Basic and Common issues

This project aims to overcome basic and common issues, such as the clarification of deterioration mechanisms, in order to contribute to the improvement of durability, economic efficiency and the performance of PEFC systems, including fuel cells for vehicles, stacks and cells. Bsic technologies, such as analysis evaluation technology, that contribute to the research and development of fuel cells will be developed.

(2) Development of Elemental Technology

In order to improve advanced elemental technology required for the practical application of fuel cells for vehicles and to establish elemental technology required for the practical application of stationary fuel cells, this program develops high-risk elemental technology for PEFC electrodes, electrolytes (including membrane-electrode-assemblies), separators, auxiliary equipment and reformers that markedly improve durability and efficiency and reduce costs.

(3) Development of Basic Production Technology

To secure the establishment of a market for stationary fuel cells, this program develops technologies for practical applications, such as basic material production technologies for fuel cell stacks, membrane-electrode-assemblies, separators and auxiliary equipment, for a highly-efficient, highly-reliable and low-cost PEFC.

2. Development of solid oxide (SOFC) system technology

SOFCs can use natural gas and local gas as fuels and are widely adaptable to small-scale distributed systems and large-scale alternative systems for thermal power with high generating efficiency. The aim of this program is to develop, design and manufacture cogeneration and combined cycle SOFC systems that can be used in small and medium-scale distributed power source markets, and to confirm the performance of the developed system through demonstrated operation. System performance evaluation technology will also be developed.

3. Development for safe utilization and infrastructure of hydrogen

In order to ensure the smooth dissemination of hydrogen fuel cells, research and development is under way in two fields: "safety technology" and "commercialization technology". R&D on safety technology will be implemented in "Program for Common Infrastructure for Construction of a Hydrogen Society", beginning in FY2005.

4. Development of fuel cell system with liquefied petroleum gas (LPG)

LPG is used in the majority of Japanese households. A stable supply and efficient distribution of energy to the residential sector, which is predicted to consume more energy in the future, is becoming an increasingly serious problem. Therefore, a highly-efficient, smaller LPG PEFC system is now under development to solve this problem, as well as to contribute to efforts for conserving energy and improving the environment.

5. Development of lithium battery technology for use by fuel cell vehicles

From the perspective of oil alternatives, improved energy conservation, and protection of the environment, there has been an urgent need to develop the technology for, and promote the introduction of, clean energy vehicles, and, in particular, fuel cell vehicles (FCVs). This has required the development of storage technology that can use fuel cells' excellent efficiency to the fullest extent. NEDO is engaged in developing technology for lithium batteries in order to bring about the commercial use of high-efficiency lithium batteries for use in automobiles, which will result in further energy efficiency and load response improvements for FCVs

6. Development of fuel cell technology for portable information devices

In recent years, portable equipment, such as mobile telephones and information terminals, have tended to consume more and more power as they have become more advanced, requiring higher energy density portable power sources.

Under this program, technology is being developed to commercialize, in several years, portable fuel cells that are expected to have a higher energy density as well as greater energy efficiency that chargeable ones currently in use as secondary batteries for portable devices.

7. Establishment of codes and standard for hydrogen economy society

In order to broadly and smoothly disseminate hydrogen and fuel cells to the general public, this program aims to obtain data related to the review of laws, Codes & Standards (C&S), and regulations for the dissemination of fuel cell vehicles and stationary fuel cell system infrastructure. This will aid in the construction of a hydrogen society and development of tests and assessment methods required for obtaining data to, in close coordination with industries, propose advanced technical standards and standardization plans as domestic and international standards, with a view to global markets.

8. Demonstration of residential PEFC systems for market creation

In order to popularize residential PEFC systems smoothly, this program conducts a large-scale and broad-based experimental study of 1kW stationary PEFC systems. The aim is to advance the practical application of fuel cells by extracting issues for future technological development from data obtained through this real life, practical use of stationary fuel cells in typical households.

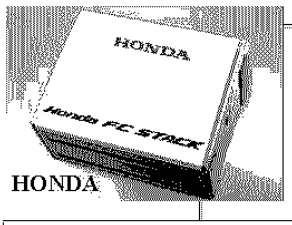
Some highlights of research results are presented at the conference site.

Strategic Research & Development of PEFC System for Commercialization (5.4 billion Yen (US$52M))

- Fundamental R&D of PEFC Technologies
  High Temperature PEM, Robust PEFC System Operating at High Temp's., Standardization of BOP with High Durability and Low Cost, New Catalysis for Reformer System
- R&D of PEFC Systems for Commercialization (50% subsidy)
  Molded Carbon and Metal Separators, Mass Production Technologies for MEA, Reduction of Amount of Pt on MEA
- Fundamental Studies of Degradation Mechanisms
  Clarification and Analysis of Degradation Mechanisms, New Measurement & Analysis Method of Fuel Cell Reaction
- R&D for Next Generation PEFC Technologies
  New Platinum Substitute Catalysts, High Temp. MEA, Ethanol Reformer, Simulation Methods

NEDO

Component R&D for Fuel Cell system



HONDA

Cell stack

Ion exchange membrane

- **4000 hrs** operation for **hydrocarbon** membrane without fluorine
- **Higher temperature operation around 120 deg.C**

Low Cost Separator ($1-2/sheet)

- **Carbon/resin Molded Separator**
- **Stain-less steel Separator**

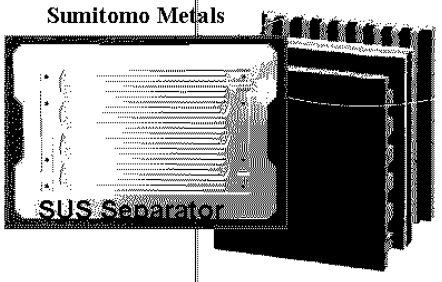
HITACHI

Anode

Cathode

NEC

Sumitomo Metals



MEA and Catalyst

- **Ultra Low Pt loading (0.035mg/cm^2)**
- **Pt** catalyst loaded **on MoOx against CO**
- **Pt** catalyst loaded **on Carbon Nana-Tube**
- **MEA for Low-humidity operation**