●Basic Stage

(Fiscal Year 2006–2008)

Yamanashi Kuninaka Area

Construction of a Decentralized Clean Energy System

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Life Sciences
IT
Environment
Nanotech Materials
Others

Framework for Project Promotion

Project Director……Koki Yokotsuka
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Chief Scientist…… Masahiro Watanabe
(Professor and Director, Clean Energy Research Center, University of Yamanashi)

Science and Technology Coordinators… Yoshihiro Imazawa
Fumiaki Sato
Toshi Nakajima

Core Research Organizations

University of Yamanashi and Comprehensive Research Organization for Science and Technology of Yamanashi Prefectural Government

Major Participating Research Organizations

Industry…Asktechnica Corporation, SCI Corporation, Kikusui Electronics Corporation, Sanyo Machine Works, Ltd., Tokyo Electron Ltd., Tokyo Gas Co., Ltd. Head Office and Kofu Branch, Tokyo Electric Power Company Head Office and Yamanashi Branch, Nistec Corporation, Nippo Precision Co.,Ltd., Fuji Electric Advanced Technology Co., Ltd., Matsushita Co., Ltd., Yamato Scientific Co., Ltd., Yamanashi Prefecture Wine Manufacturers' Association

Academia…University of Yamanashi

Government…Comprehensive Research Organization for Science and Technology of Yamanashi Prefectural Government, Yamanashi Industrial Technology Center, Yamanashi Pref. Fuji Industrial Technology Center, Yamanashi Prefectural Agricultural Technology Center

Aims of Project

This project aims to establish a next generation energy system and related fundamental technologies, that use hydrogen produced from resources such as water, fossil fuels, and biomass. The project will be carried out in cooperation with the core organizations of University of Yamanashi, providing cutting edge fuel cell research, and Comprehensive Research Organization for Science and Technology of Yamanashi Prefectural Government, providing joint research and technology transfer from industry, academia, and the government, and regional enterprises inside and outside of the prefecture.
In addition, through the cooperation of these organizations, the project seeks to construct an “Industrial Cluster for the Environment and Next Generation Energy.” This cluster will serve to aggregate newly allied industries, and enable harmonization of their practices with the environment, related techniques, and current knowledge.
The decentralized clean energy system is expected to contribute significantly to the achievement of a cyclical society in the future, which will be realized through the ongoing promotion and progression of research and development of well established, fundamental technologies.

Contents of Project

1. Research and development of hydrogen production from various fuel resources

A.Elemental study of hydrogen production by high temperature water vapor electrolysis
High-performance electrodes in a high temperature solid oxide electrolysis cell (SOEC), for efficient hydrogen production, will be developed. The production method of electrodes on stabilized zirconia solid electrolyte will be established.

B.Development of a system for hydrogen production from biomass
A fermentation system will be developed that efficiently produces hydrogen and ethanol from the residue of high energy plants such as sorghum and sweet corn - special products of Yamanashi Prefecture. Furthermore, a technique for hydrogen production from the waste of the fermentation and forest industries - which are abundantly available in Yamanashi Prefecture, will be investigated.

C.Trial manufacture of reformers and evaluation of their performance
Fuel hydrogen for PEFCs can be produced conveniently from fossil fuels by steam-reforming, a process that requires catalysts for three steps: reforming, shift, and preferential CO oxidation reactions.
In this program, we aim to establish a mass-production technology for these catalysts, and to accumulate the basic data required for application to 1 kW-sized reformer. In addition, we will clarify the most suitable operating conditions for massively producible catalysts, and describe demonstration plans for practical application.

D.Research, development and demonstration of ultra-small reformers for pure hydrogen production and a hydrogen utilization system
In order to launch and spread the initial hydrogen market effectively, we will research and develop a hydrogen production unit using reformed gas from natural gas.
We will build a demonstration system with a hydrogen production unit and hydrogen utilization system, and we will research the potential production of an optimum first model for the local hydrogen infrastructure, by using data from the demonstration system.

2. Research and development of a power generation device for fuel cell application

E.Development of highly corrosion-resistant and high performance metallic separators, and trial manufacture, evaluation and demonstration in a PEFC power generation system
Low-cost, high durability and compact metallic separators will be developed. These are essential components of fuel cells, which will become an important technology for a hydrogen-energy using society. The fuel cell stacks containing the separators will be also fabricated, and an evaluation will be conducted by replacing cell stacks in the off-the-shelf fuel cell stack system with them.

Main Results

A.Elemental study of hydrogen production by high temperature water vapor electrolysis
It was found that the exchange current density (a measure of electrocatalytic activity) increased in proportion to the circumference length of Ni nanocatalysts for the double-layer type Ni-SDC cathode. We proposed a new double-layer type anode (LSCF+SDC)/LSCF, and succeeded in enhancing the performance significantly, compared with performance of the conventional single-layer anodes.

B.Development of a system for hydrogen production from biomass
A method for the production of hydrogen from coniferous and broadleaf trees using the microbial system was developed. The production of methane and hydrogen from rice straw, waste from fruit culture, and residue from wine making was also investigated. In addition, the cultivation condition of sorghum as raw material for ethanol production was examined, resulting in 1.7 to 2.2 times increase in the harvest. On the other hand, for breeding of yeast for efficient ethanol production, the vector for over expression of the gene SED1 (involved in high sugar tolerance in the commercial strain), was prepared by gene manipulation technique.

C.Trial manufacture of reformers and evaluation of their performance
We suggested use of a honeycomb catalyst and investigated a manufacturing method and its subsequent basic performance. We established a technology to coat a catalyst powder on to a honeycomb support and confirmed its practical application and performance. In addition, using the honeycomb catalysts, we established the most suitable operating conditions to achieve the targeted value, using actual equivalency gas.

D.Research, development and demonstration of ultra-small reformers for pure hydrogen production and a hydrogen utilization system
We produced and installed a small hydrogen purification unit. The units setting area was less than 5m², the targeted value. Moreover, we achieved stable hydrogen production and a 65% hydrogen recovery rate. We also installed a 6kW fuel cell (generated by pure hydrogen) and a load resistance device using the electricity generated. In order to develop the hydrogen sensor, a sensor chip, an oscillation circuit, and a gas supply source were made for trial purposes. As a result of experiments, it was confirmed that the hydrogen sensor reacted with 2% density of hydrogen.

E.Development of highly corrosion-resistant and high performance metallic separators, and trial manufacture, evaluation, and demonstration in a PEFC power generation system
We successfully prepared metallic mono- and bi-polar separators with thin carbon/resin composite layers and serpentine one flow-field(s). We confirmed a sufficient corrosion resistance of more than 2000 h by testing through immersion in 0.1M H_2SO_4 solution, and also tested operation under practical cell-operation atmospheres. The short stack test performance produced almost the same results as that of standard graphite separators, i.e., JALI Cell, and the life-test is continued. Processes that shortened the production time without losing performance are now being further developed.