●Basic Stage

(Fiscal Year 2003-2005)

Fukui Central Area

Development of technology to produce the new materials for energy devices by using nano-plating

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Life Sciences
IT
Environment
Nanotech Materials
Others

Project Promotion

Chief Scientist… ……Masayuki Takashima
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Takaaki Demizu

Core Research Organizations

University of Fukui, Fukui University of Technology,
FUKUI NATIONAL COLLEGE OF TECHNOLOGY,
Industrial Technology Center of Fukui Prefecture

Major Participating Research Organizations

Industry…KIYOKAWA Plating Industry Co., Ltd.,
Tanaka Chemical Corporation, NICCA CHEMICAL CO.,LTD.,
SEIREN Co.,Ltd., SAKAI OVEX CO., LTD., Eyetech Co., LTD,
FUKUSHIN KOGYO Co., Ltd., Japan Atomic Energy Agency
Academia…University of Fukui, Fukui University of Technology,
FUKUI NATIONAL COLLEGE OF TECHNOLOGY
Government…Industrial Technology Center of Fukui Prefecture

Aim of research and development

In the regional area [Fukui Central Area], incubation and development of industries concerning sustainable energy generation are promoted through integration of knowledge concerned with nano-plating technology developed in University of Fukui and Industrial Technology Center of Fukui Prefecture such as "Surface modification of the fine powder particle", "Technique to evaluate the strength of the surface", "Technology about sub-millimeter electromagnetic wave", "Dyeing technology with supercritical CO_2", "Precise fluorination technology" and "Instrumentation technology", The results will be applied to development of the new products, which must return to the public benefits in the area on the basis of cooperative relationship with electric power and electric industrial corporations in addition to regional companies.

＊ Nano plating technology
Technology that controls the surface morphology and condition in nano-meter scale by plating process

＊ Sub-millimeter electromagnetic wave
Electromagnetic wave of which wavelength is in far infrared region from 1 to 0.1mm

＊ Supercritical media
Medium of supercritical state (state that can not distinguish the boundary between liquid phase and vapour phase the critical condition) caused when carbon dioxide or water are made the high temperature high pressure

＊ Precise fluorination
Technology to introduce fluorine into/onto various functional materials, especially the modification of the surface of various fine particle materials with fluorination

Contents of research

1. Preparation of the functional fine powder materials by nano-plating technology and their application to the development of a new fuel cell construction

Nano-plating technology on fine powder materials especially which are difficult to be dispersed in the aqueous plating solution containing large amount of ions has been developed. PTFE fine particle with several ten micron in diameter covered with Ni-PTFE composite film with 1 micron thickness has been prepared and the process to form the sheet which can be used as the components of PEFC (polymer electrolyte fuel cell) has been developed. The new construction of PEFC was realized and its performance has been tested. In addition, new materials for producing, storing and compressing hydrogen have been developed by using nano-plating technology. All the results in this project have been applied to development of the basic research for hydrogen energy system as well as for creating businesses.


Ni-PTFE plating particles

2. Development of the materials and the instruments for safe and reliable nuclear power system by nano-plating technology

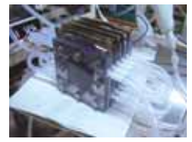
The nano-plating technology has been applied to the complicate shape substrate. A low loss wave guide tube for the electromagnetic wave with the wavelength of sub-millimeter (300GHz) has been developed. Using this low loss wave guide, the sintering system for ceramic materials with 300GHz gyrotron has been constructed. The process to prepare B4C rod with this system has been investigated to obtain a new long life control rod in the nuclear reactor. The new low loss wave guide and the total system of heating with electromagnetic wave have been taken into consideration as an industrial cooperation project for commercialization.


Sintering machine for ceramic materials using submillimeter wave

The main study results

1. Development of preparation process of Ni-PTFE composite fine particle and its application for new construction of PEFC

Ni or Ni-PTFE composite film is coated on PTFE particle of 1000 μm or less in diameter. The sheet prepared by pressing these particles has the permeability of the gas and the electric conductivity. This flexible sheet was tested as an electrode and separator composite for Ni-PEFC.


Stack prototype with Ni-PTFE composite particle compact

2.Development of the technology for separation, compression and storage of hydrogen

Using PEFC cell stack for compressing hydrogen, the hydrogen containing in the off-gas from the PEFC system can be separated and compressed. The hydrogen storage alloy covered with the Ni-PTFE composite film was prepared and was used to store the hydrogen after the compression. It proven that separation and compression of hydrogen would increase efficiency of the power consumption of the entire system.


Parallel operation of electric generation and hydrogen separation in fuel cell

3. New polymer film for light induced hydrogen evolution

The foamed polymer film impregnated with an organic semiconductor such as a porphirin has been developed by using supercritical carbon dioxide. A high efficiency of light induced hydrogen evolution was achieved.

4. Development of the new fiber reinforced metal

The nano-plating technology has been applied to the deposition of double layer metal films on the high tensile carbon fiber. This new nano-plated carbon fiber was able to be composed in aluminum alloy. The carbon fiber reinforced Al alloy having lightweight, high tension and high heat conductivity has been obtained.

5. Preparation and characterization of anti-scale film on the stainless steel

To prepare the anti-scale stainless tube for the cooling system in the nuclear plant, the process to cover the surface of stainless steel with layered CrN film in thickness of nanometer of less scale and corrosion was developed. Moreover, the environmental simulation test machine that was able to imitate an environment near the atomic energy secondary cooling equipment by the lab scale was developed for trial in production, which proved the performance of the Nano multi-layer hard anodic oxide coating.


Environmental simulation testing machine which simulates environment of actual machine with high temperatures and pressures

6. New heating system with sub-millimeter electromagnetic wave

The heating system with 300GHz gyrotron and the low loss wave guide prepared by using nano-plating technology has been constructed. Maximum temperature and heating rate have been obtained as 2,300 ℃ and 80 ℃ min-1, respectively. B4C ceramics which can not be sintered by conventional heating technique well have been sintered to obtain the B4C rod which can be used as the control rod in the nuclear reactor.

Establishment of new nano-plating technology delivered to the world from Fukui

Creation of new functional materials using nano plating technology

Plastic thin film

Photo-Hydrogen-Evolving device


Sintering machine using submillimeter wave


Plastic particles


Submillimeter wave low-loss wave guide

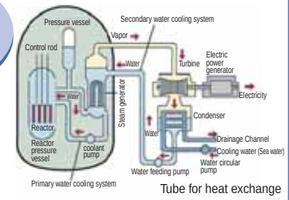
Precise fluorination technology
Nano-particle plating technology
Nano surface strength evaluation technology
Nano-film composite membrane
Uniform nano-film composite membrane
25 Open the world through nano plating technology
Functional nano-surface processing technology
Nano-surface processing technology
Electric double layer film
Monomolecular film
Atomic layer film
Control technology of nano-pore structure for carbon fiber
Atomic-level layering technology

Fuel cell (new PEFC)

High-capacity
•Secondary cell
•Capacitor


Carbon fiber


Hard anodic oxidation coating



Tube for heat exchange

Corrosion-resistant materials
Anti-scale coating materials