

The Development of Niobium Alloy Foil for Hydrogen Separation has been Progressing

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1. Governmental Measures:

(1) Ministry of Economy, Trade and Industry

On February 13, the Study Group on Energy Conservation of the Advisory Committee on Energy and Natural Resources compiled a draft report for the next energy conservation policy. It insists that energy saving in houses and buildings needs further promotion. The report includes introducing an incentive program to promote the use of high energy-saving building materials, and the requirement that houses and buildings meet the energy saving standards by 2020. For example, as well as introducing photovoltaic generators and fuel cells (FC), the study group suggests organizing a measure which helps manufactures to develop better building materials in houses and buildings (windows, insulations, piping) to save energy. They are requesting a revision of the Energy Saving Act, and the introduction of the top runner program which lists targets whereby manufacturers can aim to improve their products in three to 10 years. Furthermore, they point out the importance of drastically strengthening the energy saving measures for houses and buildings. Therefore the energy saving standard should gradually be obligatory for new building by 2020, which is detailed in the report. They also request details of the actual steps required leading up to 2020 to be shown along with the revised Energy Saving Act. (The Nikkan Kensetsu Kogyo Shimbun, February 14, 2012)

(2) Ministry of the Environment

The ministry of the environment has started inviting lease operators who would like to apply for the subsidies of the Eco Lease promotion for home and business for the fiscal 2012. This subsidy program aims to promote low carbon emission equipment for hire to homes and small businesses which cannot afford the initial investment for these devices, encouraging environmentally friendly practices. The ministry will provide subsidies for lease operators who

meet the required standards, enabling lower cost lease fees. The home products subject to the subsidy are; photovoltaic generators, wind generators, hydro power generators, solar thermal utilization equipment, geothermal utilization equipment and FCs. (Nikkan Jidosha Shimbun, February 14, 2012)

2. Local Governmental Measure:

(1) Fukui Prefecture

With the cooperation of Daiwa House Industry (Osaka city) Fukui Prefecture and Fukui Industrial Support Center, the Fukui and Daiwa House bridge project which helps the exchange of technologies between businesses in Fukui prefecture started in fiscal year 2011. With the business organization of Fukui and the University of Fukui (Fukui prefecture) established Fukui Green Innovation Center (the businesses, universities, and government cooperative research center of Fukui) in the University of Fukui last May. The research center aims to encourage developments of new materials and FCs for energy saving technology and foster sustainable energy industries. (Fukui Shimbun, February 14, 2012)

(2) Tsukuba City

Tsukuba city will establish an environmentally friendly city promotion foundation to promote a low carbon emission city by the end of March. The foundation will use the 123 million yen compensation, from Waseda University and a member of city staff, as a reserve. Tsukuba city commissioned the project, which was to produce electricity by windmills in its primary schools and junior high schools, from Waseda University, which resulted in failure and the city filed a law suit. The foundation will support Tsukuba residents who buy electric vehicles (EV) and install solar powered air conditioning systems. The type of projects includes for example, photovoltaic generators (maximum 60,000 yen each, 330 units prepared),

storage batteries with photovoltaic generators (maximum 100,000 yen each, 6 units prepared) and home energy management systems (HEMS, 8 units prepared). For FCs, 30 units of 100,000 yen are planned. (The Ibaraki Shimbun, February 16, 2012)

(3) Saitama City

Saitama city will promote next generation vehicles and full scale low carbon community structuring. The city's special economic zone application of next generation vehicle and smart energy has been approved. Next the city will develop individual measures for the next fiscal year. It will support the development and utilization of engines 50 cc or less for passenger carrying mopeds or scooters which is not currently legal, and promote utilizing fuel cell vehicles (FCV) and EVs. (Nikkan Jidosha Shimbun, February 17, 2012)

(4) Amagasaki City

Amagasaki city's budget bill for the fiscal year 2012 including a general account budget of 192.7 billion yen has been revealed. The city focuses on energizing local industries to be environmentally friendly and has a budget of 200 million yen. Amagasaki Green New Deal which targets creating sustainable city planning responding to the need of the environment as a core measure, the city will provide subsidy to new projects such as research, environment related business loans and rain water tank installation. Additionally, the city will expand projects such as replacing street lights with light emitting diodes (LED) and assist small businesses to develop new technologies and products. The installation of solar heat utilizing systems for homes, FCs for homes, and new energy conservation, environmental studies and development will also be helped with subsidies. (The Nikkan Kogyo Shimbun, February 20, 2012)

(5) Fukuoka City

The independent committee on energy of Fukuoka city in future (the council of environment and energy strategy), which promotes solar and sustainable energy, compiled an interim report. They suggest installing FCs at emergency management facilities such as city offices for disaster control on February 26 in it. By 2015, the report says the city will install FCs using coal gas at fire stations and school gyms so as to be prepared for electricity cut off during a disaster. In addition to just installing emergency generators, the

city also considers a project which is funded by local residents to install photovoltaic generators at community facilities with its profit to be returned to the residents. (The Nishinippon Shimbun, February 27, 2012)

3. Development of elements for FC

(1) Nippon Kodoshi Corporation

Nippon Kodoshi Corporation plans to move solidly into FC market. They aim to start producing non fluoride electrolyte membranes by April 2012, as well as to commercialize their membrane electrode assembly (MEA). These products are targeted to the FCV market, and the cell stacks for smaller FC will be provided. The company developed inorganic/organic hybrid electrolyte membranes by combining silicon, tungsten and zirconium oxides and polyvinyl alcohol (PVA). This product is not only cost saving, but also has proton conductivity as much as a fluoride electrolyte membrane and can withstand high temperatures, over 200 C, which allows devices to operate at efficient temperatures. Beneficially, it saves platinum catalyst and allows simple cooling devices. By thinning the membrane to 10 μm from 20 μm , the conventional product thickness, it saves on the amount of water needed to conduct protons, which negates the need for a humidifier. It also solves the degradation issue due to cross over because of its barrier performance, which is 10 times more than fluoride electrolyte membranes. (The Chemical Daily, February 17, 2012)

(2) Nippon Steel Chemical.

Nippon Steel Chemical will commercialize mesoporous carbon nano-dendrites (MCND), a new material. Having silver acetylide as the precursor, MCND has a structure of branched projections, numerous graphene walled microscopic holes which ensure high conductivity. Because metal microparticles such as platinum can be inserted into these holes, MCND is a suitable carrier. It is under consideration as a material for electrodes for FCs, electric double-layer capacitors and lithium-ion batteries (LiB). (The Chemical Daily, February 20, 2012)

(3) Tech Seimitsu

Tech Seimitsu, Fukuoka city, has developed a combustor for home FCs. The combustor creates

hydrogen by reforming coal gas. Tech Seimitsu developed a mass production technology whereby the prime parts of the combustor are made by metal stamping, which reduces the product price to 3000 yen, a tenth of the price when using the conventional method. Additionally, the product hardly produces NOx and CO by making coal gas and air easily mixed. The product will be distributed to FC manufacturers this year (The Nikkei Business Daily, March 1, 2012)

(4) Miyaki

Miyaki, Shizuoka prefecture, has developed WR Coat, the original aluminum coating technology for FCs. This alumite treatment and fluorine coating combination technology controls aluminum's hydrogen embrittlement by complete pore seal. The coating shows high water repellency which keeps products cleaner and a good resistance to both acid and alkaline. The technology will be promoted as a lightweight solution targeting automotive FC parts. (The Chemical Daily, March 2, 2012)

(5) Tokuda-Ard

Tokuda-Ard, the stamped and pressed metal manufacturer in Minamisaitama, Saitama prefecture, has established a mass production technology for 0.1 mm metallic separators. They achieved a 0.4 mm depth, 0.257 mm width electrode contact, 0.9 mm pitch fine angular groove path by stamping. This technology is available for titanium, aluminum and stainless steel. TOKUDA-ARD has already started producing aluminum separators with conductive diamond-like carbon (DLC) coating on order. The technology will be advanced toward lower cost and higher efficiency for FCs. (The Chemical Daily, March 7, 2012)

4. Development and Commercializing Solid Oxide Fuel Cells (SOFC):

(1) Nippon Shokubai.

Nippon Shokubai will increase the production of zirconia sheets and cells as the prime part for SOFCs. The product is electrodes burned to zirconia sheet which is electrolytic, and this is the core part of the electricity production by electric chemical reaction. The sheets and cells have already been in production at a partner manufacture. Because the sales of generators have been increased and the supply of zirconia, the minor metals, has been settled, Nippon

Shokubai will increase the production to 6 million sheets which is double the amount of the current production by 2012. The majority of the product will be supplied to Bloom Energy which produces FC generators in California, USA. The Bloom Energy's standard generator produces 100 kW. Their generators have been installed in the head offices and call centers of Companies such as Google and Bank of America. (The Nikkan Kogyo Shimbun, February 22, 2012)

(2) Mitsubishi Heavy Industries, Ltd.

Mitsubishi Heavy Industries has been working toward solidly commercializing a fuel cell combined cycle (FCCC) system which is composed of SOFC, gas turbines and steam turbines. The system targets 70 % electrical efficiency. The verification test will start with a 250 kW output compact micro gas turbine this summer, and Mitsubishi expects to commercialize the system by 2013 by gradually scaling up. The system is aimed to be a low cost and low environmental impact electricity generation plant. At the same time, Mitsubishi Heavy Industries will have a plan for another verification test with a 1350 kW output generator. To begin with, the system will generate electricity with SOFC by using liquefied natural gas (LNG), and then the 700-1000 C compressed gas generated from SOFC drives the gas turbine. Finally, the high temperature gas from the gas turbine drives the steam turbine. Furthermore, a verification test of FCCC with 40 MW class gas turbine combined cycle (GTCC) is planned, and this triple combined type system is targeted for industrial and business operators. Aiming for the commercialization of a 60 % electrical efficiency plant by 2017, Mitsubishi Heavy Industries expects to complete a 1GW class FCCC plant to achieve 70 % electrical efficiency by 2021. (The Chemical Daily, March 6, 2012)

5. ENE-FARM Development:

(1) Nippon Tochi-Tatemono Hanbai

Nippon Tochi-Tatemono Hanbai, Tokyo, will start selling 13 newly built houses as the 23rd term in Yokohama Azumano which is large subdivision lots in Seya ward, Yokohama city from February 18. Having Eco & Safe as its concept with increasing environmental consciousness lately, these houses are

built with strong consideration to the environmental issues. The latest ENE-FARM (a fuel cell cogeneration system) which allows generating electricity is provided for two houses. ECO WILL (another fuel cell cogeneration system) is provided for 11 houses. A photovoltaic generation system is provided for five out of 13 houses. These houses are graded 4, the highest, in the energy saving class. (Jutaku-Shimpo, February 14, 2012, The Mainichi Newspapers, February 23, 2012)

(2) Polus Group

Polus Group, Koshigaya city, will accelerate its environmentally conscious housing packages for sale. They will sell houses with a power supply for EV and FC in Toda city, Saitama prefecture, in March. Also, they will start selling houses with a storage battery in Tokyo prefecture in this year. All 43 those housing packages, Beau Village Toda, for sale come with a power supply for EV and plug-in hybrid vehicle (PHV) as a standard feature, and 10 of them come with ENE-FARM. In addition to the in-house power generation ability, the water tanks will provide water in an emergency. Polus Group will develop houses with a storage battery which hold approximately 6 kWh. The battery stores cheaper electricity at night, and then the electricity is used in the day or during power cuts or failures. (The Nikkei Business Daily, February 15, 2012)

(3) Seiko Electric Company

Seiko Electric Company, Fukuoka city, plans to develop a system which allows ENE-FARM to operate during power cut or failure. As a start Tokyo Gas will start selling the system at the end of February, and Saibugas will start introducing the system to their customers. Seiko Electric Company developed this system in November 2011 which stores electricity into the battery from ENE-FARM under normal circumstance and provides electricity for approximately 24 hours during power cut or failure. (The Nishinippon Shimbun, February 18, 2012)

(4) Living-life Corporation, Miyoshi, Asakawa Home Living-life Corporation (Tokyo), Miyoshi (Yokohama city) and Asakawa Home, (Tachikawa city) aim to start selling 238 housing lots in Yokosuka city, Kanagawa prefecture from the end of March. Purchasers are required to build a house with a photovoltaic generator and/or power supply for EV

from the contractor. ENE-FARM will be installed on demand. However, an EV recharger is featured as standard with the cooperation of Nissan to promote the electricity system sharing between EV and domestic use. (The Nikkei Business Daily, February 20, 2012)

(5) JX Nippon Oil & Energy Corporation

JX Nippon Oil & Energy Corporation started selling SOFC type ENE-FARM last October. Their number of sales is expected to reach 2200 including conventional polymer electrolyte fuel cell (PEFC) type product by the end of 2011. (The Chemical Daily, February 27, 2012)

(6) Sekisui House, Ltd

On March 1st, Sekisui House announced that they would start the sales of 67 housing lots including a housing package called Smart Common Stage Keyakidaira, Furukawa city, Ibaraki Prefecture from March 3rd. These 67 houses produce 85 households usage of electricity. The standard package comes with a power supply for FC and EV, and a photovoltaic generator which creates 423,500 kW in a year. Additionally, 10 out of 67 lots will have a house called Green First Hybrid which has a storage battery and home energy management system (HEMS). (The Nikkan Kogyo Shimbun, March 2, 2012, The Nikkei Business Daily, March 6, 2012)

The Okayama branch of Sekisui House has built an environmentally conscious house having a power supply system including a photovoltaic generator, FC and storage battery (8.96 kWh) in Minami ward, Okayama city. This is the first dwelling house with Green First Hybrid in the Nishinippon area. The prices are 448,000 yen for a solar battery, 2,400,000 yen for FC and 2,000,000 yen for storage battery. (The Sanyo Shimbun, March 3, 2012)

(7) Keiyo Gas

Keiyo Gas has reported progress of the operational streamline for the fiscal year 2011. The report shows the sales of highly efficient gas devices which help to create a low carbon emission society. The sales figures are 8644 for the condensing boiler Eco-Jozu, 94 for ENE-FARM and 61 for the gas cogeneration boiler ECOWILL. (Chiba Nippo, March 8, 2012)

(8) Yamaman

Yamaman, Tokyo, will start the development of the 25 ha environmentally conscious complex planned town

called Miraia in Yukarigaoka, Sakura city, Chiba prefecture. Its dwelling house area is approximately 10 ha. Yamaman will start building the houses called energy bill free house which includes solar panels and FC from May, and sell them over three to four years. (Architectures, Constructions & Engineerings News (Daily), March 12, 2012)

6. Cutting Edge Technology of Zero-emissions Vehicles:

(1) Daihatsu Motor Co., Ltd.

Daihatsu Motor will accelerate the development of a new FC without the need for precious metals such as platinum. The system under development uses hydrated hydrazine ($N_2H_4 \cdot H_2O$), processed from ammonia, as fuel, and cobalt and nickel, which are corrosion-resistant, for electrodes. The manufacturing cost of the electrodes is a thousandth of the conventional PEFC's with precious metals such as platinum. The new technology not only gives a large cost saving, but also it allows the whole system to be simple. Furthermore, it is easily adapted for a small car. Additionally, hydrated hydrazine can be sold at conventional gas station without a major facility alteration because it is a non-flammable liquid in room temperature. Now the issues to be solved are increasing energy output by improving the the conductivity of anion exchange membranes and enhancing durability by strengthening the molecular structure. For automobile usage a durability of approximately 5000 hours is needed. However the durability is currently 1000 hours; however it is expected to be 3000 hours by 2012 and to continue further development for commercialization. (Nikkan Jidosha Shimbun, February 21, 2012)

On February 20, Daihatsu Motor announced the verification test of an EV would start from April in Shiga prefecture and Oita prefecture. The EV uses the platform of HIJET, the micro van or micro pickup truck. Daihatsu is going to provide two of the EVs to each prefecture, and collect data while the cars are used as official vehicles. The test will last approximately one year. Daihatsu is developing EVs for business use such as small scale delivery, and the collected data are going to be used for improvement. The EV includes LiB, and its fastest driving speed is 100 km/h and its cruising distance is approximately

150 km per charge. (Nikkan Jidosha Shimbun, February 21, 2012)

(2) BMW

The Geneva International Motor Show started on March 6th. Norbert Reithofer, the CEO of BMW of Germany, expressed an interest in the expanding cooperation with Toyota, and revealed they were considering their collaborative development of FC technologies with General Motors of USA. BMW has had partnership with Toyota for the supply of BMW make diesel engines and the development of next generation storage battery since last December. (The Nikkei, March 7, 2012, The Nikkei Business Daily, March 9, 2012)

(3) Toyota

Toyota has displayed its concept vehicle, FCV-R, in the Geneva International Motor Show. "We are preparing to be able to produce tens of thousands per year by 2020 "Didier Leroy, the president of Toyota Europe, mentioned about FCV there.

"Toyota hasn't yet detailed the price or marketing plans for fuel-cell cars or set a global sales target" said John Hanson, the spokesman for the company's U.S. unit. (Fuji Sankei Business I, March 8, 2012)

(4) Honda

Starting its Fit EV's sales for lease this summer, Honda expects to achieve 1,100 vehicle sales over three years in North America. This vehicle uses the platform of Fit, the compact car, and cruise approximately 200 km per charge. Also, Honda will start information service of the EV for smart phones. It is a service to calculate cruising radius from the battery level and to show the radius on map on the smart phone before the driving, as well as the timer function for charging the vehicle. The vehicle has three driving mode, Normal, Econ which saves energy consumption, and Sport which allows a more pleasurable drive. (The Nikkei Business Daily, March 12, 2012)

7. Technology Development on Hydrogen Station:

Mitsubishi Kakoki Kaisha has developed a new highly efficient hydrogen production unit for filling stations. Presently the majority of conventional equipment for hydrogen filling station is tanks to store hydrogen, and the hydrogen must be transported by tanker truck. On the other hand, the newly developed

equipment allows a saving in transportation by producing hydrogen on site from coal gas. Mitsubishi has already commercialized three smaller on-site hydrogen production units called HyGeia which produce 50, 100 or 200 L/h of hydrogen. Now they have finished the prototype of the new unit, HyGeia A, which produces 300L/h reaching the volume zone of hydrogen filling stations. The unit saves 10 % of the fuel consumption with a highly efficient steam reformer and hydrogen pressure swing adsorption (PSA), half the installation area size of the conventional units, 3.2 x 7.2 m. Additionally, it realizes hydrogen purity of over 99.999 % and more than 85 % reformation. Mitsubishi Kakoki plans to start the verification test and to commercialize the unit early as possible. (The Chemical Daily, March 8, 2012)

8. Hydrogen Production and Process Technology Development and Marketing:

Having finished basic study niobium alloy foil for hydrogen separation membrane, Hitachi Metals announced on February 28 that they had started the development for its commercialization. The foil to be commercialized is made from 54 % niobium-nickel-titanium based alloy. The production technology will be developed by optimizing the alloy structure for mass production by 2015. It will realize a large cost saving compare to the conventional metal hydrogen permeable foil which is made with palladium alloy. The technology of the patent is held by Kitami Institute of Technology and Ulvac will be used. Although PSA is the mainstream to create high purity hydrogen, it has a downside in the large initial and running costs. The hydrogen membrane separator allows the system to be small, simple and better for energy conservation. The issue is the high cost of the palladium alloy membrane. The niobium alloy membrane has the performance equivalent to palladium alloy membrane in hydrogen permeation and hydrogen embrittlement. Because the price of niobium is around a hundredth of that of palladium, and a large cost saving is expected. (The Nikkei Business Daily, Japan Metal Daily, The Chemical Daily, February 29, 2012)

9. Business Operator's Environment Conscious:

On February 13, Iwatani Corporation announced that

its R&D center would be moved and enhanced. The construction of New General Technology Center (provisional name) will start in April, at a total construction cost of approximately three billion yen. The construction will be finished in March 2013 and the R&D function will be transferred from Shiga Technical Center, the current R&D center. The total floor area of the new center is 12,000 m², 1.5 times of Shiga Technical Center. As well as research and development related to industrial gas and other gases, the New General Technology Center will seek to meet the new and diverse needs of their customers and pursue joint research with the new experimentation environment such as constant temperature/humidity environments and clean rooms that comply with the High Pressure Gas Safety Act. Also the new center will function as an Eco House model room implemented with LPG heat pump, FCs and photovoltaic generators as an emergency power generator, wall greening and LED lighting all combined for demonstration. Additionally Iwatani considers installing a hydrogen filling station for FCV. (The Nikkan Kogyo Shimbun/ The Kobe Shimbun, February 14, 2012, The Nikkan Kensetsu Kogyo Shimbun, February 15, 2012, The Nikkei Business Daily, February 16, 2012)

— This edition is made up as of March 12, 2012—

A POSTER COLUMN

IHI's Lightest Efficient Gas Turbine Generator:

On February 16, IHI announced that it had developed the smallest and lightest gas turbine electric generator. It is 8 cm in diameter, 12 cm length, 1.2 kg weight, and outputs 400 W. Being able to runs continuously for three hours, the generator is primarily expected for emergency use. IHI expects to commercialize the product by 2015 and estimates 500 sales of it globally.

The turbine will be packaged with built-in turbine in generator, cooling fan and fuel tank for the market. The estimated price is two million yen for a unit. Twice the output of a FC is expected, and the generator is more durable. Initially IHI will proceed

with a verification test as portable generator; however, further development is also planned for robots use later.

Several companies and 5 universities from all over the world including University of Tokyo and Massachusetts Institute of Technology joined in the development. In the recent verification test, IHI proved the generator takes kerosene and diesel as well as LPG. The generator is also easy to use, and outputs electricity 30 seconds after starting. IHI will develop it to be a leading product as low environmental impact generator. (The Nikkei, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, The Nikkan Kensetsu Kogyo Shimbun, The Chemical Daily, February 17, 2012)

FC Market for Business Vitalized

The number of FCs installed for business operators has been increased due to the conversion efficiency improvement and reduced cost, which is vitalizing the market. Diverse advantages of FCs have come to attention. In North America, FCs are being considered for using shale gas and dumping site (bio) gas. In Europe their creation of low oxygen air, a by-product, is taken into account. In Japan they gain attention as decentralized or emergency electric power sources.

Four corporations, United Technologies Corporation, FuelCell Energy, Bloom Energy and Fuji Electric, are the only FCs manufacturers for business use. In US, the Bloom Energy's 1 GW SOFC introduction to the market caught people's eyes in 2010.

In many cases bio gas is used as fuel. On February 20th, Apple Inc. showed their intention to install a 500 kW FC using bio gas in the environment report. The development of shale gas should back up the market. However, the cost of the gas liquidizing process pushes the price up, which is disadvantage in the competition. Although the gas can be distributed unpressurized through pipelines, it is efficient for small gas wells to generate electricity from the gas at the place of the production and transfer the electricity to the grid.

In Europe, usage of low oxygen air receives attention. FCs use oxygen in the air during generating electricity and discharges lower oxygen air. The air is expected to lower the fire risks. The Fire Services Law been revised recently, the devices fulfilling the safety

standards may be used in dwelling houses in Europe. In Japan there is growing demand for FCs as a decentralized power supply. Gas or diesel generators come into people's mind for factories and hospitals, though the disadvantage is their CO₂ emission. On the other hand, FCs hardly emits CO₂ and Fuji Electric says that the maintenance cost is low as gas generators'. Moreover, their FCs have an advantage that the fuel may be switched to LPG due to coal gas disruption to keep supplying electricity and heat in emergencies, which gas generators do not have. Fuji Electric plans to expand their business by meeting the global demand. (The Denki Shimbun, February 28, 2012)