

## Ene-Farm Technology to be Applied to Europe's Home FC

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### 1. Governmental Measures

#### (1) MLIT

On February 25<sup>th</sup>, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) announced that safety standards of liquid hydrogen carrier ships had basically been agreed with the Australian government at a working-level on the 24<sup>th</sup>. The talks will continue to investigate protection requirements of tanks, and the final agreement is planned within FY 2014. The both governments consider jointly proposing the bilateral standards to become international to the International Maritime Organization (IMO). (The Japan Maritime Dairy, February 26, 2014)

MLIT has compiled a draft of the “Environmental Action Plan” which shows environmental policies of land and transport administrations to FY 2020. The plan includes mid- to long- term measures for global warming and forming a recycling-oriented society based on environment and energy policies of the government and experience of the Great East Japan Earthquake. As a counter-global warming measure, the target ratio of next generation vehicles such as hybrid vehicles (HVs), electric vehicles (EVs) and fuel cell vehicles (FCVs) is targeted at 50% by 2020 and 70% by 2030 in new car sales. The plan also shows measures for traffic using intelligent transport systems (ITS) and for life style change using cars with mobility management. The ministry will make a final plan in March as the earliest. (Nikkan Jidosha Shimbun, March 6, 2014)

#### (2) METI

On February 26<sup>th</sup>, the Ministry of Economy, Trade and Industry (METI) announced that a special measure would be applied to hydrogen tanks of fuel cell (FC) forklifts from late April. Under the current High Pressure Gas Safety Act, only composite containers using metal and carbon fiber are expected

for the usage. However, the new measure will allow solely metal containers. The change will hopefully contribute to a cost reduction of hydrogen tanks. (The Nikkei & The Nikkei Business Daily, February 27, 2014; Nikkan Jidosha Shimbun & The Chemical Daily, February 28, 2014)

### 2. Local Governmental Measures

#### (1) Aichi Prefecture

On February 17<sup>th</sup>, Aichi Prefecture revealed its “Aichi Prefecture Hydrogen Station Preparation and Deployment Plan”. The plan contains targets of 20 hydrogen filling stations to supply FCVs by the end of FY 2015 and 100 stations by the end of FY 2025. There are four hydrogen filling stations operating in the prefecture, and six stations are under preparation. Since FCV sales are starting next year, the prefecture will work on promotion measures. Additionally “Aichi FCV Promotion Committee” drew a plan containing deployment examples for each area. (The Nikkan Kogyo Shimbun, February 18, 2014; The Denki Shimbun, February 19, 2014; The Chunichi Shimbun, February 20, 2014)

#### (2) Ehime Prefecture

On February 17<sup>th</sup>, Ehime Prefecture announced that its initial budget for FY 2014 included ¥30 million for a subsidy scheme of FC installation for home in order to expand renewable energy usage. The scheme financially supports cities, towns and villages of the prefecture which have their own subsidy schemes for domestic FC installation. The prefectural plan will contribute half (maximum ¥450,000 for each system) the subsidy of which those cities, towns and villages pay out to each household installing a FC. Currently the Japanese government subsidizes ¥450,000 for each unit, and Matsuyama and Toon Cities also support their residents with their own schemes in the

prefecture. (The Ehime Shimbun, February 18, 2014)

#### (3) Shizuoka Prefecture

On February 17<sup>th</sup>, Shizuoka Prefecture launched a promotional organization “Fujinokuni FCV Promotion Committee” and the first meeting was held in Shizuoka City. The committee consists of 13 organizations including Suzuki, Toyota, Nissan and Honda from auto industry, bus operators and energy related businesses in the prefecture, and 17 cities and towns as well as the prefecture. Regular meetings will be held to promote preparation of hydrogen filling stations by private and public sectors. (The Shizuoka Shimbun, February 18, 2014)

#### (4) Fukuoka Prefecture

On February 20<sup>th</sup>, Fukuoka Prefecture revealed its initial budget for FY 2014 including ¥187.36 million for strategic promotion of hydrogen energy. They will focus on growing and building an industry using the prefecture’s advantage. In the promotion, ¥66.67 million is allocated for integrated promotion of hydrogen filling stations and FCVs which are to be available from 2015 as well as new projects which include subsidy schemes for taxi operators to have FCVs and hydrogen filling station preparations. (The Nikkan Kogyo Shimbun, February 20, 2014)

### 3. Technology Developments of FC Elements

#### (1) Rare Metal Material Laboratory

Rare Metal Material Laboratory which is a chemical venture in Okayama City has developed a “silver filter” to clean water and air with silver ions. Nano-size silver fiber is packed like felt to be the filter. The filter has a large surface area because very small fiber forms tight structure, which is expected to be highly effective. Due to the structure and characteristics, the product can also be used as a material for FC electrodes. A special chemical is added to a silver compound solution. The mixture is then stirred at a high speed to make particles (0.1 to 3 mm diameter) which consists of entangled silver fibers (100 nm diameter and 1,000 to 10,000 nm long). A solution with the particles is to be applied on glass fiber, a base material, in order to be used as a filter for air conditioners and water supply/removal equipment. (The Sanyo Shimbun, February 20, 2014)

#### (2) Kumamoto University

The research team of Prof. Yasumichi Matsumoto

and Associate Prof. Takaaki Taniguchi at the Graduate School of Science and Technology of Kumamoto University has developed a new technology to produce FC at a low cost using “graphene oxide”, a cheaper carbon material, as a catalyst. Already working on commercialization, they have already filed a patent application of part of the technology. In April, a study group will be formed with other research organizations in Japan in order to explore the application of graphene oxide in devices such as FC. Once the technology is commercially established, it will be used in a large field including FCVs. Prof. Matsumoto says that a composite membrane with graphene oxide is used for electrode catalysts with the new technology. Platinum costs ¥10,000 per gram; on the other hand, graphene oxide is only ¥100 per gram or less and can be mass produced. In an experiment, the new catalyst exhibited the same performance level as that of platinum. The team also discovered that lead–acid batteries using graphene oxide as a material demonstrated a high performance. (Kumamoto Nichinichi Shimbun, February 22, 2014)

#### (3) AIST

On March 4<sup>th</sup>, the National Institute of Advanced Industrial Science and Technology (AIST) and the Technology Research Association for Single Wall Carbon Nanotubes (TASC) announced that a coating material of carbon nanotubes (CNTs) dispersed in water and organic solvent had been developed. The coating solution contains high concentration of the CNTs which are 100 times longer than that of commercial products. With a printing technology, a fine pattern of an electronic circuit can be made with the material on a substrate. The product is expected to be used for electrode materials for batteries such as an electric double-layer capacitor and FC. (The Nikkei Business Daily, March 5, 2014)

#### (4) Kansai University

The study group of Associate Prof. Kiyoharu Nakagawa at the Department of Chemical, Energy and Environmental Engineering of Kansai University has developed a synthesis method of “Marimo nanocarbon”, a spherical fibrous nanocarbon. The new method allows the provision of highly concentrated fibrous nanocarbon in a spherical shape. Marimo nanocarbon has a core of a catalyst support such as a

submicron level diamond particle. CNTs and carbon filaments (CNFs) grow radial on the surface of the core like Marimo, *aegagropila linnaei*, to be a round shaped carbon composite material. The product is easily handled without worries of being blown away. Consisting of Marimo nanocarbon, CNF is composed of layers of nano graphite, and demonstrated high performance as an anode material of lithium-ion batteries (LIBs). When the nanocarbon is applied as a catalyst support for FCs, the graphite edges on the surface allow the supported metal to be highly distributed. This is as good as carbon black, a conventional material for the catalyst support. (The Chemical Daily, March 11, 2014)

#### (5) Tokyo Institute of Technology

The group of Assistant Prof. Kotaro Fujii and Prof. Masatomo Yashima at Tokyo Institute of Technology has developed a new method for electrolytes, a core component of solid oxide fuel cells (SOFCs). This method allows designing crystal structures as required, which makes ion movement to carry electrons smoothly. SOFC needs 700°C of heat or more for its operation. However, the method has the potential to significantly reduce the required temperature. Firstly it uses a combination of oxygen and various metal atoms to make up an electrolyte of a particular structure determined by the new technology. Secondly an optimal material combination and crystal structure is determined by calculating ion movement using X-rays technology to observe oxygen ion paths. With the new technology, two new materials were synthesized and connected to electrodes, which created electric currents even at 300°C. The group will study further to find out the optimal atomic combination and crystal structure in order to contribute to the development of SOFC which efficiently generates power at 400°C or less. (The Nikkei Business Daily, March 13, 2014)

### 4. Developments and Business Plans of Industrial Use FC

#### (1) Toyota Tsusho

On February 25<sup>th</sup>, Toyota Tsusho announced its entry into the direct methanol fuel cell (DMFC) business in Japan. An agreement as an exclusive agency in Japan was signed between a US-based DMFC manufacture Oorja Protonics, California, on

the 24<sup>th</sup>. DMFC characteristically needs a shorter time from start to generation. Their product generates power in a minute from the start, and operates fully within five minutes. The rated power output is 1.5 kW, and the dimensions are 77.5 cm by 32.5 cm by 34.5 cm with a weight of 79 kg. The FC produces an hour's worth of electricity for a refrigerator from 1.8 L of methanol. Although the price is unpublicized, the initial cost is said to be higher than common DMFCs due to the nature of non-mass produced product. Toyota Tsusho initially aims to sell the product to be used as an emergency power source of a cell phone base station and power source for a truck box of refrigerated vehicle which are actual usages of the product overseas. The generator uses methanol which has an already well established distribution channel globally, and is expected to spread in Japan as a stable power source which can produce cheaper electricity than hydrogen fed FCs. (The Nikkei Business Daily, Japan Metal Daily & The Chunichi Shimbun, February 26, 2014; Nikkan Jidosha Shimbun, March 5, 2014)

#### (2) South Korea

The South Korean government will develop a hybrid generation system combining FC and a gas engine. The system is to be a distributed power source with 100 kW level of power output, and the government aims to expand the market in the US as a mean of energy conversion from shale gas or gas from landfill (biogas) to electricity. Despite POSCO manufacturing a similar product in South Korea, the core component of the generator is made by US-based FuelCell Energy which is POSCO's partner. A development of their own technology has been left as the key issue for them. The government therefore picked the development of FC and gas engine hybrid generation system as a part of its Development Project of Industrial Innovative Technology which supports a total of ₩ 113.8 billion (approximately ¥10.8 billion). (The Denki Shimbun, February 28, 2014)

### 5. Ene-Farm Business Plans

#### (1) Toshiba

Toshiba FC Power will bring out a new model of Ene-Farm for houses for the first time in four years. The generation efficiency of the new product is improved from 38.5% to 39% of the current model

released in 2012, and the overall energy efficiency is increased from 94% to 95%. These improvements allow the product to be more economical and energy saving. The required space for the unit from a house wall was reduced from 79 cm to 70 cm by improving installation and maintenance methods. With a reduced noise from 38 to 37 dB, the unit works well for houses in urban areas. The product gives a fuel option of natural gas or liquefied petroleum gas (LPG), which is the first in the industry. The shipment to energy providers will start in March. For apartment units, the firm is developing a system to be installed on a floor area of approximately 1.1 m, as the trial design specification, of a pipe shaft void, which would be one of the smallest systems in the market. The model is to be designed to have a forced flue (FF) system in order to be installed in a limited pipe shaft void of an apartment unit, and they aim to have the first order in FY 2014. The firm has also developed a domestic FC with an integrated storage battery. This product can supply power from its storage battery once household consumption goes beyond its FC system's generation ability. The combined operation of a FC and a storage battery moderates the electricity demand of a household, which should save on electricity purchased from providers. The firm will investigate consumer interest of the product to decide on commercialization while running the operation tests. The system has a 700W power output FC and a 1kW power output storage battery. The storage battery supplies electricity during power shortages caused by high power appliances such as an air conditioner and hair dryer. Being cheaper as a whole, the system requires a smaller installation space than a FC and a storage battery individually installed and working together. The storage battery can also start up the FC during power cuts. (The Nikkan Kogyo Shimbun, February 27, 2014; The Denki Shimbun, February 28, 2014; The Nikkei Business Daily, March 13, 2013)

Toshiba FC Power has made arrangement with BAXI Innotech (BI) of Germany to enter the domestic FC market in Europe. BI is a group member of BDR Thermea (BDR), a major heating appliance manufacturer of the Netherlands, and will cooperate with Toshiba FC Power on development and sales of home use FC systems. Toshiba FC System will

provide FC units for the European market using Ene-Farm as the base. BI will finish the system by assembling a hot water tank, water heater and control system as a new product of the joint development. As the sales cooperation, the product will be distributed with Toshiba's FC system through the sales channel of BDR which is the parent company of BI and has many bases in Germany and other European countries. The European FC market is expected to reach a 160,000 unit level by 2020. (The Asahi Shimbun, March 15, 2014; The Nikkan Kogyo Shimbun, The Denki Shimbun, Dempa Shimbun & Architectures, Constructions & Engineerings News (Daily), March 17, 2014)

#### (2) Toho Gas

On February 28<sup>th</sup>, Toho Gas announced that its accumulated sales of natural gas Ene-Farm reached 5,000 units. The figure was achieved in four years and three months. Targeting 2,300 units for FY 2014, the firm aims to expand its sales by introducing a cheaper product costing less than ¥2 million. (The Chunichi Shimbun & Gifu Shimbun, March 1, 2014; The Nikkan Kogyo Shimbun, March 3, 2014; The Denki Shimbun, March 5, 2014)

#### (3) Daiwa House

Daiwa House has been selected as a developer of "Hidamarinooka", a housing development project, in the Hidamarinooka area of Kuwana City, Mie Prefecture. The housing development will have a communal photovoltaic generator, FC and EVs, and each house will be also installed with a photovoltaic generator and FC in order to be an energy self-sufficient smart house. The whole project of a total of 64 houses costs ¥2.2 billion. The first house delivery will start in July, 2015. (The Nikkan Kogyo Shimbun, March 4, 2014)

#### (4) Tokyu Land

Tokyu Land will sell apartment units with Ene-Farm installed in each unit from late May. The apartment house, "Branz City Shinagawa Katsushima" (total 356 units) is the first project of the "2<sup>nd</sup> CO<sub>2</sub> Reduction Leading Project of Housing and Building" of MLIT. As well as FC, photovoltaic generators are installed, and EVs are prepared for communal use. A cloud type energy management system is installed to manage the energy of whole apartment building, and usage of the facilities

including Ene-Farm allows each household to save an estimated ¥58,000 each year. (The Nikkei Business Daily & Nikkan Kensetsu Sangyo Shimbun, March 10, 2014; Jutaku Shimpō, March 11, 2014; Architectures, Constructions & Engineerings News (Daily), March 12, 2014)

#### (5) Osaka Gas

On March 10<sup>th</sup>, Osaka Gas, Aisin Seiki, Kyocera and Chofu Seisakusho announced that a new Ene-Farm was developed with their cooperation. This new “Ene-Farm type S” using SOFC will be available from Osaka Gas from April 1<sup>st</sup>. Being the cheapest among same structured systems in the market, the product will sell for ¥2.322 million which is ¥0.63 million cheaper than the existing product by reducing the cell stack and using lower cost parts. The four firms made the new product using a technology developed by Toyota Motor. The cell stack is produced by Kyocera. Aishin Seiki manufactures the FC generator unit. Chofu fabricates the boiler unit using waste heat. As well as cost reduction, the product has an optional remote controller with a wireless LAN module installed. This controller allows the user to remotely manage the unit using a smart phone with wireless LAN and check the energy usage state. (The Mainichi Newspapers, The Nikkei, The Denki Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, The Kyoto Shimbun & The Yamaguchi Shimbun March 11, 2014; The Sankei Shimbun, March 13, 2014)

#### (6) Mitsui Fudosan Subsidiary

On March 12<sup>th</sup>, Mitsui Fudosan Residential announced that all houses were to be installed with Ene-Farm as a standard feature of its new housing development “Fine-Court” in the area where Tokyo Gas supplies gas. (The Denki Shimbun & The Nikkan Kogyo Shimbun, March 13, 2014)

## 6. Cutting Edge Technologies of FCVs & EV

### (1) ABB

A Swiss major engineering firm ABB will supply quick chargers for EVs in China. An EV will be released by a venture of BYD (Guangdong), the major local automaker in China, and German-based auto giant Daimler. The charger will be provided for the EV from mid-year. Charging takes time and chargers have a safety issue, which slows the sales down. The

ABB will give technical support to the sales with its experience in Europe. (The Nikkei, February 17, 2014)

### (2) Nishimura MFG.

Nishimura MFG. which produces splitters in Kyoto City for electrodes and separators, core components of LIB, has fully renovated its headquarters and related factories over two years. The renovation is to meet increasing orders from Chinese manufacturers for batteries of EVs and HVs. Nishimura will enlarge its production capacity by improving efficiency of the production line. (The Nikkei, February 18, 2014)

### (3) Daido Kogyo & Other

On February 19<sup>th</sup>, Daido Kogyo and NGK Spark Plug announced that a semi amphibious micro EV was developed in cooperation with FOMM, a venture in Kawasaki City. Able to float and cruise in water for a long time, the four-seater micro EV “FOMM Concept One” aims to grow in Thailand where frequent floods take place. The development of the EV was carried out by 26 firms including auto part manufacturers. The dimensions are 2.4 m long, 1.2 m wide and 1.5 m high. The EV’s body and wheels are designed to be water tight, and the car itself can float in water for 24 hours without breaking down. (The Nikkei, February 23, 2014)

### (4) Toyota Motor & Others

Automakers will start deploying micro EVs, a next generation transportation method, in Europe. Toyota Motor will start a three year test in collaboration with the city of Grenoble, France, and a French power supplier at the end of 2014. A total of 70 EVs of a two-seater three-wheeler “i-Road” of Toyota Motor and “Coms” of Toyota Auto Body, a member of Toyota Group will be provided for the project. The field tests are planned to be extended to other areas. Honda Motor considers obtaining a European Standard certification for its micro EV. Although the Japanese government has prepared a certification scheme for micro EV sales to grow, there are still issues for full commercialization of these vehicles in Japan. Japanese automakers plan to earn experience in Europe which is in advance of Japan for infrastructure and institution preparation in order to promote their micro EVs. (The Nikkei, February 21, 2014)

### (5) Mitsubishi Motors

Mitsubishi Motors will sell its medium sport utility vehicle (SUV) “Outlander PHEV in Australia, West Europe and North America. The car is their key product in plug-in hybrid vehicles (PHVs) which can be charged through a domestic wall socket, and has sold in Japan and Scandinavia. Since the production system is prepared, the automaker will expand the market area, and aims for over 50,000 vehicles, a 70% increase that of FY 2013 for FY 2014. (The Nikkei Business Daily, February 25, 2014)

#### (6) Panasonic

Panasonic is having final stage discussions on a joint construction of EV battery plant in the US with Tesla Motors, a US-based EV manufacturer. Tesla and Panasonic will build a “battery complex” in order to produce batteries from material to assembly, including manufacturing cells, the heart of a battery. The material manufacturers will have their production bases in the complex as well as Panasonic and Tesla. These two have asked part makers to join the integrated production, and the total capital is expected to exceed ¥100 billion. The complex would be one of the largest production bases, and aims to operate from 2017. Tesla’s flagship sedan “Model S” has been valued for its design and environmental function, and targets 35,000 units, a 55% increase that of the previous year for 2014. Tesla will release a SUV in 2014, and a new EV is under development aiming to be introduced into the market by 2017. Because the battery largely makes up an EV’s cost, the new plant aims to bring the battery price down to compete with gasoline cars. (The Nikkei, February 26, 2014)

#### (7) Nissan & Renault

Nissan and French-based Renault have agreed to integrate their research and development departments. They consider establishing a joint venture and transferring a total of 20,000 their employees, which is 60% of their research and development departments. The reorganization is aimed at cost reduction by cooperative research of eco cars including FCV and joint developments of core components such as chassis and engines. Additionally the two automakers agreed to unite their production department. All their plants will mutually produce each other’s vehicles. (The Asahi Shimbun, March 6, 2014)

#### (8) Venture of Osaka University

Lotus Alloy, Osaka City, has developed a thermally conductive material which reduces heat five times more efficiently than conventional products. The product is expected to be used to cool down power semiconductors used for motor control of EVs and HVs. (The Nikkei, March 12, 2014)

#### (9) Sinfonia Technology

Sinfonia Technology will enter the motor market for EVs. They have developed a motor which is directly installed in each front wheel, which allows the car to have a spacious interior. The motor will be mass produced in Thailand from 2015. The manufacturer aims at ¥2 billion by FY 2017 by selling the product to automakers globally. The development was carried out in cooperation with FOMM, an EV venture in Kawasaki City. The in-wheel installation leaves more room for the interior. The motor finely controls the motion of the tire during turning, which reduces power consumption. FOMM will sell a micro EV with the motor installed from 2015 in Thailand as a start. Sinfonia Technology aims to ship an annual 10,000 units of the motor. The power output is 5kW. (The Nikkei, March 12, 2014; The Chemical Daily, March 17, 2014)

### 7. Hydrogen Filling Station Related Technology and Business Developments

#### (1) Yachiyo Industry

Yachiyo Industry aims to reduce the cost of accumulators for hydrogen filling stations and to enlarge the accumulator. They have started research and development of a resin composite container using carbon fiber in collaboration with Toho Tenax. The liner resin is currently in characteristic evaluation, and a performance test of small and medium containers will start in FY 2014. Also the firms will optimize the integral molding method of the resin liner. The manufacturing guidelines of the large container will be made by FY 2015, and the guidelines are planned to be applied to research and development of a large container of 300 to 500 L to start in FY 2016. Yachiyo has researched a resin liner composite container with wound carbon fiber since 2006. A light weight and highly durable LPG container was already developed using a technology for resin fuel tanks of automobiles as well as gaining a

filament winding (FW) technology. With the knowledge, the manufacturer will try to make a cheaper and large accumulator. (The Nikkan Kogyo Shimbun & The Chemical Daily, February 19, 2014)

#### (2) Kobe Steel

On February 24<sup>th</sup>, Kobe Steel announced that a hydrogen filling station package unit “HyAC mini” had been developed. The unit is packed with key facilities for a station, which allows for a reduction in cost and space. The construction cost can be up to 20% cheaper than conventional facilities. The price is expected to be less than ¥250 million, and the manufacturer will start taking orders in April. The product dispenses hydrogen at 70 MPa, which allows the filling of six FCVs in an hour, and has good expandability such as additional accumulators. The unit contains key devices including a large capacity high pressure compressor (HyAC) and a diffusion bonded compact heat exchanger (DCHE). The package dimensions are 3.2 m wide, 4 m long and 4.7 m high. The unit is used in a test station, and has proved itself. The firm has a compact design technology developed by its standard compressor business. These experiences and expertise made the installation space 50% smaller than installing individual devices. (The Nikkan Kogyo Shimbun & The Chemical Daily, February 25, 2014; The Nikkei Business Daily & Nikkan Jidosha Shimbun, February 27, 2014)

#### (3) Japan Steel Works

The Japan Steel Works plans to develop a light weight hybrid steel accumulator for hydrogen which is wound around by carbon fiber. The accumulator aims to be introduced into the market in 2015. The manufacturer targets 1 ton or less which is an 80% reduction in weight of its existing steel hydrogen accumulator with 300 L capacity. The hybrid accumulator has both advantages of steel, high durability, and carbon-fiber-reinforced plastic (CFRP). The dimensions of the accumulator are 5,000 mm long and 300 mm internal diameter. Although the size is currently the same as the 300 L steel accumulator, the wall thickness is planned to be thinner. The firm aims for 50,000 recharges or 15 years of designed operating life. Accumulators store hydrogen, and are expected to grow in the market as a usage for hydrogen filling stations for FCVs. Their Muroran Plant has converted

its production line of pressure containers for a petroleum refinery to install a line for hydrogen accumulator, and recently started the production of 300 L capacity hydrogen accumulator. (The Nikkan Kogyo Shimbun, February 27, 2014)

#### (4) Renewable Energy International Trade Fair

On February 26<sup>th</sup>, “Smart Energy Week 2014”, an international trade fair of renewable energy, started in Tokyo Big Sight. For FCV commercial production starting in 2015, the fair had a noticeable amount of exhibit of technologies to store and supply hydrogen efficiently for hydrogen filling stations. (The Nikkei, The Denki Shimbun & Nikkan Jidosha Shimbun, February 27, 2014; The Japan Maritime Dairy, February 28, 2014)

#### (5) Nippon Steel & Sumikin P&E

On February 27<sup>th</sup>, Nippon Steel & Sumikin Pipeline & Engineering, Tokyo, signed a memorandum on construction business for hydrogen filling stations in Japan with US-based Air Products. Technologies of Nippon Steel & Sumikin P&E and hydrogen supply experience of Air Products for filling station will be used for the construction business in Japan. Equipment will be provided by Air Products, and the construction will be carried out by Nippon Steel & Sumikin P&E. Air Products has a reputable experience of supply for over 160 hydrogen filling stations in 20 countries. (The Nikkei, The Denki Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, Japan Metal Daily & The Chemical Daily, February 28, 2014; Nikkan Jidosha Shimbun, March 6, 2014)

#### (6) Takaishi Industry

Takaishi Industry, Osaka Prefecture, will promote hydrogen resistant rubber material originally formulated for devices of hydrogen filling stations. Three types of material are under development for packing; ethylene propylene rubber (EPDM) (for low temperature and high pressure use), fluororubber (for normal temperature and high pressure use, and for high temperature and pressure use). The manufacturer supplies the materials to the project of New Energy and Industrial Technology Development Organization (NEDO) of which participants include Kyushu University and AIST. The project will examine practicality and hydrogen resistance of the material as O rings in an operation test. (The

Chemical Daily, March 6, 2014)

## 8. Hydrogen Production and Refining Technology Development

Bio hydrogen Technology Laboratory, Naha City, is developing a plant which produces hydrogen from blackstrap molasses and an electricity distribution system as well as its plant production. A test plant and design and development of the control system finished on February 15<sup>th</sup>. Hydrogen is produced by microbial fermentation of blackstrap molasses. Professor emeritus Shigeharu Tanisho of Yokohama National University provided technical support for the success of the plant design and production to stably create hydrogen. Prof. Tanisho has studied microbial generation of hydrogen for about 40 years, and discovered a microbe with excellent hydrogen production in 2004. The plant contains a fermentation tank of a 200 L capacity and a FC for power generation. A system was also originally developed to control fermentation temperature. In the plant, 8kg of blackstrap molasses produces 1 m<sup>3</sup> of hydrogen which can generate 1 kWh. Much experiment and data collection are carried out to improve productivity and reduce cost. The laboratory investigates the effect of up-scaling the plant for full commercialization, and is aiming for practical hydrogen electricity production which attracts attention as a new energy. (The Ryukyu Shimpo, February 16, 2014)

## 9. Technology Development of Hydrogen Transport & Storage

Kawasaki Heavy Industries plans to develop a compressed hydrogen trailer with approximately 30% higher hydrogen loading capacity than a conventional product. A test operation is aimed in 2015. The trailer is to have a hydrogen composite container accommodating 45 MPa. An existing 45 MPa trailer takes 24 cylinders and 200 kg of hydrogen, and the loading capacity is aimed to increase by 30% by improving the vehicle weight and the center position of gravity. The approximate vehicle body dimensions are to be 10 m long, 2.5 m wide and 3.5 m high which are the same as the conventional product. The conventional trailer has four cylinders in a row to fit to the width and three layers of them. On the other hand, the new one is to have five cylinders in a row of three

layers. The firm plans to use two curdles which are racks to accommodate 15 cylinders each, the trailer is to transport a total of 30 cylinders. The firm will develop the baseline and detailed designs. They also made the first compressed hydrogen trailer in Japan as a NEDO project. (The Nikkan Kogyo Shimbun, March 7, 2014)

## 10. FC & Hydrogen Related Corporate Businesses

### (1) JOGMEC

Japan Oil, Gas and Metals National Corporation (JOGMEC) announced that a contract on joint exploration of platinum-group metals in Pallace (Quebec, Canada) was signed with Midland Exploration, a Canadian mineral exploration company. This is the first project of platinum-group metal exploration in Canada. A discovery of mineral deposits of these metals there is expected to diversify suppliers, because platinum-group metals suppliers are unevenly distributed. JOGMEC will provide C\$ 2 million (approximately ¥190 million) of the exploration cost over three years, and gain half of the interest in discovery. (Japan Metal Daily, March 3, 2014)

### (2) Suzuki Shokan

Suzuki Shokan will sell accessory evaluation equipment with hydrogen gas circulating system. As FCV sales increase, demand for performance evaluation is expected to expand for automobile high pressure tanks and facilities of hydrogen filling stations. Their sales activity will target the demand. The conventional small batch system throws away hydrogen gas used for evaluation. The firm will propose the circulating system for evaluations uses a large amount of hydrogen such as a long term gas cycle test. (The Chemical Daily, March 3, 2014)

### (3) Krosaki Harima

Krosaki Harima aims to expand sales of its highly functional insulation material "WDS" for the high temperature use. The established usage of the product has been expanded, and the product has been recently used in domestic and industrial FCs. The product exhibits outstanding insulation performance specifically in high temperature environments, and the firm will work on getting new customers. Developed by a German manufacturer as a highly functional insulation material, WDS is composed of

ultrafine fumed silica and a substance which does not transmit infrared rays. Its micro pore structure regulates the movement of air molecules, which realizes excellent thermal insulation as still air. The insulation performance is better than other insulation materials at higher operational temperatures. WDS has a thermal insulation of 0.021 W/mK at a 200°C, and 0.030 W/mK at a 600°C, which is expected to considerably save energy. (The Chemical Daily, March 5, 2014)

#### (4) Sugino Machine

Sugino Machine, Uozu City, has developed hydraulic test equipment of pressurized containers to store hydrogen for FCV. Three facilities will be delivered to the Hydrogen Energy Test and Research Center, Fukuoka City, by the end of March: a pressure resistance and bursting test facility, a pressure cycle test facility for normal temperature and a pressure cycle test facility for environmental temperature. These facilities can evaluate pressure containers up to 500 L capacity. The standard price of the devices is approximately ¥100 million each. A 5 meter cylindrical pressure generator unit in a short period fills a pressure container with highly pressurized water of 140 to 380 MPa to examine pressure resistance, bursting strength and fatigue strength. (The Kitanippon Shimbun, The Toyama Shimbun & The Hokkoku Shimbun, March 5, 2014; The Nikkan Kogyo Shimbun, March 6, 2014; The Nikkei Business Daily, March 7, 2014)

#### (5) Alone Co.

Alone Co. participated in “PV EXPO2014” from February 26<sup>th</sup> to 28<sup>th</sup> as one of the representatives of Iwate Prefecture. Their booth exhibited a heat sink using diffusion bonding for various devices, heat exchanger related parts, FC related parts, inkjet nozzles and production samples of various gas and liquid channels. (Dempa Shimbun, March 7, 2014)

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