

# 180% PEFC Output by Microbe Enzyme Catalyst

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## 1. Governmental Measures

### (1) Liberal Democratic Party of Japan

On May 28<sup>th</sup>, the Liberal Democratic Party of Japan held a joint meeting of the environment working group, and the research group of environment and measures against global warming, and three manufacturers were invited to explain low-carbon emission facilities and the technology. Kawasaki Heavy Industries gave explanations on a method to produce hydrogen from lignite at a low cost and the significance of hydrogen use. They described that hydrogen was essential to reduce CO<sub>2</sub> emissions, and hydrogen gas turbine generation, as well as fuel cell vehicles (FCVs), were effective to promote the market. The meeting also had Chiyoda Corporation to explain hydrogen transport. (The Denki Shimbun, May 29, 2014)

### (2) METI

On May 30<sup>th</sup>, the Ministry of Economy, Trade and Industry (METI) announced that the regulations and public notices on hydrogen tanks for FCVs were partially changed. The performance requirements including filling pressure and performance of hydrogen tanks were altered to fit to the international regulations. As well as the Ordinance on Safety for Pressure Vessels” of the High Pressure Gas Safety Act, the change was made in the public notices, based on the ordinance, indications and inspection methods. The maximum filling pressure of hydrogen gas was increased from the current 75 to 87.5 MPa. Also the precondition temperature of the definition of nominal use pressure was brought down from 35 to 15°C. This temperature decrease allows more hydrogen to be filled or stored. According to the High Pressure Gas Safety Office of METI, the new regulation lets about 20% more hydrogen be filled. Additionally, the pressure of the pressure test and the number of test

cycles were changed, and the regulations of re-inspection for visual examination and leak test were prepared. (The Nikkei & Nikkan Jidosha Shimbun, May 31, 2014)

### (3) MOD

The Ministry of Defense will start development of unmanned underwater vehicle (UUV), which is equipped with a fuel cell (FC) system and can operate for a long time, with a total investment of ¥2.6 billion. Current UUVs in the market using storage battery as a power source operate for between a several hours and several dozen of hours. This project aims for a dozen of days of operation period by installing a FC generation system in the UUV. The vehicle is expected to support antisubmarine warfare and to transport and place equipment as well as underwater data collection. The tender is planned this autumn to choose a contractor. (The Nikkan Kogyo Shimbun, June 5, 2014)

## 2. Local Governmental Measures

### (1) Osaka Prefecture

On May 12<sup>th</sup>, Osaka Prefecture announced that the state approved the experiment of hydrogen energy usage at Kansai International Airport as a project of “Kansai Innovation Comprehensive Global Strategic Special Zone”. Toyota Industries plan to finish the development of a FC forklift in the FY 2014, and the airport will test it on the premises. Iwatani will develop a hydrogen supply facility for the development. (The Nikkei, May 13, 2014)

### (2) Ikoma City, Nara Prefecture

On May 12<sup>th</sup>, Ikoma City of Nara Prefecture announced that approximately 30,000 m<sup>2</sup> currently used as a sport field and to be closed in 2015, would be sold as a residential area. A condition for bidders is a

development plan of a “smart community” in which houses are equipped with a photovoltaic generator and FC. The city office will take proposals until June 16<sup>th</sup>. (The Nikkei, May 13, 2014)

### (3) Tokyo

Tokyo will investigate into making a hydrogen society. Hydrogen is a promising next generation energy in many ways such as reduction in environmental impact and improvement of energy efficiency. The Tokyo government will collect basic information through surveys to find out issues on hydrogen use. The investigation will find out profitability, economic ripple effect, energy use estimation for a grown period and the number of hydrogen filling stations required in future. (Nikkan Kensetsu Sangyo Shimbun, May 14, 2014)

On May 13<sup>th</sup>, the finance department of Tokyo announced a tender for the investigation project for hydrogen society. Before the actual tender, those who want to bid have to apply to be qualified for the tenders, and the office will take applications for qualification until 16<sup>th</sup>. The qualified bidders will be notified on 28<sup>th</sup>, and the tender results will be announced on June 4<sup>th</sup>. The investigation will last until May 13<sup>th</sup>, 2015. The bidder must fit in class A to B in the investigation of compensation assessment and the market of Tokyo’s classification for bidders. The office asks bidders to have experience of hydrogen or FC related investigations in past three years and electricity or energy, apart from hydrogen, related investigations in past two years, for Japanese or local government. Also oversea research experience of hydrogen energy is required. The investigation project will collect basic information through survey and find out issues for hydrogen society. (Architectures, Constructions & Engineerings News (Daily), May 14, 2014)

On May 16<sup>th</sup>, Tokyo held the first meeting of the Tokyo Strategy Committee for hydrogen society. The committee aims to share strategies to promote hydrogen through discussions about the possibility and issues of hydrogen usage as energy. Prof. Takeo Kikkawa was appointed as the chairperson, and the committee consists of manufacturers and energy providers including the Tokyo Electric Power Company and Tokyo Gas. In the first meeting, the committee pointed out issues including the

regulations, a high price of FCVs, higher preparation cost of hydrogen filling stations than in the West and the ensuring of human resource for hydrogen related operations. On the day, Toyota explained its FCV promotion, and JX Nippon Oil & Energy gave a talk on hydrogen infrastructure construction. The members shared and discussed the current state and issues of hydrogen usage as energy. (The Yomiuri Shimbun, The Nikkei, The Sankei Shimbun & The Tokyo Shimbun, May 17, 2014; The Denki Shimbun, May 19, 2014; Architectures, Constructions & Engineerings News (Daily) & Nikkan Kensetsu Sangyo Shimbun, May 20, 2014)

### (4) Yokohama City

Yokohama City has started taking subsidy applications for installation of smart energy equipment for established houses. The subsidy supports ¥10,000 for home energy management systems (HEMS), ¥60,000 for HEMS and domestic FCs, ¥110,000 for HEMS, domestic FCs and photovoltaic generation systems. The city will subsidize a total of 600 applicants. (Nikkan Kensetsu Sangyo Shimbun, May 15, 2014)

### (5) Greater Tokyo

On May 20<sup>th</sup>, a leader meeting of nine local governments including Tokyo, three surrounding prefectures and designated cities was held in Shinagawa-ku. The mayors and governors made a decision to request “measures to create hydrogen society” to the Japanese government, and the greater Tokyo, the largest energy consumer, will take an initiative in campaigning to raise understanding of hydrogen energy as well as the promotion of hydrogen usage. In the meeting, they all agreed to ask the state for schemes of financial support and deregulation for hydrogen filling station preparations and subsidy for FCV purchase. (The Sankei Shimbun & The Saitama Shimbun, May 21, 2014)

### (6) Kyushu Regional Strategy Committee

On June 3<sup>rd</sup>, the Kyushu Regional Strategy Committee held a meeting in Beppu City, Oita Prefecture, and decided to prioritize three energy sources, geothermal, marine and hydrogen in the expected growing energy industry in Kyushu for their early commercialization. Each field will have a working group to draw up a project plan in the FY 2014. (The Nishinippon Shimbun & Oita Godo

Shimbun, June 4, 2014)

### 3. FC Element Technology Developments

#### (1) Tokyo Institute of Technology

A research group of Associate Prof. Keiko Waki at the Interdisciplinary Graduate School of Science and Engineering of the Tokyo Institute of Technology has discovered that multi-walled carbon nanotubes (CNTs) having defects showed high catalytic activity. CNTs were previously thought to barely have catalytic activity and to need impurities such as metals or nitrogen for the activity. Replacing precious metal of catalyst in FC with defect CNT can contribute to significant cost saving. (The Nikkan Kogyo Shimbun, May 16, 2014)

A team of Prof. Takeo Ohsaka at the Tokyo Institute of Technology has developed a highly durable catalyst for FCs. The new catalyst is about eight times more durable than conventional platinum catalysts while performing at the same level. This can extend the operating time of FCs, and contributes to the growth of FCs. The team aims to improve further to establish a mass production method, and targets commercialization within five years. The trial catalyst is made of combination of tantalum oxide and platinum particles. In the catalyst, tantalum oxide particles form a structure to protect platinum particles which prevents degradation deriving from catalytic activity for generation. Also, electrons transfer between platinum and tantalum oxide particles gives higher catalytic activity. Conventional FCs use platinum particles, but they easily decrease in durability. (The Nikkei Business Daily, May 16, 2014)

A team of Prof. Masatomo Yashima and Assistant Prof. Kotaro Fujii at Tokyo Institute of Technology has discovered a new structure family of oxide-ion conducting materials in cooperation with Ibaraki University and the Australian Nuclear Science and Technology Organization. Oxide-ion conducting materials are used in solid oxide fuel cells (SOFC), oxygen concentrators and various sensors. The new material contributes to the efficiency improvement of these products, and is also expected to encourage new electron material development. The new material is neodymium barium indium oxide of new structure family, and its crystal structure was analyzed using a

neutron diffractometer at the Japan Proton Accelerator Research Complex (J-PARK) and X-ray crystallography facilities at Spring-8 and the High Energy Accelerator Research Organization (KEK). The analysis determined the structure using neutrons and X-rays in a wide range of temperature from room temperatures to 1000°C, as well as visualization of oxide ions' diffusion path. (The Nikkan Kogyo Shimbun, May 29, 2014)

#### (2) NIMS

The National Institute for Materials Science (NIMS) and Hokkaido University have announced that a boron nitride (BN) nano-sheet was found to act as an electrocatalyst for oxygen reduction. This finding hopefully leads to further development of electrode material for FCs. In this experimental development, BN was supported on a gold surface. The team discovered that the material became conductive and BN stably captured oxygen molecules by an electron state change; however, BN is an electrical insulator. They also calculated the energy change of each process of oxygen reduction on the surface. The results indicate the material can function as catalyst for oxygen reduction. In the study, nano-sheets and nano tubes of BN were supported on a gold surface to make a catalyst to examine oxygen reduction. The gold catalyst produced a maximum oxygen reduction current to the positive potential of approximately 270 mV, and its catalytic property was confirmed. Although the catalytic activity is lower than that of platinum, the findings provide remarkably effective guideline to find and design new catalyst materials. This expectantly enables the development of a more efficient catalyst for oxygen reduction by researching further with theoretical calculations. (Japan Metal Daily, May 21, 2014; The Denki Shimbun, May 26, 2014)

#### (3) Kyushu University & Nagoya University

A study group of Prof. Seiji Ogo of Inorganic Biochemistry at Kyushu University has developed a hydrogenase electrode which draws a current of 637 times higher mass activity than platinum, a conventional catalyst, in cooperation with Nagoya University. Certain microbes take electrons by using an enzyme as a catalyst, which caught these researchers' attention. The team succeeded to use "hydrogenase S-77" which is a hydrogen focused

enzyme collected in Mount Aso as cathode of proton exchange membrane fuel cell (PEFC). The hydrogenase stably takes electrons from hydrogen even while exposed to oxygen in the air. The generation ability as a FC cathode is approximately 1.8 times that of platinum, a common catalyst for FCs. Platinum is expensive and exhaustible, but this hydrogenase is made of a combination of nickel and iron which are plentiful in the nature. “This hydrogenase can be used for FCVs once its commercial production method is established”, says Prof. Ogo. (Jomo Shinbun & Kahoku Shimpo June 5, 2014; The Nikkei, The Nikkan Kogyo Shimibun, Yamagata Shimibun, Oita Godo Shimibun, The Toonippo & Akita Sakigake Shimpo June 6, 2014)

#### 4. Next Generation FC R&D

Connex Systems, Kyoto City, has developed a rechargeable FC. The system produces hydrogen inside using reaction on surface processed iron powder, which eliminates the need for an external hydrogen supply. “Shuttle-battery”, a next generation FC by Connex Systems, uses iron powder for its anode active material and a redox reaction which splits water with iron making iron oxide and hydrogen. While the battery discharges power, oxygen in the air and hydrogen react inside the FC to produce electrons and water. While electrons create a current, iron oxide and hydrogen are made by a reaction of water and iron power. The battery generates hydrogen inside; therefore, hydrogen does not need to be fed from outside. On the other hand, hydrogen takes oxygen from iron oxide turning into water and iron during charging. Thus iron powder can be used repeatedly. Iron particles coalesce at high temperature, which disadvantageously reduces the speed of reaction. The firm developed an original method to process the surface of iron particles with a material withstanding high temperatures such as ceramic for operation at 400°C. The theoretical energy density of the FC is five times that of lithium-ion battery (LIB). An electric vehicle (EV) with a conventional LIB drives approximately 200 km, while EV with the new FC can drive 300 km. On the other hand, a LIB can charge and discharge 500 to 1000 times in its life, while the FC does 200 to 300 times. However, the function of the FC recovers by replacing iron powder cartridge. The

material is cheaper than a LIB, which allows for a reduction in price to one third that of a LIB. The firm aims to commercialize the product by 2017, and targets renewable energy storage and automobiles for its application. (The Nikkei Business Daily, May 20, 2014)

#### 5. Ene-Farm Related Business Plans

##### (1) Toho Gas

On May 19<sup>th</sup>, five consumers living in Aichi Prefecture filed a complaint with Nagoya District Court against Toho Gas. According to the consumers, the Ene-Farm brochure of Toho Gas gave a wrong impression that the products would greatly reduce utility bills. These complainants sued for a total of approximately ¥12 million in damages, which was the costs including installation. The petition says that the users installed the FC in 2011 with a cost of ¥2.1 to ¥2.8 million each. The brochure explained a large electricity bill reduction which gives each household saving up to ¥55,000 annually with a chart; however, their gas bill doubled or tripled in winter, which actually increased their total utility costs. One of the complainants living in Nagoya City says that his electricity bill was reduced by ¥60,000 while gas bill increased by ¥90,000 in a year making an overall loss of ¥30,000 rather than saving. (The Chunichi Shimibun & Gifu Shimibun, May 20, 2014)

##### (2) Lemon Gas

Lemon Gas, Hiratsuka City, will develop a small smart community using liquefied petroleum gas (LPG) in Odawara City. The smart community will contain 15 houses and a communal building in an area which was used for a LPG refilling facility of the firm, and target 12 to 17% energy saving by sharing electricity and heat from LPG. Two houses share one unit of Ene-Farm, and each house will be equipped with solar panels on its roof as a standard feature. The firm aims to open in 2015. (The Nikkan Kogyo Shimibun, May 26, 2014)

##### (3) Ene-Farm Partners

The accumulated sales unit of Ene-Farm is expected to reach 100,000 in FY 2014. As well as gas providers, housing manufacturers are committed to selling the FCs with their houses, and the FCs have been installed in more apartment units. According to a private organization “Ene-Farm Partners”, the

accumulated sales unit was approximately 70,000 by FY 2013. Being installed in newly built houses, the sales unit for FY 2014 is expected to be 50,000. The accumulated sales units have been counted since the full entry to the market in FY 2009, and should make 100,000 this year, the sixth year. (The Nikkan Kogyo Shimbun, May 28, 2014)

## 6. Cutting Edge Technologies of FCV & EV

### (1) BMW

Last autumn, BMW released a production model EV “i3” which has sold strongly and reached 10,000 vehicle sales. The firm uses carbon-fiber-reinforced plastic where possible in the vehicle. “i3” will be available in the US this year. Carbon-fiber-reinforced plastic will be used in a plug-in hybrid vehicle (PHV) to be available this year. (The Nikkei, May 10, 2014)

### (2) GM

GM uses a battery of a venture from Massachusetts Institute of Technology “A123 Systems” in the “Spark EV” released in the US last year. However, the purchase from A123 Systems will stop when the 2015 model production starts in the second half of 2014. The battery will be replaced with LG Chem’s LIB used in the Volt which is an eco-car close to a PHV and was released at the end of 2010. A chief engineer of GM has said about A123 Systems that the original technology to increase energy density by using nano-materials was a decision making factor. Also, the Obama administration financially supported the battery manufacturer as a part of the environmental measure “Green New Deal”. However, GM made a decision of the battery purchase switch, because A123 Systems has been bought out by a Chinese firm. Having faced a funding shortfall, A123 Systems announced its sellout to Wanxiang Group, a Chinese automobile part manufacturer, in August 2012, and the acquisition was completed in January 2013. GM targets at annual 500,000 vehicle sales of eco-cars consisting of PHV and EV by 2017, which would be 5% of its current global sales. The firm will reinforce the battery plant in Michigan to accommodate battery purchase expansion from LG Chem. “Technology leak to the Wanxiang Group was one of reasons of the switch of the source” admitted a GM official. (The Nikkei, May 21, 2014)

On May 13<sup>th</sup>, GM announced that its FCVs using

hydrogen as fuel had driven 3 million miles (4,800,000 km) on public roads in an experiment. This mileage is worth 597,694 L of gasoline saving. The experiment of FCVs has been carried out since FY 2007 with 119 vehicles of “Chevrolet Equinox”. In the experiment, over 5,000 drivers have given their feedback about functionality and driving performance of FC technologies. Having launched a FC research and development laboratory in Michigan, the automaker considers an application of hydrogen FC technology as one of its priority projects. Cooperation of another firm had been sought, and they agreed a long-term partnership with Honda in July 2013. A joint development of next generation FC and hydrogen storage systems is being carried out for commercialization by 2020. (The Chemical Daily, May 14, 2014)

### (3) Osaka Prefecture and City

On June 7<sup>th</sup>, Osaka Prefecture and City will hold an environmental event where the latest eco-cars will be displayed and a test ride will be offered at Asia & Pacific Trade Center (ATC) in Osaka Nanko. “Osaka Eco-car Cooperation and Promotion Support Net” will bring about three cars for test rides and the 10 latest eco-cars including Nissan’s EV “Leaf”, Mitsubishi’s PHV “Outlander PHEV” and Honda’s FCV “FCX Clarity”. (Nikkan Jidosha Shimbun, May 14, 2014)

### (4) New Kansai International Airport Co.

On May 20<sup>th</sup>, New Kansai International Airport Co. announced that FC forklifts and its hydrogen refueling facility would be prepared in Kansai International Airport in collaboration with Toyota Motor and Iwatani. This is one of the environmentally friendly measures for the airport, and will also use a scheme of the “Kansai Innovation Comprehensive Global Strategic Special Zone”. The hydrogen FC forklift is under development in cooperation of Toyota Motor and Toyota Industries. As a start, two FC forklifts will be used to carry cargo, and the number of forklifts will be increased to a couple of dozen to examine performance such as durability over three years. The airport operator plans to replace all forklifts, approximately 400 vehicles, with FC forklifts by 2025. Iwatani will prepare the hydrogen refueling facility. A full scale hydrogen filling station and storage facility will be built with consideration for future demand increase with expected FCV growth

including FC buses. A hydrogen generation system will be also installed as a disaster preparation. (The Yomiuri Shimbun, The Asahi Shimbun, The Mainichi Newspapers, The Sankei Shimbun, The Nikkan Kogyo Shimbun, The Kyoto Shimbun, The Yamaguchi Shimbun, The Toyama Shimbun & The Hokkoku Shimbun May 21, 2014; The Nikkei Business Daily, May 22, 2014)

#### (5) Toyota

On May 20<sup>th</sup>, Toyota Motor announced that a new “power semiconductor” had been developed to improve fuel efficiency of hybrid vehicles (HVs) in collaboration with Denso and Toyota Central R&D Labs. The power semiconductor was examined on a test car, and the car exhibited over 5% fuel efficiency improvement. The automaker targets 10% efficiency improvement in the future. Power semiconductors are used in PCUs to control electricity flow, and also applied in EVs and FCVs. (The Chunichi Shimbun, The Kobe Shimbun, Nara newspaper, Gifu Shimbun, Fukui Shimbun, The Shinano Mainichi Shimbun, The Yamanashi Nichinichi Shimbun, Miyazaki Nichinichi Shimbun, Minami-Nippon Shimbun, The Ibaraki Shimbun, The Yamaguchi Shimbun, Jomo Shinbun, Saga Shimbun, The Shikoku Shimbun, The Tokushima Shimbun, The Toyama Shimbun, The Hokkoku Shimbun, Shimotsuke Shimbun, Chiba Nippo, The Niigata Nippo, Iwate Nippo, The To-o Nippo, The Kahoku Shimpo & Fukushima-Minpo, May 21, 2014)

On June 4<sup>th</sup>, Toyota revealed that its FCV commercial production would start in mid-December. Although FCV sales are planned in 2015, it may happen earlier in 2014. The price is expected to be about ¥8 million. Motomachi Plant in Toyota City will produce it at a level of 10 vehicles each month. (The Asahi Shimbun, The Tokyo Shimbun, Osaka Nichinichi Shimbun, The Kobe Shimbun, The Kyoto Shimbun, Nara Newspaper, The Chunichi Shimbun, Gifu Shimbun, The Ehime Shimbun, The Hokkaido Shimbun, The Nishinippon Shimbun, The Sanyo Shimbun, The Kitanippon Shimbun, Minami-Nippon Shimbun, The Chugoku Shimbun, The Saitama Shimbun, Ise Shimbun, Jomo Shinbun, The Yamanashi Nichinichi Shimbun, Shimotsuke Shimbun, The Shinano Mainichi Shimbun, The Toyama Shimbun, Fukui Shimbun, The Hokkoku Shimbun, Yamagata Shimbun, The Nagasaki

Shimbun, Saga Shimbun, The Shikoku Shimbun, The Yamaguchi Shimbun, The Tokushima Shimbun, The Kochi Shimbun, Oita Godo Shimbun, Kumamoto Nichinichi Shimbun, Nihonkai Shimbun, The Niigata Nippo, Iwate Nippo, The To-o Nippo, Chiba Nippo, The Kahoku Shimpo, The San-in Chuo Shimpo, Akita Sakigake Shimpo, The Ryukyu Shimpo, The Fukushima Minyu Shimbun & Okinawa Times, June 4 & 5, 2014)

#### (6) Fuji Heavy Industries

On May 22<sup>nd</sup>, Yasuyuki Yoshinaga, the president of Fuji Heavy Industries, revealed that its PHV and HV, rechargeable through a domestic wall socket, would be introduced to the US, Europe and China. “We also research and develop EVs, but have not considered its commercial production. FCV is hard for us to develop.” said he. (The Kobe Shimbun, The Kyoto Shimbun, Nara Newspaper, Gifu Shimbun, The Shikoku Shimbun, The Yamaguchi Shimbun, Jomo Shinbun & The To-o Nippo, May 23, 2014)

#### (7) Toyota, Nissan, Mitsubishi & Honda

On May 30<sup>th</sup>, Toyota Motor, Nissan Motor, Mitsubishi Motors and Honda Motor announced that a new venture would be prepared to build charging infrastructure in collaboration with the four automakers. The venture Nippon Charge Service, Minato-ku, Tokyo, will subsidize costs for charger installation, and provide a billing and payment system with an initial capital of ¥80 million evenly split by the four firms. The Development Bank of Japan will provide additional funding to the venture next month, and the investment ratio of these automakers will go down to 21.35% each. The venture support costs of approximately ¥5.4 million for a quick charger and ¥1.2 million for a normal charger part of which could be covered by a governmental subsidy. About 5,000 chargers combined have been prepared as of the end of March. The venture aims to increase to 17,000 chargers by the end of this year by installing them at convenience stores and rest areas of expressways by the end of this year. The automakers will accelerate infrastructure preparation for EVs by issuing universal payment cards. (The Nikkei, May 31, 2014)

#### (8) Honda

Honda Motor has revealed for the first time in Japan a new FCV concept model to be released in 2015. The

vehicle contains a newly developed FC stack which is significantly reduced in size, and its powertrain is stored underneath the front hood. This can give a roomy interior accommodating five adults comfortably and an optimal aerodynamic shape at same time. The size of cell stack was reduced by approximately 30% to allow for applying to a wide range of cars once FCVs get popular. With a power density of over 3kW/L, the vehicle has a high pressure 70 MPa hydrogen storage tank at the back, which enables a quick refill of about three minutes and driving range of 700 km (JC08 mode). (The Nikkan Kogyo Shimbun, May 29, 2014)

#### (9) Saitama Institute of Technology

Saitama Institute of Technology will build a "Manufacturing Research Center" to research and develop EV and FCV. All the technologies of the institute will be put into a vehicle development with next generation power such as a magnesium battery. The institute aims to develop a new practical technology to be used in the industry. The total cost of ¥840 million includes personnel, equipment and construction expenses. (The Nikkei, May 30, 2014)

### 7. Hydrogen Filling Station Technology Developments & Business Plans

#### (1) Iwatani

Iwatani has decided to essentially use a liquid hydrogen system for new hydrogen filling stations. They have worked on the growth of liquid hydrogen which is suitable for volume transport and storage, and will use it for new hydrogen filling stations as long as it fits to conditions of premises. A booster pump can contribute to cutting down the size of hydrogen filling stations, and its development will be speeded up to achieve commercialization in FY 2015. (The Nikkan Kogyo Shimbun, May 21, 2014)

#### (2) Toyota

Toyota Motor will prepare hydrogen refueling infrastructure for FCVs in the US and Japan. In Japan, they will prepare about five trailers with hydrogen tanks as mobile filling stations in 2015. Each trailer only requires pieces of land, smaller than stationary filling stations, and allows the initial investment of approximately ¥200 million which is a half that of a filling station. Toyota has decided to capitalize "First Element Fuel", a venture operating hydrogen filling stations in California, and will invest

in hydrogen filling stations through the venture. The venture plans to build over 19 hydrogen filling stations in California with state subsidy, and Toyota will support the operation. The automaker will support sales of FCV to be available from next year by preparing hydrogen filling stations of which the number is currently too small. (The Nikkei, May 24, 2014)

### 8. Hydrogen Production/Refining Technology Development & Business Plan

General Incorporated Foundation Japan Leading Edge Laboratory, Nagoya City, will promote hydrogen producing ceramics. The ceramic uses natural minerals as the main material, and is made into tablets to produce hydrogen safely at a low price by soaking in water. The firm targets hydrogen requiring products such as FCVs for applications as next generation energy to replace oil. With a commercial level production, the price is expected to be about ¥35 for an 8 g tablet producing 4 L of hydrogen. The tablet is sold as "FSSS" which is developed to produce hydrogen and uses natural minerals such as magnesium and aluminum as its main ingredients. The production process is simple, which significantly helps reduction in costs. The product generates 450 to 600 mL/g of hydrogen, and allows simple storage. Storage only requires low humidity place to avoid performance degradation which causes economic loss, with negligible risk. The tablet generates high purity hydrogen of over 98 to 99% a couple of minutes after soaking in water. The vigorous hydrogen production lasts one to three hours. (The Chemical Daily, May 21, 2014)

### 9. Hydrogen Transport/Storage Technology Developments & Business Plans

#### (1) Maruhachi Corp.

Maruhachi Corp., Fukui Prefecture, has received an "Innovation Award" from JEC Europe, one of the largest composite material exhibitions, for its high pressure storage tank of hydrogen fuel for FCVs. Classified as type 4, the tank uses a resin liner, and its insulation performance was highly valued by the committee. Conventional composite tanks, type 3, have aluminum as their liners which are wound by carbon fiber. The aluminum liners have been replaced

with resin liners. The firm developed a carbon fiber reinforced plastic (CFRP) container with no hydrogen leakage, and is working on a hydrogen storage container for hydrogen filling stations as well as hydrogen tanks for FCVs. A prototype of its accumulator is planned to be introduced by 2016. (The Nikkan Kogyo Shimbun, May 21, 2014)

#### (2) KHI

Kawasaki Heavy Industries (KHI) plans to develop a tanker ship to transport liquid hydrogen, and aims for commercialization by 2017. The government is preparing safety standards for hydrogen tanker ships in cooperation with KHI, and will bring the standards to the International Maritime Organization, specialized agency of the United Nations, to make the standards international. The firm has already developed an on-board storage tank for shipping in February, and has started design of the tanker ship. An experimental hydrogen transport is planned from Australia to Japan in 2017, and its sales start is aimed at the same time. (The Yomiuri Shimbun, May 31, 2014)

### 10. FC & Hydrogen Measuring & Observing Technology Development and Business Plans

#### (1) Gunze

Gunze has been working on commercialization of a “hydrogen checker” which indicates leakage of hydrogen, a colorless and odorless gas. Being small and lightweight, the checker can be attached to work clothes to detect hydrogen leakage in the surrounding environment. With an accessible price, the product can be used in volume at laboratories with hydrogen to estimate how the colorless gas spreads. The dimensions of the product are 65 mm long, 35 mm wide and 11 mm deep with a weight of 19 g including a button cell. A lithium button cell continuously operates the device for about a year, which is advantageously low power consumption. The hydrogen detection range is 0.1 to 1.0% depending on temperature and humidity. The product has been used at a laboratory of Iwatani which is a co-developer, Gunze will improve the device using users’ requests to expand sales. (The Chemical Daily, May 22, 2014)

#### (2) Oval

Oval has released a Coriolis flow meter for hydrogen filling pressure of a maximum 120 MPa for hydrogen

filling stations. Filling pressure is currently 70 to 80 MPa, and is expected to increase to 99 MPa. Speculating FCV growth, the firm increased the maximum pressure of the existing meter from 95 MPa to 120 MPa. They anticipate a 99 MPa filling pressure becoming the majority, and have started sales of the new model. The new model will sell for ¥5.4 million including consumption tax. (The Nikkan Kogyo Shimbun, June 2, 2014)

### 11. FC & Hydrogen Related Business of Private Organization

Teijin DuPont Films will promote Bi-axially oriented polyethylene naphthalate (PEN) “Teonex®” film for FC material. They will explore new applications such as gasket materials and processing paper for polymer electrolyte membranes, and seek further heat and hydrolysis resistance and gas barrier performance. More shipping expansion is aimed for by extending the application of the film to new fields in the future. Being a high function film, “Teonex®” outperforms polyethylene terephthalate (PET) films. The thickness can be around 1  $\mu$  m. Teonex® also has excellent stability in heat, hydrolysis and electrical resistance, and has been used in a wide range of products including organic semiconductor, IC card and electrical and electronics materials. The gasket is placed between a membrane electrode assembly (MEA) and separator to improve adhesion. The film has been used as processing paper of polymer electrolyte membranes, and the firm will promote the film for a catalyst layer transfer film as well as processing paper to increase the sales. The processing paper can reinforce fluorine membranes and improve their workability. The manufacturer will have a range of the film such as low temperature contracting and improved handling types to fit usages as well as a standard one with 12 to 250  $\mu$  m thickness. (The Chemical Daily, May 28, 2014)

— This edition is made up as of June 9, 2014 —