

## Japanese Safety Standards for FCV to be International

Arranged by T. Homma

### 1. Governmental Measures

#### (1) METI

The Ministry of Economy, Trade and Industry (METI) will concentrate its support for next generation vehicles on fuel cell vehicles (FCVs) from 2016, because it has determined the current measures by FY 2015 will give enough promotion for reduction in cost and infrastructure preparation for electric vehicles (EVs) and clean diesel vehicles. The new measures will focus on subsidies for purchases of fuel FCVs and preparation of hydrogen refueling facilities to promptly establish the world leading market for FCVs. This will be included in the action plans of the “Growth Strategy of Japan” to be approved on June 14<sup>th</sup>. (Nikkan Jidosha Shimbun, June 14, 2013)

#### (2) Government

On June 14<sup>th</sup>, the Japanese government approved the “Action Plan for Regulatory Reforms”. For the energy and environment field, the plan includes 74 actions e.g. a regulatory reform to help renewable energy growth and preparation of liquid hydrogen filling station standards for FCV growth. To increase the number of hydrogen filling stations an investigative meeting will be held with the related ministries and agencies to allow the refueling facilities to be built in urban areas. As soon as the technical standards are set, the building standards will be prepared as well as technical advice on construction permits of the Building Standards Act. The requirements on hydrogen filling stations for the urbanization control area will be reported within FY 2013. (Nikkan Jidosha Shimbun, Architectures, Constructions & Engineerings News (Daily), June 17, 2013)

#### (3) NEDO

On June 24<sup>th</sup>, the New Energy and Industrial Technology Development Organization (NEDO) announced the start of the construction of an “energy producing building” in Lyon, France. The project is a part of their overseas experiments to apply prominent Japanese energy technologies which are adjusted to

each environment. This positive energy building (PEB) is the first work of the project. PEB is defined as a building which is installed with energy facilities, such as a photovoltaic generator and fuel cell (FC) system, to produce more energy than the building uses. (The Denki Shimbun, June 25, 2013)

#### (4) Agency for Natural Resources and Energy

The Agency for Natural Resources and Energy of METI compiled an energy business strategy plan focusing on 11 fields which lead to innovation and new industry creation including stationary FCs, smart house and solar power plants. The seventh meeting of energy business strategy study group will be held on June 27<sup>th</sup>, and its interim report will be used to plan policies and budget requests from FY 2014. (The Nikkan Kogyo Shimbun, June 28, 2013)

#### (5) MLIT

From the end of July, the Ministry of Land, Infrastructure, Transport and Tourism will invite local governments and businesses which want to create, store and save energy with town planning. The expected project proposals are; town planning with local energy source, tourism plans using EVs and housing areas with advanced environmental technologies such as FCs, storage batteries and energy management systems (EMS). The selected proposals will be given their shape with ministry assistance by the end of FY2013. (The Nikkan Kensetsu Kogyo Shimbun, July 8, 2013)

### 2. Local Governmental Measures

#### (1) Okayama Prefecture

From June 10<sup>th</sup>, Okayama Prefecture will receive subsidy applications for new energy facilities and energy saving equipment for home. The subjects of the subsidy are photovoltaic generators with either a home energy management system (HEMS), lithium ion battery (LIB) or FC installation to houses, and ¥80,000 will be financed for each household. The budget is prepared for a total of 310 households. (The

Sanyo Shimbun, June 8, 2013)

(2) Toon City

On June 20<sup>th</sup>, Toon City of Ehime Prefecture revealed its “Green Eco House” and “Green Loan Plan” schemes for the town re-demarcation project of Shitsukawa. The city certifies houses with HEMS or new energy facilities “Green Eco House” in the area, and owners of these houses are eligible for “Green Loan Plans” which provide preferential mortgage rates. The city promotes housing developments which fit in the landscape and are environmentally conscious in the area. The criteria for the certification are; 1) to follow the housing development guidelines of the city, 2) HEMS installation to save energy and 3) two facilities or more to reduce fossil fuel consumption such as photovoltaic generator and FC. (The Ehime Shimbun, June 21, 2013)

(3) Kinki District Transport Bureau & Kobe District Transport Bureau

Kinki District Transport Bureau and Kobe District Transport Bureau drew up an “Environment Action Plan for Transportation 2013” to combat environmental issues caused by transportation. The action plan includes the promotion of low emission cars and “green logistics” as a key subject, which helps EVs and FCVs to grow. (Nikkan Jidosha Shimbun, June 27, 2013)

(4) Tsukuba City

On July 2<sup>nd</sup>, Tsukuba City, an environmental model city appointed by the state, signed an agreement for promoting “sustainable community” concepts with Daiwa House and NTT Urban Development Corporation, a NTT Group member. Developing a housing estate in the city, these firms will use sophisticated measures to realize a low carbon life-style. Covering approximately 9.3 ha of land, the development is in C43 section of the Katsuragi area near the Kenkyu Gakuen Station of Tsukuba Express. Daiwa House will build 175 houses to be energy self-sufficient with photovoltaic generators, FCs and storage batteries in the section. These houses will be sold for approximately ¥45 million from mid-September. (The Ibaraki Shimbun, July 3, 2013; The Nikkan Kogyo Shimbun, July 4, 2013)

### 3. FC Related Element Technology Developments

(1) Nagoya Institute of Technology

A study group of Prof. Koichiro Fukuda of the Department of Materials Science and Engineering at the Nagoya Institute of Technology developed a solid electrolyte which is highly conductive to oxide ions at a lower temperature of 600 °C or less. Apatite-type lanthanum silicate polycrystals were successfully orientated for the first time; however the orientation of the compound had been thought very difficult. The group laid pressurized powder of two different chemical compositions of apatite-type lanthanum silicate like a sandwich, and isothermal heat was applied to orientate the crystal structure of the material to create the highly conductive electrode by optimizing its composition ratio. The oxide ion conductivity was 0.031 S/cm at 550°C and 0.042 S/cm at 600 °C which are over double the result of their lanthanum silicate crystalline compound previously made by the group. The new electrolyte exhibits higher conductivity at low temperature than yttria-stabilized zirconia (YSZ) electrolyte, and it hopefully extends life of FCs and reduces cost. (The Nikkan Kogyo Shimbun, June 17, 2013)

(2) NIMS

National Institute for Materials Science (NIMS) revealed the mechanism of surface oxidation of aluminum. An oxygen molecule beam was originally developed to regulate molecular axis orientation. By using the beam, the team discovered that the oxygen capture rate of the aluminum surface largely depended on the molecular axis orientation. According to the result, oxygen molecules at a low speed, translational energy of 0.1 eV or more, only reacts with the surface when the molecular axis is parallel to the surface. With a translational energy of 0.2 eV or more, oxygen is captured irrespective of the molecular axis direction. As well as oxidation process, the oxygen molecule beam can be used to investigate the catalytic processes, which is expected to be applied in alternative catalyst development for FCs. (The Chemical Daily, June 20, 2013)

(3) Nippon Steel & Sumikin Chemical

On June 20<sup>th</sup>, Nippon Steel & Sumikin Chemical announced that a porous carbon material “Escarbon” was developed with Professor Emeriti Nobuyuki Nishi of the Institute for Molecular Science (IMS). The new carbon material is mesoporous carbon nano-dendrite (MCND), and it uses metal acetylide, which is metal

molecules combined with triple-bond carbon, as a precursor. The material has pores divided by a graphene sheet on its surface as well as its dendritic structure, which gives the material distinctive characteristics compared to conventional nano-carbon materials. Gas and liquid can diffuse better via the pores. As well as being highly conductive and durable, the product can support metal particles as a catalyst. The firm expects the product to be a material specifically for LIBs and FCs. With the high conductivity and porosity, the product is also considered to be used as a support for the catalyst of FCs and an agent to increase conductivity. Since a special process is included in the production at this stage, a further development is required to establish the mass production technology for early commercialization. (The Chemical Daily, June 21, 2013; The Nikkan Kogyo Shimbun, June 24, 2013; The Nikkei Business Daily, June 25, 2013)

#### (4) Tokyo Institute of Technology

On June 25<sup>th</sup>, a research team led by Prof. Masatomo Yashima of the Department of Chemistry and Materials Science of Tokyo Institute of Technology and Prof. John Kilner of Imperial College London, UK, revealed its result that the reason why a layered perovskite-type cobalt oxide “praseodymium barium cobaltite  $\text{PrBaCo}_2\text{O}_{5+6}$ ” exhibited high oxide-ion conductivity. They thoroughly investigated the crystal structure and space distribution of nuclear density of the perovskite-type cobalt oxide by methods including neutron diffraction. The result shows that oxide ions transfer through apical oxygen near praseodymium and oxygen on cobalt-oxygen surface. A mixed conductor with layered perovskite-type structure was created, and its oxygen concentration was analyzed by thermogravimetric analysis. Also, the crystal structure and pathway of fast moving oxide ions were observed by neutron diffraction. The experiment made clear that a large amount of oxygen vacancy existed in apical oxygen near praseodymium in  $\text{PrBaCo}_2\text{O}_{5+6}$ . Oxide ions transfer through the apical oxygen near praseodymium and oxygen on cobalt-oxygen surface. By increasing the temperature from 595 to 1000 °C, the space distribution of the oxide ions expands as the temperature goes up. Because an ion conductor with higher ion conductivity can effectively take oxygen in from air, the material is

expected to improve the performance of solid oxide fuel cells (SOFCs). (The Nikkan Kogyo Shimbun, June 26, 2013)

#### 4. Microbial FC Related Research Result

A study group of University of East Anglia in the UK, in collaboration with the Pacific Northwest National Laboratory in the US, proved that proteins on the surface of bacteria can produce an electric current by simply touching a mineral surface. A bacterium “*Shewanella oneidensis*” is known to reduce poisonous heavy metals, and a synthetic bacterium was made from the *Shewanella oneidensis*’s proteins thought to shuttle electrons from the inside of the microbe to the mineral. The group examined how well electrons travelled between an electron donor on the inside and a mineral on the outside, and electric current was generated by these proteins only touching the mineral surface. These bacteria are possibly used as miniature factories on the surface of an electrode, where chemical reactions take place inside the cell using electrical power supplied by the electrode through these proteins. (The Nikkei Business Daily, June 27, 2013)

#### 5. Experiments of Business Use FCs

##### (1) Tokyo Institute of Technology

On July 2<sup>nd</sup>, the Tokyo Institute of Technology revealed that its “environmental energy innovation building” with 4,570 solar panels installed in Ookayama campus had saved annual ¥30 million of utility expense. The building nearly reached its initial target of “over 60% reduction in CO<sub>2</sub> emission and electricity self-sufficiency” with combined energy saving facilities. The facilities are a 650 kW level power output photovoltaic generator, a 100 kW level power output phosphoric acid fuel cell (PAFC), a desiccant air conditioner using FC’s waste heat and a geothermal heat pump. Since July, the university has used an original smart grid developed in collaboration with NTT Data Customer Service, and a further energy saving is expected. (The Nikkan Kogyo Shimbun, The Denki Shimbun, The Nikkan Kensetsu Kogyo Shimbun, June 3, 2013)

##### (2) Nissei

To make its FC commercialized, Nissei started a test of the emergency power source for traffic lights at

“Aichi-Rinku New Energy Research Area” where new energy with advanced technologies are studied and experimented in Tokoname City of Aich Prefecture. The FC system is jointly developed with the Japan Steel Works to be used as a backup power supply for power cuts caused by disasters such as an earthquake. The system is composed of FC stacks, a control panel and three hydrogen cylinders which allow it to operate continuously for eight hours. The system is approximately 80 kg lighter than a conventional engine generator, which lets the FC be attached to the pole of a traffic light. Aiming to introduce into the market by the end of the year, Nissei will investigate how much damage salt causes to the system. The FC is planned to be applied to industrial vehicles as well as traffic lights, and the earnings of the FC business will be included in the management plan. The firm will work out how to reduce production costs and develop a new product to bring up the FC as a core product. (The Nikkan Kogyo Shimbun, July 4, 2013)

## 6. Ene-Farm Business Plans

### (1) Tokyo Gas

June 12<sup>th</sup>, Tokyo Gas announced that its Ene-Farm accumulated sales reached 20,000 units since it started the sales in May, 2009. Targeting at 12,000 units for FY 2013, the firm tries to extend its sales channel. (The Denki Shimbun, June 13, 2013; The Chemical Daily, June 14, 2013; Dempa Shimbun, June 18, 2013)

### (2) Ene-Farm Promotion Association

An Ene-Farm promotion association “Enefarm Partners” consisting of the FC production industry and natural and liquefied petroleum gas industry held its launching ceremony in Tokyo. The association will promote Ene-Farm. (The Saitama Shimbun, The Yamaguchi Shimbun, June 29, 2013; The Okinawa Times, June 30, 2013)

## 7. Cutting Edge Technologies of FCV& EV

### (1) Toyota Motor

June 11<sup>th</sup>, Toyota Motor announced its concept car “Camatte57s” would be displayed in the “International Tokyo Toy Show 2013”. The car is a three-seater convertible EV, and can be dressed up by changing 57 panels covering the body. (The Nikkei, June 12, 2013)

Toyota will introduce FCV into the US in 2015. Chief executive officer James Lentz, who has been in charge of the North America region since reorganization in April, revealed at a press conference on June 12<sup>th</sup> that “A first FCV sedan will be available in 2015 in the states”. The firm will accommodate environmental car needs with the new products including plug-in hybrid vehicles (PHV) and EVs. (The Nikkei, June 13, 2013)

### (2) Grand Front Osaka

An EV battle has started in “Grand Front Osaka” which is a commercial complex opened in April in north of the JR Osaka Station. On June 12<sup>th</sup>, US-based Tesla Motors started its EV exhibition and advertising test ride. Sedan EV “Model S” is displayed until July 16<sup>th</sup> in a showroom that Panasonic opened in Grand Front. Several thousand cylindrical LIBs by Panasonic are loaded on the EV. A venture EV developer Green Lord Motors, Kyoto City, prepared a booth in a technology exchange point “Knowledge Capital” of Grand Front, and displays its bright red EV sports car “Tommykaira ZZ”. The firm plans to produce 99 vehicles by order for FY 2013. The vehicle will sell for ¥8 million before tax. (The Nikkei, June 13, 2013)

### (3) GM

US-based General Motors will release its first EV “Spark EV” in June. The EV will be available in California and Oregon where EVs are going stronger before moving onto the global market including South Korea. “This car represents a change for GM, and will be brought up to be a global product.” said the Senior Vice President of Global Product Development, Mary Barra. (The Nikkei, June 14, 2013)

### (4) NTN

NTN, a major bearing producer, started an experiment of an originally developed micro EV on public roads. The EV will be provided to the commune of Annecy, where their subsidiary is located, for one year from June to be driven in the area. The firm developed a wheel hub motor, a motor is directly installed in a wheel, and the EV “TOO'in” uses the motor. The vehicle has small dimensions of 2.85 m long and 1.42 m wide, and its maximum speed is 76 km/h. The manufacturer plans to bring the next generation motor to be a core product for EVs. The experiment is to collect data and check quality and traveling performance on real roads for

commercialization. (The Nikkei, June 16, 2013)

#### (5) EV Japan

Electric Vehicle Japan, which is established in Toyonaka City in Osaka Prefecture by eight automobile service providers together in the Kansai area, developed a single-seater EV cart. With a 90 cm wide body, the EV can zip through narrow roads, and be recharged through a power socket at home. Because a gasoline filling station is often quite a distance for farmers in remote places, the vehicle is more convenient than gasoline pickup trucks for them. The maximum speed is 15 km/h, and the vehicle drives 30 km on a four to five hour charge with a lead-acid battery. The EV will be available from mid-July and its standard version will sell for ¥498,000. The firm targets at 100 vehicle sales for the first year. (The Nikkei, June 17, 2013)

#### (6) Germany-Japan Battery Alliance for Eco Cars

Germany-based Bosch, the largest automobile parts producer, major battery manufacturer GS Yuasa and the Mitsubishi Corporation will cooperate for batteries for EVs. The three firms will set up a joint company to develop and sell LIB in Stuttgart, Germany. GS Yuasa's technology to improve cell performance and precise battery output control technology of Bosch will be united to develop a new battery system to double the current driving range on a single charge to over 400 km to lead the industry with the growth strategy. The production method will be developed by the end of 2017. The new firm is capitalized at approximately ¥5 billion, and the ratio is 50% from Bosch, 25% each from GS Yuasa and Mitsubishi. (The Yomiuri Shimbun, The Nikkei, June 20, 2013; The Nikkei Business Daily, June 21, 2013)

#### (7) Nissan Motor

On June 21<sup>st</sup>, Nissan Motor revealed its racing car "Nissan ZEOD RC" which can drive at 300 km/h using its electric motor. The vehicle is displayed in the circuit for 24 Hours of Le Mans starting from 22<sup>nd</sup>, the automaker aims to advertise its EV technologies that it places as the core of eco car strategies. As well as LIB technology, the car has a gasoline engine on board to charge the battery, and can drive the approximately 13 km circuit only on electricity which is charged by engine drive. (The Nikkei, June 22, 2013)

#### (8) Safety Standards of FCV

Japan, the US, EU and other 30 countries and

regions take on board Japan's proposal for international safety standards for FCV, and the United Nation (UN) recently revealed the final draft of safety standards which largely includes Japan's proposal. The working group of the UN will hold a meeting in Geneva, Switzerland from June 24<sup>th</sup> to 29<sup>th</sup>, and the members including rising nations such as China and India are going to officially agree the draft there. Japan set safety standards in 2005, which was the first among the main countries. The negotiation was based on the proposal from the beginning. The proposed safety standards will cap hydrogen concentration of 4% in the pipe to drain water from FC on a vehicle, and impose on manufacturers to install a system to stop the hydrogen supply once the concentration reaches 4% to avoid a potential explosion. Also, fuel tanks must keep their shape after a cycle of being pressurized and depressurized 22,000 times as a durability test. Because the Japanese standards are widely employed, Japanese automakers do not need to change the specifications for Japan to export their FCVs. The Japanese government plans to help FCV technology innovation by deregulation. A test drive on public roads requires an authorization from MLIT, and the application will be simplified, and its process will be shortened from eight weeks to six. (The Nikkei, June 23, 2013; The Mainichi Newspapers, The Sankei Shimbun, The Tokyo Shimbun, Osaka Nichinichi Shimbun, The Kyoto Shimbun, The Kobe Shimbun, Kanagawa Shimbun, The Chunichi Shimbun, The Sanyo Shimbun, The Chugoku Shimbun, Kitanippon Shimbun, The Shikoku Shimbun, Gifu Shimbun, The Shizuoka Shimbun, The Yamaguchi Shimbun, Kumamoto Nichinichi Shimbun, Miyazaki Nichinichi Shimbun, The Nagasaki Shimbun, The Saga Shimbun, Fukui Shimbun, Nihonkai Shimbun, The Kochi Shimbun, The Shinano Mainichi Shimbun, Oita Godo Shimbun, Yamagata Shimbun, The Tokushima Shimbun, Fuji Sankei Business i, The Niigata Nippo, Iwate Nippo, The To-o Nippo Press, The San-in Chuo Shimpo, The Kahoku Shimpo, Akita Sakigake Shimpo, June 28, 2013; Nikkan Jidosha Shimbun, The Hokkoku Shimbun, July 1, 2013; Nikkan Jidosha Shimbun, July 8, 2013)

#### (9) Politician-Ministry-Business Workshop for FCV Promotion

On June 26<sup>th</sup>, auto giants including Toyota Motor, Nissan Motor, and Honda Motor, other businesses such as JX Nippon Oil & Energy, Iwatani and Kawasaki Heavy Industries, and Liberal Democratic Party of Japan started a workshop to develop policies regarding subsidy and tax benefits. To make Japanese industries' more competitive, the politician-ministry-business group aims to create a market for FCVs that manufacturers are racing to develop worldwide. The workshop is named "Promotion Workshop to Realize a Hydrogen Society with FCVs as Core" A total of 30 politicians will participate in the workshop, and the president is Yuriko Koike, a member of the House of Representatives. The workshop tries to increase its members, and Deloitte Tohmatsu Consulting works as the secretariat. Sales price is an important key for FCV growth, and the group will work on subsidies and tax benefits to bring the price down to around ¥3 million, and encourage the government to include its result in the tax system revision and budget. (The Nikkei, June 25, 2013; The Mainichi Newspapers, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, Fuji Sankei Business i, June 27, 2013; Nikkan Jidosha Shimbun, June 28, 2013)

#### (10) Honda Motor

Honda Motor will form a partnership with US-based GM for FCV. The core system will be jointly developed with their wealth of patents, and they aim to introduce FCV into the market with a price of ¥5 million by 2020. On July 2<sup>nd</sup>, Tetsuo Iwamura, a vice president of Honda, and Stephen Girsky, a vice chairman of GM announced the partnership. "GM goes ahead in the knowledge of advanced materials, and Honda has confidence in structure design and production." explained Mr. Iwamura. They also cooperate in hydrogen infrastructure preparation and standardization; however, this agreement does not include capital alliance and joint production of cars. The automobile industry has been globally restructuring due to a vast trove of development expenses. Had been independent for the development, Honda changed its strategy to compete with Toyota Motor and Nissan Motor. The race for the leading position in the FCV market will be dominated by these three auto giants. Since Germany-based VW and South Korea-based Hyundai Motor have not announced partnership, their movements are worth

noting. (The Yomiuri Shimbun, The Asahi Shimbun, The Mainichi Newspapers, The Nikkei, The Sankei Shimbun, The Nikkei Business Daily, The Nikkan Kogyo Shimbun, Nikkan Jidosha Shimbun, The Tokyo Shimbun, The Chunichi Shimbun, Osaka Nichinichi Shimbun, The Kobe Shimbun, The Kyoto Shimbun, Kanagawa Shimbun, The Nishinippon Shimbun, The Sanyo Shimbun, The San-in Chuo Shimpo, The Yamaguchi Shimbun, The Chugoku Shimbun, The Saitama Shimbun, The Hokkaido Shimbun, The Ehime Shimbun, Gifu Shimbun, The Shizuoka Shimbun, The Ibaraki Shimbun, The Saga Shimbun, The Nagasaki Shimbun, The Tokushima Shimbun, The Shikoku Shimbun, The Kochi Shimbun, Fukui Shimbun, The Toyama Shimbun, Nihonkai Shimbun, The Hokkoku Shimbun, The Shinano Mainichi Shimbun, The Yamanashi Nichinichi Shimbun, Miyazaki Nichinichi Shimbun, Kumamoto Nichinichi Shimbun, Kitanippon Shimbun, Minami-Nippon Shimbun, Oita Godo Shimbun, Jomo Shinbun, Shimotsuke Shimbun, Yamagata Shimbun, Hochi Shimbun, Fuji Sankei Business i, Chiba Nippo, The Niigata Nippo, The To-o Nippo, The Kahoku Shimpo, The San-in Chuo Shimpo, Akita Sakigake Shimpo, The Ryukyu Shimpo, Fukushima-Minpo, Okinawa Times, July 2 and 3, 2013; Dempa Shimbun, The Chemical Daily, July 4, 2013)

#### (11) NEXCO-West

Installing 22 quick chargers on its roads including the Meishin Expressway, the West Nippon Expressway (NEXCO-West) will activate 12 quick chargers for EVs in July. Remaining 10 chargers will be available between August and the end of September. These chargers will offer free charging at the moment and operate around the clock. (The Nikkei, July 5, 2013)

### 8. Hydrogen Filling Station Related Technology Developments & Business Plans

#### (1) Tokyo Gas

On June 21<sup>st</sup>, Tokyo Gas announced that hydrogen filling facilities for FCVs would be built at two places in Nerima-ku, Tokyo, and Saitama City. Prior to FCV's introduction to the market in 2015, the firm will provide natural gas for natural gas vehicles and hydrogen in the same facilities. The constructions will

start in Nerima-ku in July as well as this fall in Saitama City. The firm will receive subsidy from METI. On June 21<sup>st</sup>, the Next Generation Vehicle Promotion Center selected a total of 19 hydrogen filling facilities including two of Tokyo Gas and 10 places of JX Nippon Oil & Energy for the subsidy. (The Mainichi Newspapers, The Nikkei, June 22, 2013; The Denki Shimbun, The Nikkan Kogyo Shimbun, The Saitama Shimbun, June 24, 2013; The Nikkan Kensetsu Kogyo Shimbun, The Chemical Daily, June 27, 2013)

#### (2) Orion Machinery

Orion Machinery, Suzaka City, developed a condenser for hydrogen filling stations. The condenser prevents the temperature rise of hydrogen during refilling process to improve safety. An experimental station in Nagoya City installed the first condenser in May. With dimensions of 2.4 m wide, 3.6 m deep and 3 m high, the product is the largest condenser of the firm, which produces industrial condensers for factories and plants. (The Shinano Mainichi Shimbun, June 15, 2013)

### 9. Hydrogen Production Business

On June 11<sup>th</sup>, Iwatani announced that its joint corporation Yamaguchi Liquid Hydrogen, Osaka City, with Tokuyama started its production at the liquid hydrogen plant in Shunan City, Yamaguchi Prefecture. This is the third liquid hydrogen plant for Iwatani. The plant was capitalized at ¥3.5 billion and has a production capacity of 3,000 L/h. (The Nikkan Kogyo Shimbun, The Nikkei Business Daily, The Chugoku Shimbun, June 12, 2012)

Iwatani will double the production ability of the liquid hydrogen plant in Shunan City to 6000 L/h by FY 2015. The plant will be capitalized by approximately ¥2 billion to install more liquefiers and storage tanks. Because liquid hydrogen is expected to be more demanded for industrial purpose and FCVs, the firm will tool up the production and prepare for supply increase when other liquid hydrogen plants stop. (The Nikkan Kogyo Shimbun, June 17, 2013)

### 10. Research on Hydrogen Production and Refining Technologies

#### (1) Kyushu University

Prof. Ken Sakai at Kyushu University synthesized a

new catalyst which assists oxygen production from water using sunlight. The catalyst uses cheaper cobalt instead of commonly used ruthenium. A complex was created with cobalt and a compound “porphyrin” in chlorophyll in plants combined. The complex was mixed in water with a coloring matter which captures light. By applying visible radiation, the mixture successfully produced oxygen. Using cobalt is a significant cost saving with a value of approximately ¥3,000/kg which is an eightieth of ruthenium worth ¥240,000/kg. Because the catalytic effect only last for approximately 20 minutes at this stage, the study group will research further to keep the effect longer. Electrons are released with the catalyst when oxygen is produced. This electron movement is thought to help another catalytic reaction by shedding light to produce hydrogen smoothly. By linking these reactions, a commercial synthetic photosynthesis system will hopefully be developed to easily produce hydrogen from water by applying sunlight. The team aims for commercialization in five years. (The Nikkei Business Daily, June 24, 2013)

#### (2) Okayama University

A study group of Prof. Jian-Ren Shen of the Department of Biology at Okayama University discovered that calcium promoted the water splitting process during the photosynthesis of plants. This finding should lead to establish a “synthetic photosynthesis system technology” to produce large amount of hydrogen at a lower cost. In a previous study, the group already confirmed that plants have an enzyme to split water. The enzyme consists of four manganese atoms, five oxygen atoms and one calcium atom. Oxygen is known to attract manganese and calcium, and manganese is recognized to extract electrons from water molecules. However, the function of calcium was unknown. The group extracted the enzyme from chloroplasts of cyanobacteria, a type of algae, and replaced calcium in the enzyme with strontium which has similar properties to compare with the original enzyme. Both enzymes were exposed to light for photosynthesis to investigate the speed of enzyme release per hour. The enzyme with strontium was a half of calcium. The both enzyme was exposed to a strong X-ray at SPring -8 for structural analysis. Calcium in the enzyme bonds with water molecule for photosynthesis. The distance between calcium and

water molecule was 2.4 nm; on the other hand, strontium was 2.6 nm apart from water molecule. The group concluded that calcium pulled water molecules closer resulting in more effective photosynthesis. (The Sanyo Shimbun, June 29, 2013)

## 11. Hydrogen Transport and Storage Technology Developments

### (1) Chiyoda Corporation

Chiyoda Corporation, Yokohama City, developed a method whereby hydrogen stays liquid in a wide temperature range between -95 and 100 °C. The commercialized method liquefies hydrogen by bonding with toluene, and then extracts hydrogen from the liquid, which allows hydrogen to be transported in normal temperature under normal pressure. “Hydrogen had been thought difficult to transport in bulk or to store long-term. However, we proved that hydrogen can be transported and stored on a commercial basis.” the firm explains. Aiming to diversify energy sources, they plans to mix hydrogen in natural gas and supply FCV with hydrogen. (The Tokyo Shimbun, June 25, 2013)

On June 28<sup>th</sup>, Chiyoda Corporation signed a package agreement with Kawasaki City. The agreement includes Chiyoda to have a base on the coastal areas and supply plants with hydrogen in the area as well as constructing a power plant using hydrogen with their method to provide and transport hydrogen in bulk. In August, the city will set up a “Kawasaki Coastal Area Hydrogen Network Council (provisional name)” with experts and businesses using hydrogen to help building a hydrogen supply network and preparing commercial hydrogen power plants. (The Tokyo Shimbun, June 29, 2013)

### (2) AIST

A study group of Dr. QiangXu, a senior researcher at the National Institute of Advanced Industrial Science and Technology (AIST), developed a catalyst which produces hydrogen at twice the speed of a conventional product. For the catalyst material, they focused on a “porous coordination polymer (PCP)” which has many 3 nm diameter pores on its surface. PCP was mixed in water and an organic solvent hexane, and 1.5 to 3 nm diameter platinum particles were added. Large amount of platinum particles fixed in the pores of the cubic structured

polymer. Then, hexane and water were evaporated as reduction to make the catalyst. The catalyst was tested with an ammonia compound “ammonia borane” which is expected to be a hydrogen storage material to investigate the efficiency of its hydrogen extraction. The speed of hydrogen production was twice of a conventional platinum catalyst. (The Nikkei Business Daily, June, 27, 2013)

## 12. FC & Hydrogen Related Business Activities

### (1) E.ON, Germany

A major electric and gas utility service provider E.ON of Germany will fund startup companies specialized in energy related businesses. As a start, they capitalized two venture firms in waste heat generation and FC. E.ON has already capitalized US-based Bloom Energy which developed SOFC and commercially sold it for industrial use in the states. Also, E.ON is known to capitalize a US-based EV venture Tesla Motors. (The Nikkei Business Daily, June 13, 2013)

### (2) Hydrogenics, Canada

Hydrogenics, a major FC producer of Canada, will move into the Japanese market with its new energy technology with hydrogen as the core. In Japan, they will sell “Power to Gas” technology which uses surplus electricity from renewable energy to generate hydrogen to be stored as a fuel for later use. Iwatani facilitates customer interface between Hydrogenics and the Japanese firms as partners. Hydrogenics has been negotiating with some companies to start a project next year at earliest. (The Chemical Daily, June 26, 2013)

— This edition is made up as of July 8, 2013—