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New helpful research findings for electrode and electrolyte materials

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1. Governmental Measures:

(1) Ministry of Economy, Trade and Industry, METI

METI will support electric power and gas providers to expand their oversea business as well as to acquire an international standard for fuel cells, FCs. With advantages in energy saving and renewable energy technology, the Japan's energy industry will be aided in increasing their dealings with international firms. Having established a strategy study group on energy businesses on April 17th, the ministry plans to compile a report on measures to assist new business strategy and political support by July, and to include the findings in the Green Growth Strategy which is a governmental plan for job creation and economic growth with environment industry. (The Mainichi Newspapers, the Nikkei, April 17, 2012)

METI will build an authentication infrastructure following research and development to introduce technologies in new fields into the market faster. Manufactures, research institutes and the certification authority would start to work together in an early development stage to create a certification scheme "pilot certification" ahead of the application. Initially, the governmental or government supported projects are subject to the scheme. METI has several new energy technologies, which have not yet had established evaluation methods and criteria, in its mind as targets for the scheme such as a backward flow prevention of photovoltaic array targets, a long-term endurance testing method for power conditioners, quality test methods of hydrogen for fuel cell vehicles (FCVs) and safety evaluation methods for storage cells. (The Chemical Daily, April 20, 2012)

(2) New Energy and Industrial Technology Development, NEDO

NEDO will start research on microbial wastewater treatment technology creating electricity. It aims to develop more efficient microbial fuel cell, MFC, which generates electricity using microorganisms decomposing organic material, to feed power to the wastewater treatment system. The public offer has been made as a basic technology development of green sustainable chemical process, pursuing the same process level as the conventional activated sludge method but with 80% energy saving. This four year project is intended to establish the basic technologies for practical use. For the first two years, NEDO will fund the development of low cost oxidation-reduction catalytic converters using MFC and electrode materials with high affinity for microorganisms. In the second two years, bench scale, 10 kg to a couple of tons of production per a day, test equipment is planned to be developed to evaluate wastewater treatment capacity and energy saving level to establish the best operating technology. (The Chemical Daily, April 19, 2012)

2. Local Governmental Measure:

(1) Osaka Prefecture

On April 19th, Osaka prefecture invited neighboring municipal employees in Kansai area to the prefectural office for a test drive of a FC bus, which is jointly developed by Hino Motors and Toyota Motor. The bus is based on Hino's large transit bus model "Blue Ribbon City" and uses Toyota's FC stacks. According to Toyota Motor, the bus may run between the train station and the low-cost carrier terminal under construction in Kansai airport as an evaluation. (The Yomiuri Shimbun, April 20, Nikkan Jidosha Shimbun, April 24, 2012)

(2) Gifu Prefecture

Gifu prefecture will install next generation energy infrastructure into a roadside station (Michinoeki) "Hoshinohurusato Fujihashi" in Ibigawacho to test the fortified disaster control. Ministry of Land, Infrastructure, Transport and Tourism, MLIT, selected the plan as an infrastructure project to invigorate local community liaison with private sectors. The plan is to set up 5 kW photovoltaic

generator, 0.7 kW FC and a 20kWh storage battery to be used for lighting in the toilets, car park and the information center. During power cuts or disasters, the electricity will be used for lighting, communication and electric vehicles, EVs. The budget is 50 million yen. The design and construction will be a single order to a single firm and the bidding information will be announced in May. (The Nikkan Kensetsu Kogyo Shimbun, April 20, 2012)

(3) Mitaka City

Mitaka city, Tokyo, will invite private operators who would want to buy the 0.8 ha city owned land in Shinkawa 1-Chome to develop an environmentally conscious housing estate as "Eco Town Shinkawa 1-Chome". The Application information will be advertised in June, and proposals for the development will be accepted until late August. The project will go to the most appealing proposal. The requirements for a proposal at present are; 1) willingness to use photovoltaic generators, FCs and storage cell systems, 2) introduction of a system to use rainwater, 3) housing plans adapting the universal designs, and 4) an emergency considered living environment. (The Nikkan Kensetsu Kogyo Shimbun, May 1, 2012)

3. Technology Development of FC Elements

(1) Nikke

Nikke established a technology to create a fiber several 100 nm across without using organic solvents in spinning process. With AMBIC (Himeji city), a subsidiary, and University of Fukui, they developed the technology to produce highly functional polymers such as liquid crystal polymers, LCPs, with laser beams. The polymer is being considered for use in industrial filters and separators in FCs as well as targeted to the medical field with an advantage of being very fine. The fibers can be made from fluoride resins, polyphenylene sulfide (PPS), LCP resin or ethylene vinylalcohol copolymer (EVOH). Firstly, certain areas of a polymer are exposed to laser beams to melt it, and then high voltage electricity is applied to the polymer to form fibers. Secondly, an absorber with electrodes collects the fibers. The process is finished by removing the nanofibers from the absorber. Fibers can be as small 200 nm across depending on polymer material. Organic solvent is used to create fibers after polymer runs from the tube in a conventional process, while the new process does not need the process because of the laser beam. For the fiber, Nikke plans to target parts used at high temperatures and to combine them with other materials such as fluorine. The technology is still under development, and its mass production plan has not been arranged. (The Nikkan Kogyo Shimbun, April 12, 2012)

(2) Kyoto University

The study group has developed new material barium titanate which takes in hydrogen. Barium titanate, $BaTiO_3$, is one of the semiconductor materials. The group is led by members of Graduate School of Engineering, Kyoto University including Professor Kageyama and Assistant Professor Kobayashi and the National Institute for Materials Science. The material changes from semi conductive to conductive by absorbing hydrogen, and is expected to be used as a material for new energies such as electrode parts. Barium titanate is a barium atom surrounded by titanium and oxygen atoms. Calcium hydride is added to Barium titanate and heated to 500 °C to replace some of the oxygen atoms in the crystalline structure with hydrogen atoms to give it the required properties of the material. Hydrogen ions move about in the structure of the material at 400 °C, whereas normal barium titanate does not show this property. The crystalline structure was confirmed in a synchrotron radiation facility, Spring-8. (The Nikkei, The Nikkei Business Daily, The Kyoto Shimbun, April 16, 2012)

A New material composed of organic and inorganic compounds mixed in a complex crystal for FC electrolytes, called a coordination polymer, was revealed by Professor Kitagawa (Deputy Director of Institute for Integrated Cell-Material Sciences, iCeMS, Kyoto University) and Assistant Professor Horike (Graduate School of Engineering, Kyoto University). Made from low cost pigment, the polymer allows FCs to be produced without expensive metals such as platinum. The process involves simply mixing zinc oxide, used in cosmetics, phosphoric acid and imidazole, a compound used in medicine, in a mortar for 5 to 10 minutes. The mixture is then heated to a form plastic solid which is easy to make and process further. The polymer has been confirmed to create an electromotive force without humidity at 150 °C. The zinc can be replaced with other metals such as

aluminum and iron to change crystal structure, which may improve operating temperature and output characteristics. "The new material has the advantages of both ceramics and organic polymers. We are going to try other metals and organic compounds to pursue better performance." said Horike. (The Kyoto Shimbun, April 28, 2012, the Nikkei, April 30, 2012, the Nikkan Kogyo Shimbun, May 4, 2012, The Chemical Daily, May 7, 2012)

(3) National Institute of Advanced Industrial Science and Technology, AIST, and Hokkaido University

AIST announced a new manufacturing technology to improve the reactivity of the platinum catalyst largely developed with Hokkaido University. With this technology, water in the material moves platinum towards iron oxide, the promoter, to form an interface for effective catalytic activity. Showing very high reactivity, the catalyst oxidizes carbon monoxide, CO, in temperatures as low as -30 °C, and allows a double-digit improvement in CO oxidation speed at the temperature. The technology is expected to reduce amount of platinum required for catalysts, which constitutes the major demand for the metal. Catalyst oxidation at low temperature is beneficial for preventing electrodes degrading in polymer electrolyte fuel cells, PEFCs, removing CO in heating facilities and reducing the speed of food going bad in a refrigerator. The institutes plan to improve the technology and expand the application range for the market by investigating the reaction mechanisms of catalysts to reduce the amount of platinum whilst sustaining or increasing the level of activity. (Japan Metal Daily, April 16, 2012)

(4) Tohoku University

Tohoku University established a method to produce large quantities of nanowires from amorphous alloy by using a conventional technique - gas atomization. The method allows cost saving by avoiding expensive methods such as nanoimprinting and lithography/dry etching. In the conventional gas atomization method, metals and alloys are heated until molten to form powder by jet-gas. In the new process, the alloy is cool to the temperature at which it would normally solidify, but it is kept in a molten state before forming nanowires. This supercooling process gives the alloy a viscosity, which forms wires rather than spheres. The diameter of the wires is 50 nm to 2 μm and the length is 50 μm to 1 cm. All the alloy is converted into nanowires, and the process can be applied to almost of all amorphous alloys. Being a non-crystalline solid, amorphous alloys have good mechanical characters such as ultrahigh strength and high elasticity. The nanowires are expected to be a good material for FC electrodes and sensitive magnetic sensors. (The Nikkan Kogyo Shimbun, the Chemical Daily, April 20, 2012, Japan Metal Daily, April 25, 2012)

(5) National Institute for Materials Science, NIMS

On April 23rd, NIMS reported that a 15-fold greater catalytic activity of electrode material for FC had been successfully exhibited with its new metallic nanoparticle solubilization technology. Due to the large improvement in activity, the technology leads to a reduction of rare metals needed for FC materials. Because solubilization of metallic nanoparticles and their dispersion to electrode surfaces is easy, other metallic nanoparticles can be used for the process as well as pure platinum nanoparticles. The process allows dispersing metallic nanoparticles to penetrate deeply and widely on a complex nanostructured material by solubilizing an agglomeration of metallic nanoparticles in water. With this process, the amount of rare metals in a FC electrode can be lowered to a hundredth or less by using a mesoporous material which has a large specific surface area. (The Nikkan Kogyo Shimbun, Japan Metal Daily, April 24, 2012)

A study group with Hasegawa a group leader of International Center for Materials Nanoarchitectonics, at NIMS succeeded in confirming the transfer of electrons and depositing metal ions in "solid electrochemical reaction", which is the principle reaction of FCs, at the atomic scale. Observing new phenomena, which the formula did not show, may help in using the products and the reaction more efficiently. In the solid electrochemical reaction, metal ions turns into metal (deposition) or metal ionizes by electron transfer in ion conductors where ions move. This reaction is widely applied in electrodes for FCs; however, the detailed mechanism of the phenomena was unknown at the atomic level. This time, adding iron to ion conductors of rubidium silver iodide, RbAg4I5, allowed the observation of electron transfer and the deposition of atoms through a scanning tunneling microscope. The report may contribute to the development of a material to increase the reaction

efficiency of FC electrodes. (The Nikkan Kogyo Shimbun, April 30, 2012)

4. Business Plan and Activity of Phosphoric Acid Fuel Cells (PAFCs):

On April 10th, Tokyo Institute of Technology opened its newly built environmental energy research building, in Ookayama campus, to the press. Completed in February, 2012 with an overall cost of 3.6 billion yen, the environmental energy innovation building has seven stories above ground and two levels below, and 9,553 m^2 of total floor area. The power for the building is provided by 4,500 roof and walls covering solar panels, made by seven different manufacturers including Panasonic, and in addition 100 kW PAFC from Fuji Electric on the roof. Also, an absorption refrigerator, which uses the high temperature exhaust heat of the FC, is installed, as well as a desiccant air conditioner which uses the low temperature exhaust heat of the FC. Having a total generation of 650 kW from solar panels with other means such as geothermal heat pumps, the facilities are planned to supply all the electricity the building needs for the research. (The Tokyo Shimbun, April 10, 2012, the Asahi Shimbun, the Nikkan Kogyo Shimbun, Architectures, Constructions & Engineerings News (Daily), the Chemical Daily, April 11, 2012)

5. Developments and Business Plans of Solid Oxide Fuel Cells (SOFCs):

(1) Sumitomo Precision Products and Miura

On April 19th, Sumitomo Precision Products, Amagasaki city, announced the start of a development on SOFC for business users with Miura, Matsuyama city. Combining generation systems of Sumitomo Precision Products and expertise on utilizing the exhaust heat of Miura, the new product is planned to be introduced into the market by the fiscal year 2013. Aiming for a 48% generation efficiency, these firms intend to finish the major joint improvement by the fiscal year 2012 and to move into the testing phase by installing 5 kW level SOFCs to restaurants and convenience stores from the fiscal year 2013. These firms are anticipating that the sales activity will be led by Miura. Sumitomo Precision Products sets its goal in sales of FCs at up to 10 billion yen. (The Nikkei, The Nikkei Business Daily, the Ehime Shimbun, April 20, 2012, the Nikkan Kogyo Shimbun, April 25, 2012)

(2) JX Nippon Oil & Energy

JX Nippon Oil & Energy aims to start selling SOFCs for home use in Germany by 2015. With local firm's cooperation, the latest SOFC is planned to be in the market with a price of about 500,000 yen, a fifth the price of a conventional model, by improving technology and production scale. The SOFC generates electricity about 30% more efficient than conventional types. JX Nippon Oil & Energy produces its FCs at a subsidiary in Gunma prefecture, and sold 2,100 units in the fiscal year 2011. As its oversea activity, a demonstration experiment will start in South Korea with a local firm prior to the sales in 2013. Also, JX Nippon Oil & Energy aims at 50,000 units in FC sales for the fiscal year 2015. (The Nikkei, April 20, 2012, the Nikkan Kogyo Shimbun, April 26, 2012, the Nikkei Business Daily, May 2, 2012)

(3) Mitsubishi Heavy Industries

On April 27th, Mitsubishi Heavy Industries revealed its business plan for the fiscal year 2012 to 2014. The sales target of the energy and environment field is raised to 1.46 trillion yen, 150% of the current target, for the fiscal year 2014. To achieve the goal, Mitsubishi Heavy Industries lays the stress on expanding the sales of new products such as the world most efficient "J type Gas Turbine" for a gas turbine combined cycle (GTCC). Other plans were also indicated such as an enthusiastic development of next generation gas turbines with an entrance temperature level of 1700 °C and the start of a proving test on a triple combined system where GTCC and SOFC are joined together. (The Denki Shimbun, May 2, 2012)

6. Business Plans for EneFarm and Energy Management System, EMS:

(1) Sekisui House

On April 11th, Sekisui House announced the opening ceremony of its Smart Town where environmentally conscious houses have been prepared in Tomiyamachi, Miyagi prefecture for April 27th. 20% of the houses in the area is planned to have a photovoltaic generator or/and a FC within five years. Sekisui House plans to develop its Smart Town in Koga city, Ibaraki prefecture, and Fukuoka city, Fukuoka prefecture.

(The Mainichi Newspapers, the Nikkei, the Nikkei Business Daily, April 12, 2012, The Nikkan Kensetsu Kogyo Shimbun, Jutaku-Shimpo, April 29, 2012)

Sekisui House has been developing its Smart Town concept in six places and will continue until the end of January, 2013. The start was Smart Common City Akashidai which had its opening ceremony on April 27th in Tomiyamachi, Miyagi prefecture. The sales of Smart Town will start in four places in the metropolitan Tokyo area and one place in the Kyushu area, in succession. Total electricity production is expected to be 150 to 200% of the whole consumption in the area with all the houses having storage batteries, home energy management systems, HEMS, and twin energy source of EneFarm, fuel cell cogeneration, and photovoltaic generators. (The Nikkan Kogyo Shimbun, the Nikkan Kensetsu Kogyo Shimbun, April 25, 2012, the Yomiuri Shimbun, the Asahi Shimbun, the Mainichi Newspapers, the Sankei Shimbun, April 28, 2012, the Kahoku Shimpo, Fukushima Minpo News, April 29, 2012)

(2) Asahi Kasei Homes, Tokyo Gas and Osaka Gas

On April 23rd, Asahi Kasei Homes announced its newly developed energy sharing system for a house with a secondary suite, with Tokyo Gas and Osaka Gas. A house with a secondary suite is where a couple with children and parents of one of the couple can live, but they usually have separate utility bills and living space. The system allows the households to be utility bill free, with a net zero carbon footprint, by sharing the electricity and heat from EneFarm and photovoltaic generator. Asahi Kasei Homes will start to sell packages of a house with the system "Hebel Haus & NiCO" from April 28th. (The Denki Shimbun, the Nikkan Kogyo Shimbun, the Chemical Daily, April 24, 2012, the Nikkei Business Daily, the Nikkan Kensetsu Kogyo Shimbun, April 25, 2012, Jutaku-Shimpo, May 1, 2012)

(3) Tokyo Gas

Tokyo Gas announced that the accumulated sales of EneFarm had reached 10,000 units on April 19th. The total sales of the cogeneration in the whole market are a slightly more than 20,000 units, which means that the firm holds nearly half of the market share. Tokyo Gas aims for 7,100 unit sales for the fiscal year 2012. (The Nikkei Business Daily, April 25, 2012, the Chemical Daily, May 1, 2012)

(4) Osaka Gas

On April 26th, Osaka Gas revealed its brief report for the fiscal year 2011 which ended the end of March in 2012. The statement shows the firm increased its sales to 1.2947 trillion yen, a 9.1% rise from a year earlier, but fell in ordinary profit with 76.5 billion yen, an 8.1% drop from the previous year. Due to liquefied natural gas (LNG) price increases, its LNG operation resulted in half of the operating income for the last year. However, the sales for EneFarm were 4,100 units, a 75% rise from last year. (The Mainichi Newspapers, April 27, 2012)

7. The State of Development on Next Generation Zero-emissions Vehicle:

(1) Mitsubishi Fuso Truck and Bus

Mitsubishi Fuso Truck and Bus revealed drawings of a FC truck projected for 2032, 20 years later. The truck would run on storage batteries and FCs, and a group of the vehicles would be able to cruse automatically in a line. The driver would also be able see information such as a map, weather and his or her health status on the window. The firm intends to build an actual vehicle from the drawings as the year 2032 will be the 100th anniversary of its brand. (The Nikkei Business Daily, April 16, 2012)

(2) China

On April 18th, the Chinese government announced its supporting plan for next generation zero-emission vehicles. The plan focuses on assisting the industry of electric vehicles and plug-in hybrid vehicles which can be charged at home. The government will help the industry's production and sales with accumulated sales targets of a half million units by 2015 and 5 million or more units by 2020. The plan was decided in an executive meeting of State Council, the government, led by Premier Wen Jiabao. Next generation zero-emission vehicles running on electricity must increase in share in China, the largest market for vehicles, due to rocketing consumption of petrol. Also, the program has a target to increase the technology level for related components such as batteries and motors. This may be a business opportunity for oversea firms who take a lead in the industry of the next generation eco cars. (The Nikkei, April 19, 2012)

(3) IBM, USA

On April 20th, IBM announced a new partnership with two houses Asahi Kasei and Central Glass for developing lithium–air batteries which are expected to be the next generation battery for EVs. They aim to introduce the battery, which powers more than an 800 km cruise on a single charge, in the market by early 2020. Using oxygen from the air as an active material, the battery does not require a material positive-electrode in the cells. It is expected to have 10 times higher energy density than conventional batteries. Asahi Kasei has the largest share in separators (insulation material or membrane) for lithium-ion batteries, LiBs. On the other hand, Central Glass has an advantage in additives that affect the performance of electrolysis solutions. These two firms plan to develop a new separator and additives for the battery together. (The Nikkei, April 20, 2012)

(4) Honda Motor

Honda Motors has developed a FCV with a CHAdeMO, a quick charging method, connection. Auto manufacturers have been working on a development to add a charging function to a vehicle which can also be a power source for home. Honda Motors plans the FCV to be a moving generator. Due to the higher electricity output than standard EVs, it has advantages during disasters. (The Denki Shimbun, April 24, 2012)

On April 23rd, Honda started a demonstration experiment of Honda Smart Home System, HSHS, in Saitama prefecture. As an industry-government-academia research with Saitama city, Saitama University and Shibaura Institute of Technology, two houses with HSHS were built on land owned by Saitama city in Sakuraku. HSHS is composed of a gas engine cogeneration system, water heating unit and photovoltaic generator. Connecting EV and FCV, the experiment will give data to evaluate sharing electricity between home and vehicle and among vehicles. Honda aims to introduce the system to the market by 2015. (The Yomiuri Shimbun, the Nikkei Business Daily, Nikkan Jidosha Shimbun, the Kyoto Shimbun, Fuji Sankei Business i, April 24, 2012)

8. Development of Hydrogen Filling Station:

Hydrogen Energy Test and Research Center (Itoshima city), an extra-departmental organization of Fukuoka prefecture, will install the first test facility to examine the safety of large tanks to supply hydrogen for FCVs for filling stations. The installation is the first introduction to a public agency in Japan. The operating and maintenance cost is about 66 million yen. The Ministry of Economy, Trade and Industry selected their application for the subsidy of a demonstration and evaluation facility, operating and maintenance, and the organization will receive about 33 million yen. (The Nishinippon Shimbun, April 28, 2012)

— This edition is made up as of May 7, 2012—

A POSTER COLUMN

Toyota starts EV sales in US this summer

On May 7th, Toyota Motors announced that its "RAV4 EV" was to be introduced into the US market this summer. Jointly developed with an EV venture firm Tesla Motors who has been a partner since 2010, the EV was revealed at International Electric Vehicle Symposium in Los Angeles. Toyota plans to enter fully into the compact EV market, where Nissan Motor takes a lead, by introducing a small EV within this year. The EV series gives consumers more choices for eco cars on top of hybrid vehicle, Toyota's advantage.

Toyota will start the sales of RAV4 EV in California. California started a regulation that gives auto manufacturers a minimum level of sales in zero-emission vehicles from 2012. To meet the regulations, Toyota plans to sell 2,600 units of the EV over three years. With a list price of $49,800 (about four million yen), the vehicle will also be sold to consumers.

With LiB, the key component of Tesla Motors, the EV runs 160 km on a full charge which takes about six hours. Toyota Motor Manufacturing Canada takes the production role. "Tesla brought to the table a fast and flexible development style. Toyota shared its expertise in engineering and manufacturing" said Bob Carter, the vice president of US Toyota Motor Sales emphasizing the effect of the partnership. (The Nikkei, May 8, 2012)

8 US & Germany Auto Firms Unveiled a New Charging Method for EVs

A battle between the West and Japan has been visible over charging methods for EVs in the automotive industry. At the International Electric Vehicle Symposium in Los Angeles, the Western alliance revealed a new charging system "Combined Charging System (Combo)", and General Motors, Volkswagen, Ford Motor, Chrysler, Daimler, BMW, Audi and Porsche agreed to adopt the system.

The Combo system allows full charging of a battery in as short as 15 minutes. A single plug is used for both quick/emergency charge and standard charge, which takes cheaper electricity at night. On the other hand, Japanese firms use "CHAdeMO" for quick charge, which takes 30 minutes for 80% charge with Nissan Leaf. Also, the system has separate plugs for standard charge and quick charge.

(The Nikkei, May 9, 2012)

・20th Fuel Cell Symposium

Date：28-29,May, 2013
Site: Tower Hall Funabori,
Edogawa_ku, Tokyo, Japan