

Energy Harvesting & Storage

Room: Mauka - Session EH-TuP

Energy Harvesting & Storage Poster Session

EH-TuP4 Synthesis and Hydrogen Properties of Beryllium Intermetallic Compound, Jae-Hwan Kim, Japan Atomic Energy Agency, Japan, *H. Iwakiri*, University of the Ryukyus, Japan, *M. Nakamichi*, Japan Atomic Energy Agency

Beryllium intermetallic compounds have shown a variety of excellent properties, such as neutron multiplier, refractory function, hydrogen storage, superconductivity and so on. Be_{12}M compounds ($\text{M}=\text{Ti}$, V and Zr) have been investigated as neutron multiplier in fields of fusion reactor while Be_{17}M_2 compounds have been focused on refractory materials. In addition, Be_2M have been known as a Laves phase which is characterized by an A_2B type compound performing higher H_2 gas storage potential. Although great interest on hydrogen properties of Be_2M owing to its lower density has been aroused from viewpoints of reactivity with H_2O , trap site of hydrogen and amount of H_2 gas in this compound, few studies on the Be_2M found and its data base is still unsatisfactory.

In this study, we report on preliminary synthesis of Be_2Ti compound and its properties, such as hydrogen generation due to reaction with H_2O and hydrogen storage. Additionally, first principles calculation of hydrogen trap site in this compound was carried out in order to compare to empirical data.

X-ray diffraction profiles and electron probe micro-analysis results clarify that the preliminary synthesis of Be_2Ti was successful by homogenization treatment and plasma sintering. Hydrogen generation rate of the Be_2Ti by a reaction with 1 % H_2O increased as test temperature increased. High temperature exposure with H_2O leads to formation of TiO_2 on the surface. In addition, hydrogen storage result of Be_2Ti evaluated by pressure-concentration-temperature curve depicts that Be_2Ti indicated H_2 gas storage concentration with 1.6 w.t. % at 323 K when the H_2 pressure increases up to 10 MPa. According to the first principle calculation, there were two hydrogen trap sites, tetrahedron and center of triangle with solidus energies of -0.52 and -0.05 eV, respectively, indicating maximum trap site with 5.4 w.t. %.

EH-TuP5 Characterization of Real Cyclic Performance of Air Electrode for Li-Air Batteries, DaeHo Yoon, Y.J. Park, Kyonggi University, Republic of Korea

In this study, we characterized the cyclic performance of an air electrode employing a carbon nanotube (CNT)/ Co_3O_4 nanocomposite. The lithium anode and electrolyte were replaced every 50 cycles in order to exclude the effect of a corrupted anode and electrolyte and to determine the "real" cyclic performance of the electrode. The overpotential of the cells increased during the first 50 cycles; however, it almost vanished when the lithium anode and electrolyte were replaced. This result indicates that the increased overpotential of the cells during cycling is highly attributed to the corrupted lithium anode and electrolyte [1, 2]. The cycle life of the cell also significantly increased upon replacement of the lithium anode and electrolyte. This confirms that air electrodes have the ability to maintain their designated capacity (such as $1000 \text{ mAh} \cdot \text{g}_{\text{electrode}}^{-1}$) for much longer cycles if the lithium anode and electrolyte can be made more stable. A polydopamine-coated electrode and a LiI-containing electrolyte were introduced and characterized in order to obtain enhanced cyclic performance of the air electrode.

References

- [1] P. G. Bruce, M. M. Ottakam Thotiyil, *J. Am. Chem. Soc.* 135(2013) 494-500
 [2] Jun Lu, Yu Lei, *Nature Communications* DOI:10.1038/ncomms3383

EH-TuP6 Nano-Sized $\text{Li}[\text{Li}_{0.2}\text{Ni}_{0.16}\text{Mn}_{0.56}\text{Co}_{0.08}]\text{O}_2$ /Carbon Composite for Improving Electrochemistry Performance, S.B. Lim, Kyonggi University, *YongJoon Park*, Kyonggi University, Republic of Korea

Since the commercialization of lithium ion battery, development of cathode materials with high capacity has been one of the important factors for enhancing the performance of that. Lithium rich compounds are promising cathode materials due to their high capacity for satisfying demand of high-capacity batteries. However, they have several disadvantages to overcome for commercialization such as poor rate capability, low cyclic performance, and low stability. In this study, we prepared nano-sized $\text{Li}[\text{Li}_{0.2}\text{Ni}_{0.16}\text{Mn}_{0.56}\text{Co}_{0.08}]\text{O}_2$ /carbon composite for enhanced electrochemical performance such as rate capability. A general method to improve the surface electronic conductivity and enhance the rate capability of cathode is

carbon coating. The carbon coating by in-situ carbonization from organic precursors has been successfully applied to LiFePO_4 . However, it is difficult to apply to Li-rich compounds because they will lose oxygen during carbonization. That is why we introduced composite between cathode and carbon, instead of carbon coating. In this work, super P, a commercial carbon, was composed with nano-sized $\text{Li}[\text{Li}_{0.2}\text{Ni}_{0.16}\text{Mn}_{0.56}\text{Co}_{0.08}]\text{O}_2$. Nano-sized powders were synthesized by combustion method using surfactants (HPC and Gelatin) to disperse the granule particles [1-3]. The polydopamine pre-coating layer was used as a binding agent between cathode powder and super P [4-8]. Nano-sized $\text{Li}[\text{Li}_{0.2}\text{Ni}_{0.16}\text{Mn}_{0.56}\text{Co}_{0.08}]\text{O}_2$ /Super P composite is expected to exhibit improved rate capability because of dispersed nano-sized lithium rich particles and good electronic conductivity attributed to Super P.

References

- [1] D. Desai, F. Rinaldi, S. Kothari, S. Paruchuri, D. Li, M. Lai, S. Fung, D. Both, *Int. J. Pharm.* 308, 40 (2006) [2] M.Y. Mo, C.C. Ye, K. Lai, Z. Huang, L. Zhu, G. Ma, H. Chen, K.S. Hui, *Appl. Surf. Sci.* 276, 635 (2013)
 [3] A.D. Spong, G. Vitins, J.R. Owen, *J. Electrochem. Soc.* 152, A2376 (2005)
 [4] H. Lee, B.P. Lee, P.B. Messersmith, *Nature* 448 (2007) 338.

EH-TuP8 Fabrication of Structured Organic Solar Cell with Patterned ITO Electrode and Study of Their Effect on Power Conversion Efficiency, Jin-Hyo Boo, J.S. Lee, Sungkyunkwan University, Korea

In organic photovoltaics (OPVs), there is a competition between the reduction of absorber thickness and the improvement of the probability of carrier collection. To overcome the competition a highly structured interface is highly desirable. However, a solution-based soft-lithography processing resulted in non-uniform structured surfaces. In this report, we proposed and demonstrated a silica-templated soft-lithographical approach for structuring well-defined and controllable transparent ITO layer for enhancing power conversion efficiency (PCE). Also, we focused on the morphological effects of the patterned ITO on optical properties and PCE.

The brief experimental scheme is as follow. First, close-packed PS nanospheres were formed on a cleaned ITO glass substrate by using gas-liquid-solid interfacial self-assembly method and drying for 3days in vacuum desiccator. After that, PS covered ITO glass was etched at 65°C with TIN etching solution. Finally, PEDOT:PSS, P3HT:PCBM, and Al electrode were gradually deposited.

The morphology, optical, electric, and cell properties are investigated by FE-SEM, AFM, UV-VIS spectrophotometer, Haze measurement, and solar simulator.

EH-TuP9 Supercapacitive Properties of 2D-arrayed Inverse-Opal Nanostructure of Manganese Oxide, Ilhwan Ryu, D. Park, G. Kim, S. Yim, Kookmin University, Republic of Korea

Supercapacitor has attracted growing attention as an important energy conversion and storage device which basically consists of current collector, electrolyte and active materials. Manganese oxide (MnO_2) is one of the most promising active materials due to its environmentally friendly characteristic and low price. Fabrication of nanostructured active materials has also been widely studied since it can provide large surface area and short diffusion path for ions and electrons, and hence improve the capacitive properties of the supercapacitors. In this work, we fabricated well-ordered MnO_2 inverse-opal nanostructures using two-dimensionally arrayed polystyrene nanospheres. We also investigated their optical, morphological and electrochemical properties, and compared them with the properties of the device based on the planar MnO_2 films.

EH-TuP10 Inorganic-organic Core-Shell Nanowire Solar Cells with Excellent Light-Trapping Properties, Keisuke Sato, Tokyo Denki University, Japan, *M. Dutta, N. Fukata*, National Institute for Materials Science, Japan

Development of solar cells using one-dimensional architecture, such as semiconductor nanowires (NWs), have been proceeding rapidly in recent years. The main advantage of such NWs-based solar cells is that they cause greater light absorption (minimal reflectivity) due to incident light-trapping within the NW arrays. This phenomenon is most glaringly apparent in silicon nanowires (SiNWs)-based solar cells, leading to higher absorbance per unit thickness than achieved by commercial crystalline Si solar cells. Thus, the introduction of the SiNW arrays with high light-trapping properties enable lower-cost cell production due to the massive reduction of the consumption of Si materials needed for cell fabrication. We have developed inorganic-organic core-shell NW solar cells in which the vertically-aligned SiNWs were surrounded by organic poly(3,4-

ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) layer in order to further facilitate the cell fabrication. We report herein on the cell performances of Si-PEDOT:PSS core-shell NW solar cells with excellent light-trapping properties. To investigate the light-trapping capability, the lengths of the core-shell NWs were varied within the range from 2 to 8 μm . In the core-shell NWs with shorter length of 2 μm , the reflectance were suppressed to below 8%, which is extremely lower than the crystalline Si with value of 31%, over a wide spectrum range between 300 and 1000 nm. This suppression is far more effective for longer NW length, resulting in a reflectance of below 4.6% for the core-shell NWs with longer length of 8 μm . These results demonstrate that the longer core-shell NW arrays can extend the broadband anti-reflection effect due to enhanced light-trapping in NW arrays. However, the cell performances of such core-shell NW solar cells closely were intimately related to the NW length-dependent carrier transport efficiency rather than the light-trapping effects. The core-shell NW solar cells with shorter length of 2 μm exhibited the best cell performance with a power conversion efficiency (PCE) of approximately 7%, exceeding those with longer length of 8 μm (PCE of 3.7%). The depression of cell performance with the increase in the NW length was caused by inefficient carrier collection at electrodes due to the enhancement of the carrier recombination, because the transportation distances to electrodes were increased with NW length. Therefore, we suggest that it is important to simultaneously tune the NW length and light-trapping properties to be able to fabricate efficient inorganic-organic core-shell NW solar cells.

EH-TuP11 Characterization of Zn(O,S) Buffer Layers for Cu(In,Ga)Se₂ Solar Cells. *JiHyun Choi, S.M. Hwang, A. Garay Dixon, C.W. Chung, Inha University*

In photovoltaic solar cell, CdS thin films are mostly used buffer layer due to their wide direct band gap (~2.42 eV). The CdS buffer layers which form a p-n junction with absorber layer are deposited by using a variety of deposition methods such as chemical bath deposition (CBD), spray pyrolysis, vacuum-evaporation and sputtering. Among these techniques, chemical bath deposition is widely used method due to its advantage such as easy and inexpensive process. However, CBD technique also has some disadvantages including production of toxic liquid waste containing Cd and ammonia and difficulty in application to mass production scale. In addition, CBD method should be done in liquid phase, so that it can oxidize the absorber layer.

To overcome these disadvantages of CBD method and to apply for large scale deposition, sputtering of Zn(O,S) thin films was proposed. Sputtering method of Zn(O,S) films can reduce the liquid wastes and save the deposition time for fast deposition. It enables all processes for solar cells to be carried out by vacuum processes without exposure to air. In addition, Zn(O,S) thin films can replace the CdS which contains a toxic Cd. Generally, Zn(O,S) thin films can be deposited by sputtering with pure ZnS target by adding oxygen or by co-sputtering using ZnO and ZnS targets. ZnS itself has very high band gap about 3.6 eV, so that oxygen should be added to control the band gap. Currently, their electrical and optical properties of the sputtered Zn(O,S) films have not been fully studied yet.

In this study, Zn(O,S) thin films are deposited on Cu(In,Ga)Se₂ layer and glass substrate by RF sputtering in O₂/Ar atmosphere using pure ZnS target. By varying the deposition parameters including O₂ concentration in O₂/Ar, deposition pressure and RF power, the electrical, optical properties and the morphology of the sputtered Zn(O,S) films were investigated. From this research, the optimal condition for Zn(O,S) buffer layer using sputter method will be obtained.

EH-TuP12 Formation of CuInSe₂ from Cu-Se and In-Se binary compounds by wet process for solar cell application. *Hyungmin Lee, D.-S. Jeong, C. Park, Yeungnam University, Republic of Korea*

CIS was synthesized from binary compound of CuCl, InCl and selenium powder using alcohols as solvent. CIS thin film was prepared by mixing powders of Cu-Se and In-Se binary phase and heat treatment. The binary precursors such as CuSe, InSe and In₂Se₃ were synthesized using facile chemical route from suitable resources at different stoichiometric ratios. And then, high-quality CIS absorption layer was formed by using three binary compounds. The properties of CIS films were studied and characterized, systematically. The structural and optical properties of CIS films were studied by using X-ray Diffraction, photoluminescence (PL), and UV-Vis. The surface morphological property of the films was also recorded by Scanning Electron Microscope (SEM). The CIS solar cells having the structure of Soda lime glass (SLG) / Mo / CIS / CdS / i-ZnO / Al-doped ZnO (AZO) / Al metal grid was then fabricated. The solar cells' current density-voltage (J-V) characteristics were investigated both in the dark and under AM1.5G illumination by a solar simulator (Keithley 69911).
Keywords: CuInSe₂, Binary compound, Solar cell, Wet process, Photoluminescence
Acknowledgment This work was supported by the New & Renewable Energy Core Technology Program of the Korea Institute of

Energy Technology Evaluation (No. 20133030011330) and the Human Resources Development Program (No. 20104010100580) Planning (KETEP), granted financial resource from the Ministry of Trade, Industry & Energy, Republic of Korea.

EH-TuP13 In-situ Investigation of phase Evolution during Cu₂ZnSnSe₄ Thin Film Photovoltaic Absorber Formation from Various Stacked Cu-Zn-Sn Precursors. *Hyeonwook Park, J. Han, W.K. Kim, Yeungnam University, Republic of Korea*

For several decades, chalcopyrite Cu(InGa)Se₂ (CIGS) thin films were considered as a potential candidate for use as light absorbers in high-efficiency thin film photovoltaic cells. Recently, a cell efficiency of 20.9% (Solar Frontier, 2014), which is a little bit higher than multi-crystalline Si cells (20.4%), has been reported. Over the last decade, great attention has been moved to kesterite Cu₂ZnSn(S,Se)₄ (CZTSSe) as a promising low-cost alternative to chalcopyrite CIGS. In this paper, temperatur-dependent reaction pathways to kesterite Cu₂ZnSnSe₄ (CZTSe) thin film photovoltaic absorber formation by selenization of various stacked precursor structures including (Cu+Sn)/Zn and (Cu+Zn)/Sn were systematically investigated using in-situ high-temperature X-ray diffraction system, consisting of a PANalytical X'pert Pro MPD diffractometer and an Anton Paar HTK 1200 N furnace. A custom-designed graphite dome was utilized in order to create Se vapor at the elevated temperatures and minimize the loss of vaporized Se. Furthermore, CZTSe films formed by selenization of stacked Cu-Zn-Sn/Se precursors were characterized by X-ray diffraction and raman spectroscopy. The results revealed that the formation temperature of CZTSe and detailed phase evolution would be affected by stacked structure of Cu-Zn-Sn. Furthermore, precursor structure with co-sputtered Cu and Sn (e.g., (Cu+Sn)/Zn and Zn/(Cu+Sn)) could reduce Sn loss effectively during the formation of CZTSe than that with single-layered Sn (e.g., (Cu+Zn)/Sn and Sn/(Cu+Zn))

EH-TuP14 Feasibility Study on Graphene as Back Contact for Cu(InGa)Se₂ Thin Film Solar Cells. *Hee-San Ryu, K. Moon, Yeungnam University, Republic of Korea, Y. Jun, J. Kim, Korea University, Republic of Korea, W.K. Kim, Yeungnam University, Republic of Korea*

Chalcopyrite Cu(InGa)Se₂ (CIGS) solar cells have been considered as the most promising thin film solar cell, holding a record cell efficiency of 20.9% (Solar Frontier, 2014), which is slightly higher than that of multi-crystalline Si solar cells (20.4%). Molybdenum (Mo) is the most common material used as a back contact electrode for CIGS solar cells due to its low cost and electrical suitability with CIGS layer. In this paper, mono- or multi-layer graphene has been explored as an alternative back contact electrode to replace Mo layer. As a back contact electrode, graphene has many attractive properties such as high flexibility, excellent optical transmittance, low resistance, and high mechanical and chemical stabilities. In particular, transparent back contact like a graphene is essential to bifacial photovoltaic cells that can absorb lights from the front and back sides. In this study, the graphene films produced by chemical vapor deposition process on Cu foil were transferred onto soda-lime glass substrate using a simple wet-based transfer process. Graphene-coated glass was analyzed by tape test, four point probe measurement and UV visible spectroscopy to evaluate adhesion strength, resistance and transparency, respectively. CIGS absorbers were then deposited onto graphene-coated glass by using 3-stage co-evaporation process in a vacuum evaporator. A series of characterizations including X-ray diffraction, scanning electron microscopy and raman spectroscopy were performed to investigate the effect of number of graphene layers (e.g., 1, 2 and 4 layers) on the formation of chalcopyrite CIGS structure, and compare the characteristics of CIGS absorbers on different back contacts, graphene vs. Mo layers.

EH-TuP15 SnO₂ Hollow Spheres with Core-Shell Nanostructures of TiO₂ Nanosheets for Dye-Sensitized Solar Cells. *J.Y. Lim, S.H. Ahn, C.H. Park, Jong Hak Kim, Yonsei University, Korea*

In this study, SnO₂ hollow spheres were synthesized using sulfonated polystyrene (PS) as template. After sintering at 450oC for removing PS, SnO₂ hollow spheres were dispersed in isopropyl alcohol with amounts of titanium isopropoxide and diethyltrilamine followed by transferring to Teflon-lined autoclave. The mixture was heated to 200 oC and maintained for 24 hour, centrifuged, and calcined to obtain a highly crystalline phase. These preformed SnO₂ hollow spheres with core-shell nanostructures of TiO₂ nanosheets were mixed with sol-gel solution of graft copolymer PVC-g-POEM for preparing photoanode of DSSC. The solution was deposited on FTO glasses by doctor-blade method. These core-shell nanostructures were uniformly distributed in the TiO₂ film with large pores, high porosity, and good inter-connectivity due to its relatively low density resulting from high porosity and empty voids inside the shell. Nanostructures of SnO₂ hollow spheres with core-shell nanostructures of TiO₂ nanosheets provide good pore-filling for solid polymer electrolytes, faster electron transfer, and enhanced light scattering, as confirmed by reflectance spectroscopy,

incident photon-to-electron conversion efficiency (IPCE), and intensity-modulated photocurrent spectroscopy (IMPS) / intensity-modulated photo voltage spectroscopy (IMVS). DSSC with this material shows a high-energy conversion efficiency of 8.2% at 100 mWcm⁻². This is one of highest values for N719-based, solid-state, dye-sensitized solar cells.

EH-TuP16 Effect of MoN Diffusion Barrier on High Temperature Selenization of Cu(In,Ga), *Min-Su Kwon, H.-G. Kim, S.-H. Kim, C.-W. Jeon,* Yeungnam University, Republic of Korea

In commercial manufacturing of CIGS photovoltaic module, the absorber films are usually produced by sputtering and selenization/sulfurization process. During high temperature selenization above 450 °C, the surface of Mo back contact is easily transformed to MoSe₂, which is beneficial for ohmic contact formation in Mo/CIGS interface.[1] Although MoSe₂ has a high resistance, because it is a semiconductor of having bandgap energy of 1.35~1.41 eV, the thin layer of 100nm or less does not adversely affect the characteristics of solar cell.[2] However, since MoSe₂ may provide a current blocking capability when thicker than 200nm, it is necessary to control the thickness of the MoSe₂. In this study, Mo/MoxN/Mo multi-layer back contact was selenized to evaluate capability of diffusion barrier of MoxN layer to prevent the excessive MoSe₂ formation. The CIGS absorber films were obtained by solid state selenization, where a sputtered CuInGa alloy film on Mo/MoxN/Mo/glass was subsequently selenized at 460~560 °C for 10 minutes by using Se vapor. Behavior of generated MoSe₂ was analyzed by using XRD, SEM. The conducting compound of MoxN as a diffusion barrier against Se was deposited by a reactive sputtering. The thickness and N content of MoxN was found to be linearly proportional to N₂ gas flow rate, which suggests that MoxN could be easily adjusted by a simple modification of Mo formation process. As a result of selenization, because of the formation of MoSe₂, thickness of Mo mono-layer precursor was abruptly increased. But the thickness of multi-layered back contact with MoxN was not changed significantly. Therefore, as a diffusion barrier, MoxN was confirmed to be excellent diffusion barrier that is suited for a high temperature selenization process. The effect of MoxN layer on solar cell performance will be discussed. Acknowledgements This research was financially supported by the Ministry of Knowledge Economy(MKE), Korea Institute for Advancement of Technology(KIAT) and Dae-Gyeong Leading Industry Office through the Leading Industry Development for Economic Region). References [1] P.J. Rostan*, J.Mattheis, G.Bilger, U. Rau, J.H. Werner, *Thin Solid Films* Volume 480-481, Pages 67-70(2005). [2] SeJin Ahn, Ki hyun Kim, Jae Ho Yun, and Kyung Hoon Yoon, *Journal of Applied Physics* 105, 113533(2009)

EH-TuP17 Nano-patterned Pt Counter electrode Enhancing Light harvesting for Dye-Sensitized Solar Cells, *Won Seok Chi, D.J. Kim, J.P. Jung, J.H. Kim,* Yonsei University, Korea

Nano-patterning is one of the most simple and effective techniques for efficiently light trapping to boost the energy conversion efficiency. By imprinting with poly(dimethyl siloxane) (PDMS) nanostamp cross-rotate two steps onto thin layered commercial TiO₂ paste, a mesh-shaped (200 nm × 200nm) TiO₂ scaffold electrode with a large area was fabricated. Platinum (Pt) nanoparticles deposited onto TiO₂ pattern by diverse method such as sputtering, thermal deposition and UV-radiation deposition. The Pt nanoparticles distribution as mesh-shaped structure onto counter electrode was characterized by a field emission scanning electron microscope (FE-SEM) and an atomic force microscope (AFM). Moreover, the light trapping ability was measured reflectance by comparison of mesh-shaped patterned and non-patterned counter electrode as a function of angle. For the four cases : 1) patterned Pt counter electrode by sputtering, 2) non-patterned Pt counter electrode by sputtering, 3) non-patterned Pt counter electrode by thermal deposition and 4) patterned counter electrode by UV-radiation deposition were fabricated for all-solid-state dye-sensitized solar cells (ssDSSCs). Among them, patterned Pt counter electrode by sputtering assembled solar cell showed highest solar energy conversion efficiency up to 7.0%. This remarkable result, observed for N719 dye based DSSC, was due to enhanced light harvesting and superior surface area confirmed by incident photon-to current efficiency (IPCE), electrochemical impedance spectroscopy (EIS), and cyclic voltammetry (CV) measurements. More importantly, we believe this approach is universally applicable to a variety of electrochemical cells requiring Pt catalysts such as fuel cells and catalytic chemical reactors. Furthermore, this process could include nano- and micro-sized patterns and can be extended to metal nanoparticles other than Pt.

Authors Index

Bold page numbers indicate the presenter

— **A** —

Ahn, S.H.: EH-TuP15, 2

— **B** —

Boo, J.-H.: EH-TuP8, **1**

— **C** —

Chi, W.S.: EH-TuP17, **3**

Choi, J.H.: EH-TuP11, **2**

Chung, C.W.: EH-TuP11, 2

— **D** —

Dutta, M.: EH-TuP10, 1

— **F** —

Fukata, N.: EH-TuP10, 1

— **G** —

Garay Dixon, A.: EH-TuP11, 2

— **H** —

Han, J.: EH-TuP13, 2

Hwang, S.M.: EH-TuP11, 2

— **I** —

Iwakiri, H.: EH-TuP4, 1

— **J** —

Jeon, C.-W.: EH-TuP16, 3

Jeong, D.-S.: EH-TuP12, 2

Jun, Y.: EH-TuP14, 2

Jung, J.P.: EH-TuP17, 3

— **K** —

Kim, D.J.: EH-TuP17, 3

Kim, G.: EH-TuP9, 1

Kim, H.-G.: EH-TuP16, 3

Kim, J.: EH-TuP14, 2

Kim, J.H.: EH-TuP15, 2; EH-TuP17, 3

Kim, J.-H.: EH-TuP4, **1**

Kim, S.-H.: EH-TuP16, 3

Kim, W.K.: EH-TuP13, 2; EH-TuP14, 2

Kwon, M.-S.: EH-TuP16, **3**

— **L** —

Lee, H.: EH-TuP12, 2

Lee, J.S.: EH-TuP8, 1

Lim, J.Y.: EH-TuP15, 2

Lim, S.B.: EH-TuP6, 1

— **M** —

Moon, K.: EH-TuP14, 2

— **N** —

Nakamichi, M.: EH-TuP4, 1

— **P** —

Park, C.: EH-TuP12, 2

Park, C.H.: EH-TuP15, 2

Park, D.: EH-TuP9, 1

Park, H.: EH-TuP13, **2**

Park, Y.J.: EH-TuP5, 1; EH-TuP6, **1**

— **R** —

Ryu, H.-S.: EH-TuP14, 2

Ryu, I.: EH-TuP9, **1**

— **S** —

Sato, K.: EH-TuP10, **1**

— **Y** —

Yim, S.: EH-TuP9, 1

Yoon, D.H.: EH-TuP5, **1**