YOUNG-WOON BYEON, PH.D.

Postdoctoral Research Scholar

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References: Website, LinkedIn, Google scholar, Researchgate, ORCID

RESEARCH INTERESTS

All-solid-state Li metal batteries having both a long cycle life and a high energy density:

- Design/Development of buffer layers to stabilize the interfaces: CAM/SSE and SSE/Li metal
- Investigation on the buried interface/interphase by using correlative techniques with minimized damage.
- Surface manipulation of Li ceramic/thio-phosphate solid-state electrolytes for materials protection.

Correlative analyses on the degradation behaviors of $LiNi_xCo_yMn_zO_2$ (NCM) cathode material:

- Irreversible phase transition behavior induced by cation mixing and lattice strain in NCM materials
- Characterization of the solid-electrolyte interphase (SEI) at the surface of cathode active material (CAM)
- Correlation study between performance degradation of battery material and process parameters (particle size, coating material, thickness, binder distribution, composite cathode, etc.)

Understanding of synthesis reaction mechanism on the energy storage materials

- When and How does Thermodynamics vs. Kinetics govern the solid-state synthesis reaction?
- Exploration of the preferrable reaction pathway to reduce the production costs.
- Unraveling the synthesis reaction mechanisms how the conditions control the formation of products.

Advanced analyses based on bleeding-edge electron microscopy techniques:

- *In situ* / *operando* studies on the diffusion of charge-carrier (H^+/Li^+/Na^+/K^+, etc.) ions during reactions.
- 4D-STEM analysis and spectrum processing for statistical analysis in a large area at materials interfaces.
- Low e-beam dose / Cryo-EM techniques to minimize the sample damage during the observation.
- STEM / FIB tomography of the environment sensitive materials and their data processing.
- ML / Automation on the EM analysis process (Sample prep–Transfer–Acquisition–Processing–Report).

EDUCATION

09/2013 – 02/2020 **Korea University** Seoul, Korea
Ph.D. in Materials Science and Engineering.

Thesis title: Studies of sodiation behaviors in Sn anodes using *in situ* electron microscopy
(Advisor: Prof. Jae-Chul Lee)

03/2007 – 08/2013 **Korea University** Seoul, Korea
B.S. in Materials Science and Engineering.

(Advisor: Prof. Ho Jang)

WORK EXPERIENCES

03/2020 – present ***Postdoctoral Research Scholar*** Berkeley, CA, USA
(Principal Investigators: Dr. Haegyeom Kim and Dr. Peter Ercius)

Materials Sciences Division, Lawrence Berkeley National Laboratory (LBNL)

- Investigated the buried interphases between a solid-state electrolyte and a metal anode, based on the one of the most advanced TEM in the world: TEAM I in NCEM LBNL.
- Developed an airtight sample transfer system to characterize air-sensitive materials.
- 3D STEM/FIB tomography on the bionanomaterials using diatom frustules.
- Systematically synthesized and characterized on the high-performance oxide catalyst support materials for PEMFC applications.

05/2013 – 02/2020 ***Research Assistant*** Seoul, Korea
(Principal Investigator: Dr. Jae-Pyoung Ahn)

Electron Microscopy Group, Advanced Analysis Center
Korea Institute of Science and Technology (KIST)

- Studied various TEM functions and analytical techniques.
- Developed an airtight sample transfer system to characterize air-sensitive materials.
- Pioneered the correlative analysis of battery electrode materials by using various analytical instruments (XRD, XPS, SEM, TEM, EDS, EELS, and APT).
- Observed the formation and growth behavior of SEI layer during fast charging/discharging.

03/2014 – 12/2017 ***Teaching Assistant*** Seoul, Korea
Department of Materials Science and Engineering, Korea University

- *Course Offering*: Engineering Mathematics II (2017); Mechanical Properties of Materials (2015); Metallic Material Processing (2014); Engineering Mathematics I (2014)

01/2012 – 02/2012 ***Undergraduate Intern*** Seoul, Korea
(Principal Investigator: Dr. Chang-Woo Lee)

Research team, Battelle-Korea

- Synthesized nanoparticles (NiO, MgO) and applied them to energy storage technology

03/2009 – 04/2011 ***Sergeant*** *(honorable discharged)* Jinju, Korea
Education & Training Command, Republic of Korea Air Force

- Produced e-learning contents for aircraft maintenance and air-traffic control

SERVICE and OUTREACH EXPERIENCES

- **President**, KSEA Berkeley Local Chapter 2021 – Present
- **Member**, Electrochemical Society 2022 – Present
- **Member**, Korean-American Scientists and Engineers Association (KSEA) 2020 – Present
- **Member**, Materials Research Society 2018 – Present
- **Member**, Korean Society of Metals and Materials 2014 – Present
- **Member**, Korean Society of Microscopy 2014 – Present
- **Journal Reviewer**, *Materials Today Energy, Electrochimica Acta, ACS Applied Materials & Interfaces, Applied Sciences, Materials, IJMS, Molecules, Batteries, Energies*

SELECTED RESEARCH PROJECTS

- *"Solid state batteries with long cycle life and high energy density through materials design and integration"* DOE/EERE/VTO Lab call, USA **(FY2022-26)**
- *"Understanding performance degradation of Li-cathode materials"* Rivian Automotive, Inc., USA **(FY2023)**
- *"High-Conductivity Ceramic Catalyst Supports for PEMFC,* Robert Bosch Corporation, USA **(FY2020-22)**
- *"Designer bionanomaterials using diatom frustules"* Laboratory Directed Research and Development Program of LBNL under U.S. DOE Contract (**FY2021-23**)
- *"Investigation of buried interphases between a solid-state electrolyte and a metal anode"* Laboratory Directed Research and Development Program of LBNL under U.S. DOE Contract **(FY2020-21)**
- *"Advanced characterization and mechanism clarification for designing the fast chargeable and high-power battery"* Samsung Research Funding & Incubation Center for Future Technology, Korea **(2016-19)**
- *"Development of characterization techniques of cell and material of Li-ion all solid-state battery"* Hyundai Motor Company, Korea **(2017-20)**
- *"Development of convergence typed big data platform and construction of ecosystem"* Ministry of Science and ICT, National Research Foundation of Korea **(2018-20)**
- "*Development of all solid-state battery technology based on NCM cathode / solid electrolyte design*" Ministry of Science and ICT, National Research Foundation of Korea **(2017-19)**

ORAL PRESENTATION / INVITED TALKS

[5] "Ti-Rich $Mg_{1-x}Ti_{2+x}O_5$: A Highly Conductive and Acidic- Stable Ternary Oxides"
242nd ECS Meeting, Atlanta, GA, USA (2022.10.12).

[4] "Recent Approaches on Designing High-Performance All-solid-state Batteries: Based on Understandings of Interface and Interphase Issues"
2022 Korea Institute of Machinery and Materials, Remote presentation (2022.10.05).

[3] "Trends in Material Analysis Techniques Developments in All-solid-state Battery Research"
2022 SK Global Forum, Santa Clara, CA, USA (2022.06.11).

[2] "Isotropic and Ultrafast Sodiation Behavior of Sn Crystals"
2018 Material Research Society (MRS) Fall Meeting, Boston, MA, USA, November 25-30 (2018.11.27).

[1] "Lattice Strain and Phase Transition Induced by Li Migration in Cyclic NCM111 ($LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$)"
5th International Conference on Electronic Materials and Nanotechnology for Green Environment (ENGE 2018), Jeju, Korea, November 11-14 (2018.11.12).

AWARDS AND HONORS

2019.10.29 **Best Poster Award**, 2019 Fall conf. of Korean Institute of Metals and Materials (KIM), Daegu, Korea
2019.01.31 **Best Student Researcher Award**, Korea Institute of Science and Technology (KIST)
2018.11.29 **Best Poster Award**, 2018 MRS Fall Meeting, Boston, MA, USA
2018.06.22 **Best Poster Award**, 2018 Spring conf. of Korean Society of Microscopy, Jeju, Korea
2017.10.27 **Best Poster Award**, 2017 Fall conf. of KIM, Daegu, Korea
2016.05.13 **Excellence Paper Award**, 2016 Spring conf. of Korean Battery Society, Seoul, Korea
2016.04.29 **Best Poster Award**, 2016 Spring conf. of KIM, Gyungju, Korea
2015.10.30 **Best Poster Award**, 2015 Fall conf. of KIM, Daejeon, Korea
2015.04.24 **Best Poster Award**, 2015 Spring conf. of KIM, Changwon, Korea
2014.10.24 **Best Poster Award**, 2014 Fall conf. of KIM, Jeongseon, Korea
2012.02.02 **Best Paper Award**, 4th Internship papers competition for undergraduates, Korea University

2022.04.14 **Networking of Next-generation Leaders in Science and Technology (2022)**, KOFST
2017.12.20 **Industrial Scholarship (2018-2019)**, LG Chem
2014.05.07 **Korea Technocomplex Scholarship (2014)**, Korea University

2012.02.24 **Undergraduate Scholarship (2012-2013)**, Haedong Foundation for Science and Culture

PROFICIENCY

Self-operation skill of research/analytical instruments:

- **TEM** *(Transmission Electron Microscope)*
  - Thermo Fisher Scientific (former FEI): TITAN Themis (300kV, Cs-corrected), TALOS F200, TECNAI G2
  - Cryo-TEM, STEM, HRTEM, SAED, PED, CBED, EELS, EDS, *in situ* TEM (heating and indenting)
- **SEM** *(Scanning Electron Microscope)* / **Dual-beam FIB** *(Focused Ion Beam)*
  - FEI: Inspect F50, FEG-Nova 600, Quanta 3D FEG, Nova FIB, FIB Strata, Helios (G3 and G4 UX),
  - TEM sampling, EDS, EBSD, EBIC, *in situ* experiment/analysis (Nano-indentation, manipulation, 4-probe measurement), 3D tomography visualization and analysis (Amira, Avizo Software Suite)

Experiences on material characterization:

- **Correlative analyses**: XRD, XANES/EXAFS, RIXS, XPS, SEM, FIB, TEM, APT (*macro to sub-nm scale*)
- ***In-situ* experiments in EM**: Mechanical / Chemical / Electrical / Structural characterizations
- **Simulation and data processing**: Python, C++, JEMS, MATLAB, Diffractions (X-ray, electron)
- **3D CAD capability:** Design All solid-state battery cell, Airtight sample transfer system between analysis devices for oxygen/water sensitive materials (Li, S, etc.)

Personal strengths:

- Strong and positive attitudes to learn and improve expertise.
- Working well with other people with flexible and considerable communication skills.

PATENTS

[1] Shape-controlled multi-pod nanowire structure for direct methanol fuel cell application and preparation method thereof, *KR Patent: 1014211040000* (2014)

JOURNAL PUBLICATIONS

*You can also see the list at Google scholar, Researchgate, and ORCID († equal contribution, * corresponding author)*

◦ *In preparation (papers participated as the first author only)*

[-] **Young-Woon Byeon**, Hong-Kyu Kim, Hyun-Jeong Lee, Ji Yeong Lee, Hyung Cheoul Shim*, and Jae-Pyoung Ahn* "Understanding the Degradation Mechanism of $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ Cathode Material in Lithium-ion Batteries", *In Preparation*, (Expected in 2023).

[-] **Young-Woon Byeon**, Hyun-Jeong Lee, Hong-Kyu Kim, So-Hee Kim, Hae-Ryung Kim, and Jae-Pyoung Ahn* "Understanding the Degradation Mechanism of NMC Cathode Material in All-solid-state Li metal Batteries", *In Preparation*, (Expected in 2023).

[-] **Young-Woon Byeon**, Shirin Mehrazi, Bjoern Stuehmeier, Jeonghoon Lim, Dong-min Kim, Bryan D. McCloskey, Lei Cheng*, and Haegyeom Kim*, "Improved performance of Metal oxide protected Pt/C catalyst via chemical functionalization", In preparation, (Expected in 2023).

◦ *In progress (submitted / under review / under revision)*

[-] Zheren Wang, Yingzhi Sun, Kevin Cruse, Yan Zeng, Yuxing Fei, Zexuan Liu, Junyi Shangguan, **Young-Woon Byeon**, KyuJung Jun, Tanjin He, Wenhao Sun, Gerbrand Ceder* "Optimal Thermodynamic Conditions to Minimize Kinetic Byproducts in Aqueous Materials Synthesis", ***Nature Synthesis,*** *Under Revision*, (Submitted in 2022).

[-] Youngmin Ko, Michael A. Baird, Xinxing Peng, Tofunmi Ogunfunmi, **Young-Woon Byeon**, Liana M. Klivansky, Haegyeom Kim, Mary Scott, Brett A. Helms* "An Omics Approach to Mixed-Anion Electrolyte Discovery for Lithium Metal Batteries for Electric Aircraft", ***Nature Materials***, *Under Review*, (Submitted in 2022).

[-] Sung-Yeob Kim, Hee-Jae Ahn, Hyun-Min Lee, Son-Jae Sim, Young-Hoon Kim, Hong-Kyu Kim, **Young-Woon Byeon**, Jae-Chul Lee*, "Self-Healing CuS Anodes with Conversion Reaction for Ultrafast Na-ion Storage", ***Journal***

of Materials Chemistry A, *Submitted*, (Submitted in 2023).

◦ *Published* (11 of first-authored, out of 21 in total published/accepted papers)

[21] Piyachai Khomein†, **Young-Woon Byeon**†, Dongye Liu, Jin Yu, Andrew M. Minor, Haegyeom Kim*, Gao Liu* "Lithium Phosphorus Sulfide Chloride-Polymer Composite via Solution-Precipitation Process for Improving Stability Toward Dendrite Formation of Li-Ion Solid Electrolyte", ***ACS Applied Materials & Interfaces***, vol.15, no.9, pp.11723-11730, (2023). Link

[20] **Young-Woon Byeon**, Min-Jeong Gong, Zijian Cai, Yingzhi Sun, Nathan J. Szymanski, Jianming Bai, Dong-Hwa Seo, Haegyeom Kim* "Effects of Cation and Anion Substitution in $KVPO_4F$ for K-ion Batteries", ***Energy Storage Materials***, vol.57, pp.81-91 (2023). Link

[19] Kyu-Joon Lee†, **Young-Woon Byeon**†, Hyun-Jeong Lee†, Ye-Bin Lee, Soohyung Park, Hye-Ryung Kim, Hong-Kyu Kim, Soong Ju Oh, and Jae-Pyoung Ahn*, "Crack-healing Mechanism of NCM Composite Cathode for Sustainable Cyclability of Sulfide-based Solid Batteries", ***Energy Storage Materials***, vol.57, pp.326-333 (2023). Link

[18] Yan Zeng, Bin Ouyang, Jue Liu, **Young-Woon Byeon**, Lincoln Miara, Yan Wang, Gerbrand Ceder* "High-entropy mechanism to boost ionic conductivity", ***Science***, vol.378, no.6626, pp.1273-1274 (2022). Link

[FEATURED IN THE NEWS ARTICLE : LBNL]

[17] Liliang Huang, Peichen Zhong, Yang Ha, Zijian Cai, Fengyu Xie, **Young-Woon Byeon**, Tzu-Yang Huang, Yingzhi Sun, Han-Ming Hau, Haegyeom Kim, Mahalingam Balasubramanian, Bryan D. McCloskey, Wanli Yang, and Gerbrand Ceder* "Optimizing Li-Excess Cation-Disordered Rocksalt Cathode Design through Partial Li Deficiency", ***Advanced Energy Materials***, 2202345 (2022). Link

[16] **Young-Woon Byeon**, Jonathan P. Mailoa, Mordechai Kornbluth, Gihyeok Lee, Zijian Cai, Yingzhi Sun, Wanli Yang, Christina Johnston, Jake Christensen, Soo Kim*, Lei Cheng* and Haegyeom Kim* "Electronic Structure Manipulation by Composition Tuning for the Development of High Conductive and Acidic-stable Oxides", ***Journal of Materials Chemistry A***, vol.10, pp.23155-23164 (2022). Link

[FEATURED AS A HOT PAPERS COLLECTION IN THE JOURNAL]

[15] Hyun-Jeong Lee, Jong-Seok Moon, **Young-Woon Byeon**, Woo Young Yoon, Hong-Kyu Kim*, and Jae-Pyoung Ahn* "Lithiation Pathway Mechanism of Si-C Composite Anode Revealed by the Role of Nanopore using in-situ Lithiation", ***ACS Energy Letters***, vol.7, pp.2469-2476, (2022). Link

[FEATURED IN THE NEWS ARTICLES: #1_EurekAlert! / #2_Newswise]

[14] Haegyeom Kim*, **Young-Woon Byeon**, Jingyang Wang, Yaqian Zhang, Mary C. Scott "Understanding of Electrochemical K^+/Na^+ Exchange Mechanisms in Layered Oxides", ***Energy Storage Materials***, vol.47, pp.105-112 (2022). Link

[13] Jae-Hwan Kim, Young-Hwan Lee, Jun-Hyoung Park, Byeong-Joo Lee, **Young-Woon Byeon**, Jae-Chul Lee*, "Ultrafast Na Transport into Crystalline Sn via Dislocation-Pipe Diffusion for Rapid Battery Charging", ***Small***, 2104944 (2021). Link

[12] Jun-Hyoung Park, Yong-Seok Choi, ChangHyeon Kim, **Young-Woon Byeon**, Yongmin Lee, Byeong-Joo Lee, Jae-Pyoung Ahn, Hyojun Ahn, Jae-Chul Lee*, "Self-Assembly of Pulverized Nanoparticles: An Approach to Realize Large-Capacity, Long-Lasting, and Ultra-Fast-Chargeable Na-Ion Batteries", ***Nano Letters***, vol.21, no.3, pp.9044-9051 (2021). Link

[11] **Young-Woon Byeon**, Haegyeom Kim*, "Review on Interface and Interphase Issues in Sulfide Solid-State Electrolytes for All-Solid-State Li-Metal Batteries", ***Electrochem***, vol.2, no.3, pp.452-471 (2021). Link
[FEATURED AS A COVER STORY OF THE JOURNAL]

[10] **Young-Woon Byeon**, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Diffusion along Dislocations Mitigates Self-limiting Na Diffusion in Crystalline Sn", ***Small***, 2004868 (2020). Link

[9] Jun-Hyoung Park, Yong-Seok Choi, **Young-Woon Byeon**, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Diffusion Kinetics Governing the Diffusivity and Diffusional Anisotropy of Alloying Anodes in Na-ion Batteries", ***Nano Energy***, vol.65, 104041 (2019). Link

[8] **Young-Woon Byeon**†, Yong-Seok Choi†, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Isotropic Sodiation Behavior of Ultrafast-chargeable Sn Crystals", ***ACS Applied Materials & Interfaces***, vol.10, no.48, pp.41389-41397 (2018). Link

[7] Yong-Seok Choi, **Young-Woon Byeon**, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Evaluation of Energy Loss at Sn Anodes based on Phase Transition Behaviors and Formation of Electrically Resistive Phases of Na-Sn Batteries", ***Journal of Materials Chemistry A***, vol.6, no.20, pp.9428-9436 (2018). Link

[6] Yong-Seok Choi†, **Young-Woon Byeon**†, Jun-Hyoung Park, Jong-Hyun Seo, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Ultrafast Sodiation of Single-Crystalline Sn Anodes", ***ACS Applied Materials & Interfaces***, vol.10, no.1, pp.560-568

(2017). Link

[5] **Young-Woon Byeon**†, Yong-Seok Choi†, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Origin of High Coulombic Loss During Sodiation in Na-Sn Battery", ***Journal of Power Sources***, vol.343, pp.513–519 (2017). Link

[4] Yong-Seok Choi†, **Young-Woon Byeon**†, Jae-Pyoung Ahn, and Jae-Chul Lee*, "Formation of Zintl Ions and Their Configurational Change during Sodiation in Na–Sn Battery", ***Nano Letters***, vol.17, no.2, pp.679–686 (2017). Link

[3] Jung Sub Kim, A-Young Kim, **Young-Woon Byeon**, Jae-Pyoung Ahn, Dongjin Byun, and Joong Kee Lee*, "Porous Zn_2GeO_4 Nanowires with Uniform Carbon-Buffer Layer for Lithium-Ion Battery Anodes with Long Cycle Life", ***Electrochimica Acta***, vol.195, pp.43–50 (2016). Link

[2] **Young-Woon Byeon**, Yong-Seok Choi, Jong-Hyun Seo, Ka-Hyun Hur, Jae-Pyoung Ahn, and Jae-Chul Lee*, "A Simple Method of Analyzing the Phase Transition Behavior of a Na-Sn Battery Using Energy-Dispersive X-Ray Spectroscopy", ***Korean Journal of Metals and Materials***, vol.53, no.12, pp.926–930 (2015). Link

[1] Jin-Woo Cho, Sung-Hoon Kim, **Young-Woon Byeon**, Ji Yeong Lee, Jae-Pyoung Ahn*, "Next-Generation Analysis Technologies of Nano materials: Based on Electron Microscopy", ***Trends in Metals and Materials Engineering***, vol.28, pp.26-43 (2015). Link