

YOUNG-WOON BYEON, P.H.D.

Senior Research Scientist

Affiliation: Advanced Analysis and Data Center, Korea Institute of Science and Technology (KIST)

Address: L5147A, 5 Hwarang-ro-14-gil, Seongbuk-gu, Seoul 02792, South Korea

E-mail: (Personal) youngwoonbyeon@gmail.com

(Office) ywbyeon@lbl.gov

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 by using correlative techniques with minimized sample damage.
- Surface manipulation of Li ceramic/thio-phosphate solid-state electrolytes for materials protection.

Correlative analyses on the degradation behaviors of $\text{LiNi}_x\text{Co}_y\text{Mn}_z\text{O}_2$ (NCM) cathode material:

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

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).

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 preferable reaction pathway to reduce the production costs.
- Unraveling the synthesis reaction mechanisms how the conditions control the formation of products.

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.

WORK EXPERIENCES

- 11/2023 – present **Senior Research Scientist** Seoul, Korea
 Head of the TEM group, Advanced Analysis and Data Center,
 Korea Institute of Science and Technology (KIST)
 • Developing advanced analysis techniques for energy storage materials application.
 • Investigation on the buried interface/interphase between a solid-state electrolyte and a cathode composite
- 03/2020 – 10/2023 **Postdoctoral Research Scholar** Berkeley, CA, USA
 (Principal Investigators: Dr. Haegyom 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 bio-nanomaterials 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 Team, Advanced Analysis Center, KIST
 • 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

- **Member**, Electrochemical Society 2022 – Present
- **Member**, Materials Research Society 2018 – Present
- **Member**, Korean Society of Metals and Materials 2014 – Present
- **Member**, Korean Society of Microscopy 2014 – Present
- **Member**, Korean American Scientists and Engineers Association (KSEA) 2020 – 2023
- **President**, KSEA Berkeley Local Chapter 2021 – 2023
- **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 bio-nanomaterials 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 batteries” 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 batteries” Hyundai Motor Company, Korea (2017-19)
- “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
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- 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

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 $\text{LiNi}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3}\text{O}_2$ Cathode Material in Lithium-ion Batteries”, *In preparation*, (Expected in 2024).
- [-] **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 2024).
- [-] **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 2024).
- [-] **Young-Woon Byeon**, Vankata Sai Avvaru, Dongmin Kim, Haegyeom Kim*, “Achieving high stable composite cathode via chemical functionalization of 3D rGO”, *In preparation*, (Expected in 2024).

◦ In progress (submitted / under review / under revision / in press)

- [-] 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 High Entropy Electrolyte Discovery for Lithium Metal Batteries for Electric Aircraft”, *Nature*, *Under Review*, (Submitted in 2023).

◦ Published (11 of first-authored, out of 23 in total published papers)

- [23] 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*, vol.11, pp.21972-21982 (2023). [🔗Link](#)
- [22] Haeseong Jang, Ivana Hasa, Hyunchul Kim, Yoon Hwa, **Young-Woon Byeon**, Robert Kostecki*, Haegyeom Kim* “Exploring the storage mechanism of alkali ions in non-graphitic hard carbon anodes”, *Journal of the Electrochemical Society*, vol.170, no.9, pp.090538 (2023). [🔗Link](#)
- [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](#)