Sungin Kim

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Education

2024.09-present	**Postdoc researcher**, Department of Chemistry and Chemical Biology, *Cornell University* (Ithaca, NY, USA) (Host: Prof. Yao Yang) **Sejong Science Fellowship (Sep 24' – Aug 25')*
2024.03-2024.08	**Postdoc researcher**, Department of Chemical and Biological Engineering, *Seoul National University* (Seoul, South Korea) (Host: Prof. Jungwon Park & Prof. Jaeyune Ryu)
2017.09-2024.02	**Ph.D.**, Department of Chemical and Biological Engineering, *Seoul National University* (Seoul, South Korea). GPA: 3.9/4.3 *Advisor*: Prof. Jungwon Park *Thesis:* Investigating Surface Atomic Coordination Chemistry and Degradation Processes of Pt Nanocrystals by Liquid-Cell TEM
2013.03-2017.08	**B.S.**, Department of Chemical and Biological Engineering, *Seoul National University* (Seoul, South Korea). GPA: 3.7/4.3 (*cum laude*)

Research Interests & Experiences

My research focus lies in extending dimensionality in energy material analysis by developing and employing advanced analytic methods to establish rational design principles for high-performance energy materials.

- Resolving the **time-resolved structural dynamics in energy materials under operating conditions** through electrochemical liquid-cell transmission electron microscopy (EC-LCTEM): Unraveling their *in situ* electrochemical reaction mechanisms
- Resolving the **3D atomic structures of inorganic nanocrystals** through the graphene liquid-cell (GLC) technique: Revealing their structure-property relationships

<u>1) Time-resolved structural dynamics in energy materials under operating conditions</u>

- Unraveling serial degradation process of fuel cell catalysts (Pt/C) under AST.
  * (*Journal of the American Chemical Society* **2025**, 147, 181-191)
- Revealing *in situ* formation of Cu_2O adparticles on the Cu-Ag alloy during CO2RR.
  * (*Nature Catalysis* **2025**, 8, 697-713)
- Developing heating/cooling EC-LCTEM method and exploring temperature-dependent Cu electrodeposition dynamics.
  * (*Journal of the American Chemical Society* **2025**, 147, 23654-23671)
- Revealing *in situ* formation of Cu nanograins from Cu single-atom catalyst.
  * (*Journal of the American Chemical Society* **2025**, *Accepted*)

- Demonstrating the EC-LCTEM with external standard reference electrode and unraveling mass-transfer effect on Cu electrodeposition behavior.
  * (*Submitted*)
- Investigating Li plating and stripping behaviors under different current conditions.
  * (*In preparation*)
- Investigating aqueous battery chemistry under potential applied condition.
  * (*In preparation*)

2) 3D atomic structures of inorganic nanocrystals
- Determining the 3D atomic structures of synthesized Pt nanocrystals
  * (*Science* **2020**, 368, 60-67. 2nd author)
- Quantifying surface atomic structures of the synthesized Pt nanocrystals
  * (*Nano Letters* **2021**, 21, 1175-1183)
- Investigating adsorption properties of large-sized molecules on complex surfaces
  * (*Nanoscale* **2023**, 15, 532-539)
- Revealing a structure-activity (alkaline HER) relationship of the synthesized Pt nanocrystals by using multi-scale simulation
  * (*In preparation*)

Peer-reviewed Publications († equal contribution)

8 x first author | 4 x second author

2025

20) Z. Zhang†, **S. Kim**†, V. Briega-Martos, E. R. Kennedy, S. E. Zeltmann, E. H. Thiede, and Y. Yang*, "Benchmarking Nanoscale Electrochemistry in *Operando* TEM with Standard Reference Electrode", *Submitted*.

19) J. Choi†, **S. Kim**†, J. Y. Choi†, S. Park†, K. Je, S. Liu, J. Jiang, S. Yang, C. J. Pollock, R. Guzman-Soriano, K. Bairley, E. H. Thiede, Y. J. Hwang*, J. Park*, and Y. Yang*, "Dynamic Evolution from Single-Atom Catalysts to Active Nanograins for CO2 Reduction", *Journal of the American Chemical Society* **2025**, *Accepted*. [https://doi.org/10.1021/jacs.5c14123]

18) D. D. Mal, N. Redkar, K. Liu, H. Park, E. R. Kennedy, **S. Kim**, W. Li, Y. Yang*, Y. Qi*, M. Neurock*, and L. Luo*, "Electrosynthesis of Agrochemicals via Alternating-Current-Driven Selective, Continuous Dehalogenation", *Journal of the American Chemical Society* **2025**, *Accepted*. [https://doi.org/10.1021/jacs.5c12620]

17) **S. Kim**†, V. Briega-Martos†, S. Liu, K. Je, C. Shi, K. Marusak, S. E. Zeltmann, Z. Zhang, R. Guzman-Soriano, W. Li, J. Jiang, J. Choi, Y. J. Negash, F. S. Walden II, N. L. Marthe Jr., P. S. Wellborn, Y. Guo, J. Damiano, Y. Han, E. H. Thiede, and Y. Yang*, "*Operando* Heating and Cooling Electrochemical 4D-STEM Probing Nanoscale Dynamics at Solid-Liquid Interfaces", *Journal of the American Chemical Society* **2025**, 147, 23654-23671. [https://doi.org/10.1021/jacs.5c05005]

16) I. Kim†, G.-B. Lee†, **S. Kim**†, H. D. Jung†, J.-Y. Kim, T. Lee, H. Choi, J. Jo, G. Kang, S.-H. Oh, W. Kwon, D. Hong, H. G. Kim, Y. Lee, U. Kim, H. Kim, M. Kim, S. Back*, J. Park*, Y.-C. Joo*, and D.-H. Nam*, "Unveiling the reconstruction of copper bimetallic catalysts during electrochemical CO2 reduction", *Nature Catalysis* **2025**, 8, 697-713. [https://doi.org/10.1038/s41929-025-01368-9]

15) S. Kang†, J. Kim†, **S. Kim**†, H. Chun, J. Heo, C. F. Reboul, R. Meana-Pañeda, C. T. S. Van, H. Choi, Y. Lee, J. Rhee, M. Lee, D. Kang, B. H. Kim, T. Hyeon, B. Han*, P. Ercius*, W. C. Lee*, H. Elmlund*, and J. Park*, "Time-resolved Brownian tomography of single nanocrystals in liquid during oxidative etching", *Nature Communications* **2025**, 16, 1158. [https://doi.org/10.1038/s41467-025-56476-8]

14) **S. Kim**, J. Kwag, M. Lee, S. Kang, D. Kim, J.-G. Oh, Y.-J. Heo*, J. Ryu*, and J. Park*, "Unraveling Serial Degradation Pathways of Supported Catalysts through Reliable Electrochemical Liquid-Cell TEM Analysis", *Journal of the American Chemical Society* **2025**, 147, 181-191. [https://doi.org/10.1021/jacs.4c08825]

13) M. Lee, Y. Jeon, **S. Kim**, I. Jung, S. Kang, S.-H. Jeong*, and J. Park*, "Unravelling complex mechanisms in materials processes with cryogenic electron microscopy", *Chemical Science* **2025**, 16, 1017-1035. [https://doi.org/10.1039/D4SC05188B]

2024

12) J. Kim, **S. Kim**, J. Park, S. Kang, D. J. Seo, N. Park, S. Lee, J. J. Kim, W. B. Lee, J. Park*, and J.-C. Lee*, "Covalent-Frameworked 2D Crown Ether with Chemical Multifunctionality", *Journal of the American Chemical Society* **2024**, 146, 4532-4541. [https://doi.org/10.1021/jacs.3c11182]

11) H. Wietfeldt, R. Meana-Pañeda, C. Machello, C. F. Reboul, C. T. S. Van, **S. Kim**, J. Heo, B. H. Kim, S. Kang, P. Ercius, J. Park*, H. Elmlund*, "Small, solubilized platinum nanocrystals consist of an ordered core surrounded by mobile surface atoms", *Communications Chemistry* **2024**, 7, 4. [https://doi.org/10.1038/s42004-023-01087-x]

2023

10) J. Kwag, **S. Kim**, S. Kang, and J. Park*, "Multiple-length scale investigation of Pt/C degradation by identical-location transmission electron microscopy", *Bulletin of the Korean Chemical Society* **2023**, 44, 488-494. [https://doi.org/10.1002/bkcs.12690]

9) J. Heo†, D. Kim†, H. Choi†, **S. Kim**, H. Chun, C. F. Reboul, C. T. S. Van, D. Elmlund, S. Choi, K. Kim, Y. Park, H. Elmlund*, B. Han*, and J. Park*, "Method for 3D atomic structure determination of multi-element nanoparticles with graphene liquid-cell TEM", *Scientific Reports* **2023**, 13, 1814. [https://doi.org/10.1038/s41598-023-28492-5]

8) D. Kang†, **S. Kim**†, J. Heo, D. Kim, H. Bae, S. Kang, S. Shim*, H. Lee*, and J. Park*, "Complex ligand adsorption on 3D atomic surfaces of synthesized nanoparticles investigated by machine-learning accelerated ab initio calculation", *Nanoscale* **2023**, 15, 532-539. [https://doi.org/10.1039/d2nr05294f]

2022

7) J. Kim, A. Park, J. Kim, S. J. Kwak, J. Y. Lee, D. Lee, S. Kim, B. K. Choi, **S. Kim**, J. Kwag, Y. Kim, S. Jeon, W. C. Lee, T. Hyeon, C.-H. Lee, W. B. Lee*, and J. Park*, "Observation of H_2 Evolution and Electrolyte Diffusion on MoS_2 Monolayer by In Situ Liquid-Phase Transmission Electron Microscopy", *Advanced Materials* **2022**, 34, 2206066. [https://doi.org/10.1002/adma.202206066]

6) J. Heo, D. Kang, **S. Kim**, H. Chun, B. Han*, B. H. Kim*, and J. Park*, "3-Dimensional Scanning of Entire Unit Cells in Single Nanoparticles", *ChemNanoMat* **2022**, 8, e202200057. [https://doi.org/10.1002/cnma.202200057]

2021	5) S. Jeon†, T. Heo†, S.-Y. Hwang†, J. Ciston, K. C. Bustillo, B. W. Reed, J. Ham, S. Kang, **S. Kim**, J. Lim, K. Lim, J. S. Kim, M.-H. Kang, R. S. Bloom, S. Hong, K. Kim, A. Zettl, W. Y. Kim, P. Ercius*, J. Park*, and W. C. Lee*, "Reversible disorder-order transitions in atomic crystal nucleation", *Science* **2021**, 371, 498-503. [https://doi.org/10.1126/science.aaz7555]
	4) C. F. Reboul†, J. Heo†, C. Machello, S. Kiesewetter, B. H. Kim, **S. Kim**, D. Elmlund, P. Ercius, J. Park*, and H. Elmlund*, "SINGLE: Atomic-resolution structure identification of nanocrystals by graphene liquid cell EM", *Science Advances* **2021**, 7, eabe6679. [https://doi.org/10.1126/sciadv.abe6679]
	3) **S. Kim**, J. Kwag, C. Machello, S. Kang, J. Heo, C. F. Reboul, D. Kang, S. Kang, S. Shim, S.-J. Park, B. H. Kim, T. Hyeon, P. Ercius*, H. Elmlund*, and J. Park*, "Correlating 3D Surface Atomic Structure and Catalytic Activities of Pt Nanocrystals", *Nano Letters* **2021**, 21, 1175-1183. [https://doi.org/10.1021/acs.nanolett.0c04873]
2020	2) B. H. Kim†, J. Heo†, **S. Kim**, C. F. Reboul, H. Chun, D. Kang, H. Bae, H. Hyun, J. Lim, H. Lee, B. Han, T. Hyeon, A. P. Alivisatos, P. Ercius*, H. Elmlund*, and J. Park*, "Critical differences in 3D atomic structure of individual ligand-protected nanocrystals in solution", *Science* **2020**, 368, 60-67. [https://doi.org/10.1126/science.aax3233]
2019	1) J. Sung†, B. K. Choi†, B. Kim, B. H. Kim, J. Kim, D. Lee, **S. Kim**, K. Kang*, T. Hyeon*, and J. Park*, "Redox-Sensitive Facet Dependency in Etching of Ceria Nanocrystals Directly Observed by Liquid Cell TEM", *Journal of the American Chemical Society* **2019**, 141, 18395-18399. [https://doi.org/10.1021/jacs.9b09508]

Presentations

2025	14) **S. Kim**, "Electrochemical Liquid-Cell Transmission Electron Microscopy (EC-LCTEM) for Advanced Analysis of Energy Materials", *The Korean Scientists and Engineers Community at Cornell (KSECC) Seminar*, Mar. 2025 (Oral presentation)
	13) **S. Kim**, "Quantitative Electrochemical Liquid-Cell TEM Studies of Catalyst Degradation Mechanisms", *Protochips Webinar*, Jan. 2025 (Oral presentation)
2024	12) **S. Kim**, "Advanced Analysis of Energy Materials through Electrochemical Liquid-Cell Transmission Electron Microscopy", *BMCE Seminar at Catholic University*, Oct. 2024 (Oral presentation)
	11) **S. Kim**, Z. Zhang, and Y. Yang*, "*Operando* Electrochemical Liquid-Cell STEM (EC-STEM) at Dynamic Battery Interfaces", *New York Battery and Energy Storage Technology Consortium (NY-BEST) 2024 Annual Fall Technology and Innovation Conference*, Oct. 2024 (Poster)
	10) **S. Kim**, J. Kwag, and J. Park*, "Reproducible Electrochemical Liquid-cell TEM for Tracking Degradation of Individual Pt nanoparticles on Carbon Supports", *The Korean Electrochemical Society (KECS) 2024 Spring meeting*, Apr. 2024 (Oral presentation)

	9) **S. Kim**, J. Kwag, and J. Park*, "Reproducible Electrochemical Liquid-cell TEM for Tracking Degradation of Individual Pt nanoparticles in Fuel Cell Catalysts", *Nano Convergence Conference 2024 (NCC2024)*, Jan. 2024 (Oral presentation)
2023	8) **S. Kim**, J. Kwag, and J. Park*, "Developing a Reliable and Reproducible Electrochemical Liquid-cell TEM Method for Understanding the Degradation Process of Fuel Cell Catalysts", *The 20th International Microscopy Congress (IMC20)*, Sep. 2023 (Oral presentation)
	7) **S. Kim**, G. H. Gu*, and J. Park*, "Investigating catalytic activity of an ensemble of synthesized small Pt nanocrystals through their 3D atomic structure and multiscale simulation", *Samsung Global Technology Symposium*, Aug. 2023 (Poster)
	6) **S. Kim**, Y. Kim, G. H. Gu*, and J. Park*, "Investigating catalytic activity of an ensemble of synthesized small Pt nanocrystals through 3D atomic structure and multiscale simulation", *The Korean Society of Industrial and Engineering Chemistry (KSIEC) 2023 Spring meeting*, May 2023 (Poster)
2022	5) **S. Kim**, D. Kang, J. Kwag, D. Kim, J. Heo, and J. Park*, "3D atomic structure of Pt nanocrystals related to their catalytic activity and surface ligand adsorption", *Materials Research Society (MRS) 2022 Fall meeting*, Dec. 2022 (Oral presentation)
	4) **S. Kim**, D. Kang, and J. Park*, "Complex adsorption behavior of a PVP ligand on 3D atomic surfaces of synthesized Pt nanoparticles", *The Korean Institute of Chemical Engineers (KIChE) 2022 Fall meeting*, Oct. 2022 (Poster)
	3) **S. Kim**, D. Kang, and J. Park*, "Complex adsorption behavior of a PVP ligand on 3D atomic surfaces of synthesized Pt nanoparticles", *Center for Hybrid Interfacial Chemical Structure (CICS) 2022 Workshop*, Jun. 2022 (Poster)
2021	2) **S. Kim**, J. Kwag, and J. Park*, "Reproducible real-time imaging method for degradation process of fuel cell catalysts using *in situ* TEM", *72nd Annual Meeting of the International Society of Electrochemistry*, Sep. 2021 (Poster)
2018	1) **S. Kim**, B. H. Kim, J. Heo, D. Kang, and J. Park*, "3D reconstruction of single nanoparticle and structure analysis in atomic resolution", *The Korean Society of Industrial and Engineering Chemistry (KSIEC) 2018 Spring meeting*, May 2018 (Poster)

Teaching Experience

Teaching assistant

Spring 2020	Physical Chemistry 1 *(45 contact hours)*
Fall 2018	Elementary Lab. for Chemical and Biological Engineering (*40 contact hours*)

Mentoring

Spring 2019	Tutor for Learning Community 'Sublime'

	(2 students, one for Organic Chemistry – *13.5 contact hours* and the other for General Chemistry – *15 contact hours*)
Fall 2018	Tutor for Learning Community 'Sublime' (2 students, one for General Chemistry – *15 contact hours* and the other for General Chemistry – *9 contact hours*)
Summer 2018	Tutor for Learning Community 'Sublime' (1 student for General Chemistry – *9 contact hours*)
Spring 2018	Tutor for Learning Community 'Sublime' (1 student for General Chemistry – *12 contact hours*)

Awards and Honors

2024	**Student Poster Prizes (3rd place)**, *New York Battery and Energy Storage Technology Consortium (NY-BEST) 2024 Annual Fall Technology and Innovation Conference*
	Best Student Oral Presentation Awards, *Nano Convergence Conference 2024 (NCC2024)*
2023	**Best Oral Presentation Awards**, *The 20th International Microscopy Congress (IMC20)*
2020	**Jeju Human Resources Development Scholarship** (~$1,600), *Jeju Institute for Lifelong Education and Scholarship*
2017, 2018	**Lecture & Research Scholarship** (2 terms: ~$8,000 total), School of Chemical and Biological Engineering, *Seoul National University*
2017	***cum Laude***, *Seoul National University*
2016, 2017	**Work-Study Scholarship** (2 terms: ~$2,400 total), *Seoul National University*
2016	**GS Caltex Global Project** (Gold Prize: ~$800). School of Chemical and Biological Engineering, *Seoul National University*
2014-2016	**Chungsoo Scholarship** (Full funding of tuition for 6 terms: ~&15,000 total), *Chungsoo Scholarship Foundation*

Skills

Research Skills:

- *In situ* electrochemical liquid-cell TEM/STEM (EC-LCTEM/STEM)
- Identical-Location TEM/STEM (IL-TEM/STEM)
- Electrocatalysis performance test (RDE, H-cell) for ORR, HER, and CO2RR
- 3D structure determination for nanocrystals (3D SINGLE)
- Nanomaterial characterization (Raman, XRD, NMR, IR, and so on)
- Photolithography
- Nanoparticles/Catalysts synthesis

Software:

- Python

Leadership Experiences

2025	**President (Sep 25' – Aug 26'),** **KSECC (Korean Scientists and Engineers Community at Cornell University)** *@ Cornell University*
2019	**Vice President (Sep 19' – Feb 20'),** **ACT (Startup Consulting Group)** *@ Seoul National University*
2014	**President (Mar 14' – Dec 14'),** **SOCCHEM (Department Soccer Club)** *@ Seoul National University*
2013	**President (Mar 13' ~ Aug 13'),** **Class A in Department of Chemical and Biological Engineering** *@ Seoul National University*

Academic References

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Seoul National University
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