Yeonsu Kwak

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EDUCATION

Ph.D. in Chemical & Biomolecular Engineering — Aug 2021 – Nov 2026
University of Delaware (UD), Newark, DE, United States

M.S. in Energy — Sep 2016 – Aug 2017
Texas A&M University (TAMU), College Station, TX, United States

B.S. in Chemical Engineering — Mar 2012 – Aug 2016
Pohang University of Science and Technology (POSTECH), Pohang, South Korea

RESEARCH INTERESTS

Heterogeneous catalysis and reaction engineering | Electrified and intensified chemical manufacturing
Hydrogen and low-carbon process systems modeling | Catalytic upcycling of biomass and plastics

RESEARCH EXPERIENCE

Postdoctoral Researcher (Incoming) — Late 2026
National Laboratory of the Rockies (NLR) (Host: Dr. Gregg Beckham)

Graduate Research Assistant — Aug 2021 – Nov 2026
University of Delaware, Newark, DE, United States (Advisor: Prof. Dionisios G. Vlachos)

- Synthesized $PtSn/SiO_2$ catalysts and demonstrated coke-resistant microwave propane dehydrogenation (PDH) without H_2 co-feed, with higher energy efficiency and slower nanoparticle sintering than furnace heating
- Quantified the linear scaling of dielectric loss with oxygen-vacancy concentration in reduced rutile TiO_2 and related microwave absorption to reduction kinetics and reverse water-gas shift performance using operando dielectric and spectroscopic measurements
- Used rapid pulsed Joule heating to intensify methane coupling while suppressing coke and aromatic byproducts relative to continuous heating
- Integrated CFD, kinetic modeling, and experiments to design an internally Joule-heated ethane cracker with enhanced ethylene yield, projected lower capital requirements, and reduced CO_2 emissions

R&D Intern — 05/2026 – 08/2026
Linde Engineering America, Tonawanda, NY (Managers: Dr. Monica Zanfir & Dr. Troy M. Raybold)

- Developed a hybrid equilibrium–kinetic model that defines the thermodynamic over-reduction boundary of Fe_3O_4 water-gas-shift catalysts and predicts hydrocarbon slip from finite-rate methanation and Fischer–Tropsch reactions
- Developed a UniSim blue-hydrogen flowsheet and evaluated reformer and shift configurations to quantify H_2 recycle, carbon intensity, heat integration, and process-design trade-offs

Visiting Scholar — Jun 2024
ITACA Institute, Universitat Politècnica de València, Spain (Host: Prof. José M. Catalá-Civera)

- Developed perturbation-based dual-mode cavity protocols to quantify microwave heating profiles and dielectric properties for operando catalysis studies
- Coordinated ITACA–UD dual-mode cavity co-development, international shipment and customs, and preparation for XAS-compatible microwave experiments at QAS, BNL

Visiting Scholar — Nov 2022
INMA Institute, University of Zaragoza, Spain (Host: Prof. Jesús Santamaría)

- Conducted cross-laboratory experiments to verify the reproducibility of microwave-assisted PDH performance

Research Scientist (Alternative Military Service) — Nov 2019 – Aug 2021
Korea Institute of Science and Technology (KIST), Seoul, South Korea

- Advanced LOHC dehydrogenation systems from catalyst benchmarking to low-platinum-loading catalyst development via atomic layer deposition for scalable hydrogen release

- Designed and constructed Ni-alloy foam architectures for Joule-heated ammonia decomposition reactors
- Scaled an LOHC dehydrogenation reactor to 2.3 Nm^3 hr^{-1} H_2 production using phase-change thermal management
- Managed multi-year projects funded by Hyundai Motor Company and National Research Foundation of Korea

Research Engineer (Alternative Military Service) Aug 2017 – Nov 2019
Institute for Advanced Engineering (IAE), Yongin, South Korea

- Scaled a continuous 5 ton yr^{-1} sustainable aviation fuel pilot process integrating palm-oil deoxygenation, hydrocracking, isomerization, and distillation to produce jet-fuel-range hydrocarbons meeting ASTM D7566 specifications
- Managed continuous pilot operations, rotating shift schedules, and process-safety procedures

Graduate Research Assistant Sep 2016 – Aug 2017
Texas A&M University, College Station, TX, United States (Advisors: Profs. Hae-Kwon Jeong & Phanourios Tamamis)

- Synthesized CO_2-capturing amyloid biomaterials via peptide self-assembly and validated CO_2 uptake

PUBLICATIONS

(†Equal contribution, *Corresponding authors, Full list of publications)

First-author Publications

[11] **Y. Kwak**†, A. S. Sundaramoorthy†, A. Mittal†, C. Arumugam, B. Teressa, D. Debraj, H. Goyal* & D. G. Vlachos*
"From electromagnetic field-material interactions to intensified chemical manufacturing via microwave catalysis"
Chemical Society Reviews, 2026.

[10] **Y. Kwak**†, R. Railkar†, W. Zheng & D. G. Vlachos*
"Tandem non-oxidative coupling of methane and carbon dioxide reduction via pulsed Joule thermochemistry"
ACS Energy Letters, 2025, 10, 12, 6188–6196.

[9] A. Mittal†, **Y. Kwak**†, W. Zheng, M. Ierapetritou & D. G. Vlachos*
"Short contact time, high temperature, internally-heated ethane crackers"
Chemical Engineering Journal 523 (2025) 168251.

[8] **Y. Kwak**†, Y.-J. Lee†, S. Moon†, K. Lee, S. Ramadhani, E.-R. On, C.-I. Ahn, S.-J. Hwang, H. Sohn, H. Jeong, S. W. Nam & Y. Kim*
"Scalable atomic-layer tailoring of abundant oxide supports unlocks superior interfaces for low-metal-loading dehydrogenation"
Angewandte Chemie International Edition 2025, 64, e202417598.

[7] **Y. Kwak**, C. Wang, K. C. Ajit, K. Yu, E. Selvam, R. Mallada, J. Santamaria, H. Goyal, I. Julian, J. M. Catala-Civera, W. Zheng & D. G. Vlachos*
"Microwave-assisted, performance-advantaged electrification of propane dehydrogenation"
Science Advances, 9 (37), eadi8219 (2023).

[6] D. K. Kang†, **Y. Kwak**†, S. Moon, S. Ramadhani, W. Jeong, H. Jeong, H. Sohn, S. W. Nam, Y. S. Jo, C. W. Yoon & Y. Kim*
"Thermally manageable and scalable reactor configurations towards efficient hydrogen release from liquid organic hydrogen carriers"
Energy Conversion and Management 307 (2024) 118345.

[5] **Y. Kwak**, S. Moon, C.-I. Ahn, A. Kim, Y. Park, Y. Kim, H. Jeong, H. Sohn, S. W. Nam, C. W. Yoon* & Y. S. Jo*
"Effect of support properties in dehydrogenation of biphenyl-based eutectic mixture as LOHC over Pt/Al_2O_3 catalysts"
Fuel 284 (2021) 119285.

[4] **Y. Kwak**, J. Kirk, S. Moon, T. Ohm, Y.-J. Lee, M. Jang, L.-H. Park, C.-I. Ahn, H. Jeong, H. Sohn, S. W. Nam, C. W. Yoon, Y. S. Jo* & Y. Kim*
"Hydrogen production from homocyclic LOHCs: Benchmarking studies and energy-economic analyses"
Energy Conversion and Management 239 (2021) 114124.

[3] **Y. Kwak**, H. Shin, S. Moon, J. Kirk, Y. Park, H. Jeong, H. Sohn, S. W. Nam, C. W. Yoon, Y. S. Jo* & Y. Kim*

"Investigation of a hydrogen generator with the heat management module utilizing liquid-gas organic phase change material"
International Journal of Energy Research (2021) 45, 10378–10392.

[2] Y. Park†, **Y. Kwak**†, S. Yu, A. Badakhsh, Y.-J. Lee, H. Jeong, Y. Kim, H. Sohn, S. W. Nam, C. W. Yoon, J. H. Han* & Y. S. Jo*
"Degradation mechanism of a Pd/Ta composite membrane: Catalytic surface fouling with inter-diffusion"
Journal of Alloys and Compounds 854 (2021) 157196.

[1] **Y. Kwak**, J. H. Jang, S. Kim, M. Ahn, E.-S. Lee, G. B. Han*, B. H. Jeong, J. S. Han & C.-H. Jeon*
"Reaction characteristics of hydrocarbon fuels under various operation conditions of hydro-upgrading process for vegetable oil-based bio-jet fuel production"
Journal of Oil & Applied Science, 35 (2018) 731–743.

Co-author Publications

[16] G. Yan†, S. Yoon†, **Y. Kwak**, A. Kizil, J. A. Boscoboinik, W. Zheng & D. G. Vlachos
"Facet dependence of redox cycling of ceria nanocrystals"
Catalysis Science & Technology, 2026.

[15] J. Choi, M. Kim, **Y. Kwak**, A. Pophali, G. Halada, H. Luo, G. Kwon, I. Ro, J. Kim, M. Rafailovich & T. Kim*
"Elucidating the role of surface species in CO oxidation catalyzed by boron nitride nanotube supported transition metal oxides"
Journal of Catalysis 456 (2026) 116715.

[14] S. Luo†, A. Kamali†, J. M. Little, A. Warty, J. K. Keum, P.-Y. Chen, **Y. Kwak**, H. K. Kim, D. G. Vlachos, K. Zhang, J. Yang & D. Liu*
"Vapor-phase pillarization of MXenes for engineering hierarchical interlayer porosity"
Journal of Materials Chemistry A, 2026.

[13] R. Railkar, **Y. Kwak** & D. G. Vlachos*
"Intensifying steam methane reforming and water-gas shift in tandem via rapid pulsed Joule heating"
Chemical Engineering Journal 512 (2025) 162700.

[12] E. Selvam, Z. O. G. Schyns, J. A. Sun, P. A. Kots, **Y. Kwak**, L. T. J. Korley, R. F. Lobo & D. G. Vlachos*
"Conversion of compositionally diverse plastic waste over earth-abundant sulfides"
Journal of the American Chemical Society 2025, 147 (13) 11227–11238.

[11] E.-R. On†, K. Lee†, **Y. Kwak**, C. Kim, Q. Dao, H. Sohn, S. W. Nam, J. Kim, Y. Kim* & H. Jeong*
"Promoter-guided reaction intermediate dynamics enhance perhydro-benzyltoluene dehydrogenation"
ACS Catalysis, 2025, 15, 5531–5545.

[10] J. Y. Park, **Y. Kwak**, J. E. Lee, Y. D. Kim, S. H. Lee, D. W. Jeong, B. S. Kim & Y. H. Choa
"Hydrovoltaic electricity generator using a hierarchical NiFe LDH-coated CuO nanowire mesh device"
Chemical Engineering Journal 485 (2024) 149914.

[9] S. Gupta, **Y. Kwak**, R. P. Raj & P. Selvam*
"Ytterbium-nitrogen co-doped ordered mesoporous TiO_2: The innovative hetero-phase photocatalyst for harnessing solar energy in green hydrogen production"
Journal of Materials Chemistry A (2024) 12, 6906–6927.

[8] C. Wang†, S. Sourav†, K. Yu, **Y. Kwak**, W. Zheng & D. G. Vlachos*
"Green syngas production by microwave-assisted dry reforming of methane on doped ceria catalysts"
ACS Sustainable Chemistry & Engineering 2023, 11 (36) 13353–13362.

[7] I. S. Lim, Y. Jeong, **Y. Kwak**, E.-R. On, H. Jeong, H. Sohn, S. W. Nam, T.-H. Lim, K. Muller & Y. Kim*
"Maximizing clean hydrogen release from perhydro-benzyltoluene: Energy-efficient scale-up strategies and techno-economic analyses"
Chemical Engineering Journal 478 (2023) 147296.

[6] C.-I. Ahn, **Y. Kwak**, A.-R. Kim, M. Jang, A. Badakhsh, J. Cha, Y. Kim, Y. S. Jo, H. Jeong, S. H. Choi, S. W. Nam, C. W. Yoon* & H. Sohn*
"Dehydrogenation of homocyclic liquid organic hydrogen carriers over Pt supported on an ordered pore structure of 3-D cubic mesoporous KIT-6 silica"
Applied Catalysis B: Environment and Energy 307 (2022) 121169.

[5] J. Y. Park, **Y. Kwak**, H.-R. Lim, S.-W. Park, M. S. Lim, H.-B. Cho, N. V. Myung & Y.-H. Choa*

"Tuning the sensing responses towards room-temperature hypersensitive methanol gas sensor using exfoliated graphene-enhanced ZnO quantum dot nanostructures"
Journal of Hazardous Materials 438 (2022) 129412.

[4] A. Badakhsh, **Y. Kwak**, Y.-J. Lee, H. Jeong, Y. Kim, S. W. Nam, C. W. Yoon, C. W. Park* & Y. S. Jo*
"A compact catalytic foam reactor for decomposition of ammonia by the Joule-heating mechanism"
Chemical Engineering Journal 426 (2021) 130802.

[3] Y.-J. Lee, J. Cha, **Y. Kwak**, Y. Park, Y. S. Jo, H. Jeong, H. Sohn, C. W. Yoon, Y. Kim*, K.-B. Kim* & S. W. Nam*
"Top-down syntheses of nickel-based structured catalyst for hydrogen production from ammonia"
ACS Applied Materials & Interfaces 2021, 13, 1, 597–607.

[2] Y. Kim, **Y. Kwak**, Y.-J. Lee, Y. S. Jo, H. Sohn, H. Jeong, H. J. Kim, J. H. Han *et al.*
"Compact ATR-WGS-integrated bioethanol fuel processor for portable and on-board fuel cell applications"
ACS Sustainable Chemistry & Engineering 2020, 8 (41) 15611–15619.

[1] S. Kim, J. H. Jang, M. Ahn, **Y. Kwak**, G. B. Han, B. H. Jeong, J. S. Han & J. K. Kim
"Effects of reaction conditions on composition of the organic liquid product during the deoxygenation process of palm oil"
Journal of Oil & Applied Science, 35 (2018) 865–875.

MANUSCRIPTS UNDER REVIEW, IN REVISION, AND IN PREPARATION

[2] L. F. Rasteiro, **Y. Kwak**, N. Wang, P. S. Sinhmar, J. Sweet, M. Cendejas, S. R. Bare, A. J. Medford, F. Boukouvala, J. Kwan, W. Liu, D. G. Vlachos, J. C. Hicks, D. S. Sholl, T. S. Choksi & C. Sievers*
"Challenges and opportunities of catalytic process with alternative forms of energy input"
Chemical Reviews, under review

[1] **Y. Kwak**, A. P. Jones, M. P. Bobbin, T. U. Rahman, S. Yoon, P. J. Plaza-Gonzalez, J. M. Catala-Civera, W. Zheng & D. G. Vlachos*
"Electromagnetic field-enhanced redox catalytic activity in reducible oxides"
In preparation

ISSUED PATENTS

- Hydrogen extraction reactor and hydrogen extraction process using phase change materials, **US 11,674,068 B2**
- A catalyst for dehydrogenation of LOHCs and method for producing the same, **KR 10-2472412**
- Apparatus for manufacturing eco-friendly transportation fuel and method therefor, **KR 10-2859154**
- Apparatus for separating and producing hydrocarbon fuels, **KR 10-2786950**

SELECTED ORAL PRESENTATIONS

- Rethinking Chemical Reaction Engineering through Electrification, CCP Monthly Meeting, DE 2026
- Process Electrification for Scalable and Intensified Chemical Manufacturing, KAIST YGIS, Korea 2026
- Dynamic Electrification of Nonoxidative Propane Dehydrogenation, NAM29, GA 2025
- Electrified Biogas Upgrading into Value-Added Chemicals, AIChE Fall, CA 2024
- Mechanistic Insights into Microwave-Assisted Thermal Catalysis, 5GCMEA, Japan 2024
- Microwave-Assisted Direct Propane Dehydrogenation, AIChE Fall, FL & NAM28, RI 2023
- Electromagnetic field driven catalysis for electrification, ACS Spring, Hybrid 2023

AWARDS & HONORS

- Theodore A. Koch Graduate Student Travel Award | Catalysis Club of Philadelphia (CCP) 2026
- NSF Delaware EPSCoR Graduate Bridge Fund Award 2025 – 2026
- Best Oral Presentation Award | 5th Global Congress on Microwave Energy Applications (5GCMEA) 2024
- AIChE Hanwha Travel Award | Hanwha Solutions & TotalEnergies Petrochemical 2024
- Graduate Student Travel Awards | UD Graduate College & UD CCST 2024 – 2025
- Commendation for Oral Ph.D. Qualifier Exam (Exceptional) | UD ChBE 2022
- Finalist, Fulbright Graduate Scholarship | U.S. Department of State & Fulbright Korea 2021
- Master of Science in Energy Scholarship | Texas A&M Energy Institute 2017

- Global Engineers Fostering Scholarship (M.S. Full Funding) | EDRC of Seoul National University 2016 – 2017
- National Scholarship in Science and Technology (B.S. Full Funding) | Ministry of Education of Korea 2012 – 2016
- 4th Place Award, Korea Chemical Process Simulation Olympiad | KIChE, Schneider Electric 2016
- Research Scholarship for Undergraduate Research Program | POSTECH 2015
- Exchange Student Scholarship (National University of Singapore, Fall 2015) | POSTECH 2015
- Exchange Student Scholarship (Nanyang Technological University, Summer 2014) | POSTECH 2014

SERVICE & LEADERSHIP

Peer Reviewer | American Association for the Advancement of Science, American Chemical Society, Royal Society of Chemistry & Elsevier 2022 – Present

- Completed 40+ peer reviews for Science Advances, ACS Catalysis, Chemical Engineering Journal, Fuel, International Journal of Hydrogen Energy, Catalysis Today, Molecular Catalysis, ACS Omega, Journal of Alloys and Compounds, RSC Advances, and Fuel Processing Technology

Research Mentor | UD Delaware Energy Institute 2023 – Present

- Auden Jones ('24–'25): Microwave catalysis of metal oxides; admitted to the University of Houston's Ph.D. program
- Matthew Conlon ('23): Microwave heating of carbon materials; admitted to Purdue's Ph.D. program

President ('23–'24), Treasurer ('22–'23) | UD Korean Graduate Student Association 2022 – 2024

- Managed annual finances exceeding $3,000 and organized 10+ academic and community events, serving 100+ members of the UD Korean and Korean-American community

Teaching Assistant | UD ChBE 2023

- CHEG614/814 (Special Topics in Energy, Spring), Instructor: Prof. Dionisios G. Vlachos. Led office hours and facilitated graduate-level discussions on energy systems
- CHEG445 (Chemical Engineering Lab II – Distillation, Fall), Instructor: Prof. Nicholas Shevchenko. Supervised distillation pilot plant operations and graded technical reports for 30+ seniors, adhering to safety protocols

PROFESSIONAL MEMBERSHIP

- Catalysis Club of Philadelphia (CCP), Graduate Student Member 2024 – Present
- American Institute of Chemical Engineers (AIChE), Graduate Student Member 2022 – Present
- Korean-American Scientists and Engineers Association (KSEA), Graduate Student Member 2022 – Present
- Korean Institute of Chemical Engineers (KIChE), Regular Member (on leave) 2017 – Present

REFERENCES

Contact information available upon request

- Dionisios G. Vlachos, Ph.D. | Ph.D. Advisor | Professor, University of Delaware, USA
- Raul Lobo, Ph.D. | Ph.D. Dissertation Committee | Professor, University of Delaware, USA
- José M. Catalá-Civera, Ph.D. | Research Collaborator | Professor, ITACA Institute, Spain
- Yongmin Kim, Ph.D. | Supervisor at KIST | Principal Researcher, KIST, South Korea