Boreum Lee

School of Energy and Chemical Engineering

Ulsan National Institute of Science and Technology

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Research Interests

Techno-economic analysis

· Process design and modeling for chemical processes

· Economic feasibility analysis using cost estimation, sensitivity analysis, and profitability analysis, and uncertainty analysis

Environmental assessment

· Environmental impact and sustainability assessment

Comprehensive analysis

· Multi-criteria decision analysis using techno-economic analysis and environmental assessment results

Education

· March 2019 ~ August 2021

Ulsan National Institute of Science and Technology, Ulsan, Republic of Korea

Doctor of Chemical Engineering expected in August 2021

GPA: 4.15 out of 4.30

Research Advisor: Dr. Hankwon Lim

Dissertation Title: Techno-economic and environmental assessment of PEM water electrolysis for green H_2 generation

· March 2016 ~ February 2018

Catholic university of Daegu, Gyeongbuk, Republic of Korea

Master of Science in Advanced Materials and Chemical Engineering

GPA: 4.44 out of 4.50

Research Advisor: Dr. Hankwon Lim

Dissertation Title: Techno-economic analysis (TEA) of a multi-bed series reactor for simultaneous perfluorinated compounds abatement and utilization without HF effluent

· March 2012 ~ Febuary 2016

Catholic university of Daegu, Gyeongbuk, Republic of Korea

Bachelor of Science in Advanced Materials and Chemical Engineering

Graduation with the highest honor

GPA: 4.29 out of 4.50, GPA in major courses: 4.50 out of 4.50

Experience

Work experience

· September 2021 ~

Yale University

Post-doctoral researcher

· September 2018 ~ February 2019

Process simulation and techno-economic analysis of chemical processes

Ulsan National Institute of Science and Technology, Ulsan, Republic of Korea

Researcher

Teaching assistant

· September 2019 ~ December 2019

Teaching assistant

Ulsan National Institute of Science and Technology, Ulsan, Republic of Korea

Subject name: Separation Processes

· February 2019 ~ June 2019

Teaching assistant

Ulsan National Institute of Science and Technology, Ulsan, Republic of Korea

Subject name: Advanced Chemical Engineering Laboratory

Summary of Publications

· SCIE (Science Citation Index Expanded) Journal Papers: **42** (First author **29**)

JCR Top 10%: **17** (First author **12**, ~29%)

· Non SCIE Journal Papers: **1**

· KCI (Korean Citation Index) Journal Papers (in English): **3** (First author **2**)

Publications

SCIE Papers Published

2022

43. H. Ly[§], **B. Lee**[§], J. Sim, Q. Tran, S.-S. Kim, J. Kim, B. Brigljevic, H.-T. Hwang, H. Lim, "Catalytic pyrolysis of spent coffee waste for upgrading sustainable bio-oil in a bubbling fluidized-bed reactor: Experimental and techno-economic analysis", Chemical Engineering Journal 427 (2022) 130956.

2021

42. H. Kim[§], **B. Lee**[§], D. Lim, C. Choe, H. Lim, "What is the best green propylene production pathway?: Technical, economic, and environmental assessment", Green Chemistry (2021) Accepted

41. J. Cha[§], Y. Park[§], B. Brigljevic[§], **B. Lee**, D. Lim, T. Lee, H. Jeong, Y. Kim, H. Sohn, H. Mikulcic, K. Lee, D. Nam, K. Lee, H. Lim, C. Woon, Y. Jo, "An efficient process for sustainable and scalable hydrogen production from green ammonia", Renewable & Sustainable Energy Reviews (2021) Accepted

40. H. Lee[§], A. Kim[§], A. Lee, **B. Lee**, H. Lim, "Optimized H_2 fueling station arrangement model based on total cost of ownership (TCO) of fuel cell electric vehicle (FCEV)", International Journal of Hydrogen Energy (2021) Accepted.

39. D. Lim[§], **B. Lee**[§], H. Lee, M. Byun, H. Cho, W. Cho, C.-H. Kim, B. Brigljevic, H. Lim, "Impact of voltage degradation in water electrolyzers on sustainability of synthetic natural gas production: Energy, economic, and environmental analysis", Energy Conversion and Management 245 (2021) 114516.

38. H. Lee[§], **B. Lee**[§], M. Byun, H. Lim, "Comparative techno-economic analysis for steam methane reforming in a sorption-enhanced membrane reactor as simultaneous H_2 production and CO_2 capture", Chemical Engineering Research and Design 171 (2021) 383.

37. **B. Lee**, D. Lim, H. Lee, H. Lim, "Which water electrolysis technology is appropriate?: Critical insights of potential water electrolysis for green ammonia production", Renewable & Sustainable Energy Reviews 143 (2021) 110963.

36. **B. Lee**, D. Lim, H. Lee, M. Byun, H. Lim, "Techno-economic analysis of H_2 energy storage system based on renewable energy certificate", Renewable Energy 167 (2021) 91.

35. H. Kim[§], S. Lee[§], **B. Lee**[§], J. Park, H. Lim, W. Won, "Improving revenue from lignocellulosic biofuels: An integrated strategy for coproducing liquid transportation fuels and high value-added chemicals", Fuel 287(2021) 119369.

2020

34. H. Lee[§], **B. Lee**[§], M. Byun, H. Lim, "Economic and environmental analysis for PEM water electrolysis based on replacement moment and renewable electricity resources", Energy conversion and management 224 (2020) 113477.

33. **B. Lee**, H. Lee, D. Lim, B. Brigljevic, W. Cho, H.-S. Cho, C.-H. Kim, H. Lim, "Renewable methanol synthesis from clean H_2 and captured CO_2: How can power-to-liquid technology be economically feasible?", Applied Energy 279 (2020) 115827.

32. **B. Lee**[§], H. Kim[§], H. Lee, M. Byun, W. Won, H. Lim, "Technical and economic feasibility under uncertainty for methane dry reforming of coke oven gas as simultaneous H_2 production and CO_2 utilization", Renewable & Sustainable Energy Reviews 133 (2020) 110056.

31. M. Byun[§], **B. Lee**[§], H. Lee, S. Jung, H. Ji, H. Lim, "Techno economic and environmental assessment of methanol steam reforming for H_2 production at various scales", International Journal of Hydrogen Energy 45 (2020) 24146.

30. J. Heo[§], **B. Lee**[§], H. Lee, H. Lim, "Integrative technical, economical, and environmental feasibility analysis for ethane steam reforming in a membrane reactor for H_2 production", ACS Sustainable Chemistry & Engineering 8 (2020) 7011.

29. J.-C. Lee[§], **B. Lee**[§], Y. S. Ok, H. Lim, "Preliminary techno-economic analysis of biodiesel production over solid-biochar", Bioresource Technology 306 (2020) 123086.

28. D. Kim, D. Shin, J. Heo, H. Lim, J.-A. Lim, H. Jeong, B.-S. Kim, I. Heo, I.-H. Oh, **B. Lee**, M. Sharma, H. Lim, H. Kim, Y. Kwon, "Unveiling electrode-electrolyte designing based NO reduction for NH_3 synthesis", ACS Energy Letters 5 (2020) 3647.

27. H. Lee, A. Kim, **B. Lee**, H. Lim, "Comparative numerical analysis for an efficient hydrogen production via a steam methane reforming with a packed-bed reactor, a membrane reactor, and a sorption-enhanced

membrane reactor", Energy Conversion and Management 213 (2020) 112839.

26. B. Brigljevic, **B. Lee**, R. Dickson, S. Kang, H. Lim, "Concept for temperature-cascade hydrogen release from organic liquid carriers coupled with SOFC power generation", Cell Reports Physical Science 1 (2020) 100032.

2019

25. **B. Lee**, H. Lee, J. Heo, C. Moon, S. Moon, H. Lim, "Stochastic techno-economic analysis of H_2 production from Power-to-Gas using a high-pressure PEM water electrolyzer for small-scale H_2 fueling station", Sustainable Energy & Fuels 3 (2019) 2521.

24. **B. Lee**, J. Park, H. Lee, M. Byun, C.W. Yoon, H. Lim, "Assessment of the economic potential: COx-free hydrogen production from renewables via ammonia decomposition for small-sized H_2 refueling stations", Renewable & Sustainable Energy Reviews 113 (2019) 109262.

23. **B. Lee**[§], H. Lee[§], S. Kim, H.-S. Cho, W.-C. Cho, B.-H. Jeon, C.-H. Kim, H. Lim, "Quantification of economic uncertainty for synthetic natural gas production in a H_2O permeable membrane reactor as simultaneous power-to-gas and CO_2 utilization technologies", Energy 182 (2019) 1058.

22. **B. Lee**, H. Lee, S. Kang, H. Lim, "Stochastic techno-economic analysis of power-to-gas technology for synthetic natural gas production based on renewable H_2 cost and CO_2 tax credit", Journal of Energy Storage 24 (2019) 100791.

21. **B. Lee**[§], H. Lee[§], H.-S. Cho, W.-C. Cho, C.-H. Kim, H. Lim, "Projected economic outlook and scenario analysis for H_2 production by alkaline water electrolysis on the basis of a unit electricity price, a learning rate, and an automation level", Sustainable Energy & Fuels 3 (2019) 1799.

20. **B. Lee**[§], J. Heo[§], S. Kim, C.-H. Kim, S.-K. Ryi, H. Lim, "Integrated techno-economic analysis under uncertainty of glycerol steam reforming for H_2 production at distributed H_2 refueling stations", Energy Conversion and Management 180 (2019) 250.

19. **B. Lee**, H. Lim, "Cost-competitive methane steam reforming in a membrane reactor for H_2 production: Technical and economic evaluation with a window of a H_2 selectivity", International Journal of Energy Research 43 (2019) 1468.

18. **B. Lee**[§], S.-W. Yun[§], S. Kim, J. Heo, Y.-T. Kim, S. Lee, H. Lim, "CO_2 reforming of methane for H_2 production in a membrane reactor as CO_2 utilization: Computational fluid dynamics studies with a reactor geometry, Energy". International Journal of Hydrogen Energy 44 (2019) 2298.

17. J.-C. Lee, **B. Lee**, J. Heo,. H.-W. Kim, H. Lim H. Lim, "Techno-economic assessment of conventional and direct-transesterification processes for microalgal biomass to biodiesel conversion", Bioresource Technology 294 (2019) 122173.

16. J. Heo, S. Kim, W. Yeon, H. Lee, **B. Lee**, H. Lim, "Deterministic and stochastic economic analysis based on historical natural gas and CO_2 allowance prices for steam reforming of methanol", Energy Conversion and Management 193 (2019) 140.

15. S. Kim, S.-W. Yun, **B. Lee**, J. Heo, K. Kim, Y.-T. Kim, H. Lim, "Steam reforming of methanol for ultra-pure H_2 production in a membrane reactor: Techno-economic analysis", International Journal of Hydrogen Energy 44 (2019) 2330.

2018

14. **B. Lee**[§], J. Heo[§], S. Kim, C. Sung, C. Moon, S. Moon, H. Lim, "Economic feasibility studies of high pressure PEM water electrolysis for distributed H_2 refueling stations", Energy Conversion and Management 162 (2018) 139.

13. **B. Lee**, S. Kim, J. Song, S.-K. Ryi, H. Lim, "Conceptual design for a new SF_6 abatement technology in a

multi-bed series reactor for the production of valuable chemicals free of toxic wastes", Energy Science and Engineering 6 (2018) 73.

12. J. Heo, **B. Lee**, J.-N. Kim, H. Lim, "Techno-economic analysis of a biological desulfurization process for a landfill gas (LFG) in Korea", Separation Science and Technology 53 (2018) 2769.

11. J. Heo, **B. Lee**, H. Lim, "Techno-economic analysis for CO_2 reforming of a medium-grade landfill gas in a membrane reactor for H_2 production", Journal of Cleaner Production 172 (2018) 2585-2593.

10. S. Jeong, S. Kim, **B. Lee**, S.-K. Ryi, H. Lim, "Techno-economic analysis: Ethane steam reforming in a membrane reactor with H_2 selectivity effect and profitability analysis", International Journal of Hydrogen Energy 43 (2018) 7693.

9. C.-H. Kim, J.-Y. Han, S. Kim, **B. Lee**, H. Lim, K-Y. Lee, S-K. Ryi, "Hydrogen production by steam methane reforming in a membrane reactor equipped with a Pd composite membrane deposited on a porous stainless steel", International Journal of Hydrogen Energy 43 (2018) 7684.

2017

8. **B. Lee**, J. Heo, N. Choi, C. Moon, S. Moon, H. Lim, "Economic evaluation with uncertainty analysis using a Monte-Carlo simulation method for hydrogen production from high pressure PEM water electrolysis in Korea", International Journal of Hydrogen Energy 42 (2017) 24612.

7. **B. Lee**, H. Chae, N. Choi, C. Moon, S. Moon, H. Lim, "Economic evaluation with sensitivity and profitability analysis for hydrogen production from water electrolysis in Korea", International Journal of Hydrogen Energy 42 (2017) 6462.

6. **B. Lee** and H. Lim, "Parametric studies for CO_2 reforming of methane in a membrane reactor as a new CO_2 utilization process", Korean Journal of Chemical Engineering 34 (2017) 199.

5. **B. Lee**, S. Jeong, S. Lee, H. Jung, S. Ryi, H. Lim, "Preliminary techno-economic analysis of a multi-bed series reactor as a simultaneous CF_4 abatement and utilization process", Greenhouse Gases Science and Technology 7 (2017) 542.

4. J. Han, C. Kim, **B. Lee**, S. Jeong, H. Lim, K-Y. Lee, S-K. Ryi, "Reaction enhancement of catalytic CF_4 hydrolysis by consecutive HF removal using a multi-stage catalyst-adsorbent reactor", Greenhouse Gases Science and Technology 7 (2017) 1141.

3. J. Han, C. Kim, **B. Lee**, S. Nam, H. Lim, K. Lee, S. Ryi, "Sorption enhanced catalytic CF_4 hydrolysis with a three-stage catalyst-adsorbent reactor", Frontiers of Chemical Science and Engineering 11 (2017) 537.

2016

2. **B. Lee,** S. Lee, H. Lim, "Numerical modeling studies for a methane dry reforming in a membrane reactor", Journal of Natural Gas Science and Engineering 34 (2016) 1251.

1. **B. Lee**, S. Lee, H. Jung, S. Ryi, H. Lim, "Process simulation and economic analysis of reactor systems for Perfluorinated compounds abatement without HF effluent", Frontiers of Chemical Science and Engineering 10 (2016) 526.

KCI Journal Papers (in English)_Published

3. **B. Lee**, H. Lee, C. Moon, S. Moon, H. Lim, "Preliminary Economic Analysis for H_2 Transportation Using Liquid Organic H_2 Carrier to Enter H_2 Economy Society in Korea". Trans. of Korean Hydrogen and New Energy Society 2 (2019) 119.

2 J. Heo, **B. Lee**, S. Kim, S.-M. Kang, H. Lim, "Economic evaluation with uncertainty analysis of glycerol steam reforming for a H_2 production capacity of 300 m^3 h^{-1}, *Applied Chemistry for Engineering* 29 (2018)

589.

1. **B. Lee**, H. Lim, “Comparative studies for the performance of a natural gas steam reforming in a membrane reactor”, Journal of the Korean Institute of Gas 20 (2016) 95.

SCIE Papers Under Review/In Revision

· SCIE (Science Citation Index Expanded) Journal Papers: **17** (First author 9)

17. J. Kim, H. Lee, **B. Lee**, J. Kim, H. Oh, I.-B. Lee, Y.-S. Yoon, H. Lim, “Development of an integrative process for blast furnace and SOEC for hydrogen utilization on steel sector: techno-economic and environmental impact assessment", Chemical Engineering Journal (2021) Submitted.

16. H. Lee, D. Lim, **B. Lee**, H. Lim, “What is the optimized cost for a used battery?: Economic analysis in case of energy storage system as 2nd life of battery”, Applied Energy (2021) Submitted.

15. Y.-L. Lee§, D. Lim§, **B. Lee**, M. Upadhyay, B. Brigljevic, H.-S. Roh, H. Lim, “Economically Viable Green Methanol Production via CO2 Reforming of LFG with Highly Active and Stable Ni-MgO-CeZrO2 Catalyst” Green Chemisty (2021) Submitted.

14. D. Lim, M. Byun, B. Lee, A. Lee, A. Kim, B. Brigljevic, H. Lim, “H2 production from catalytic dry reforming of landfill gas utilizing membrane reactor with combined heat and power system: 3E (energy, economic and environmental) feasibility analysis” Energy Conversion and Management (2021) Under Review

13. M. Byun§, D. Lim§, **B. Lee**, A. Kim, I.-B. Lee, B. Brigljevic, H. Lim, “Economically Feasible Decarbonization of the Haber-Bosch Process through Supercritical CO2 Allam Cycle Integration” Applied Energy (2021) Under Review

12. B. Brigljevic, M. Byun, H. Lee, A. Kim, **B. Lee**, C. Moon, J. Choi, H. Yoon, C. Yoon, Y. Ok, D.-H. Lim, C.-H. Kim, H. Lim, “When Bigger is not Greener: Ensuring the Sustainability of PtG Hydrogen on a National Scale” ACS Sustainable Chemistry & Engineering (2021) In Revision

11. A. Kim, H. Kim, H. Lee, **B. Lee**, H. Lim, “Comparative economic optimization on overseas hydrogen supply chain with mixed-integer linear programming”, ACS Sustainable Chemistry & Engineering (2021) In Preparation

10. H. Kim§, M. Byun§, **B. Lee**, H. Lim, “Carbon-neutral methanol synthesis as CO_2 utilization at different scales: Economic and environmental perspective”, Energy Conversion and Management (2021) Under Review

9. C. Choe§, **B. Lee**§, M. Byun, H. Kim, H. Lim, “Comparative economic feasibility assessment of synthetic natural gas production using water electrolysis with renewable energy resources”, International Journal of Hydrogen Energy (2021) Under Review

8. **B. Lee**§, H.-S. Cho§, H. Kim, D. Lim, W.-C. Cho, C.-H. Kim, H. Lim, “Integrative techno-economic and environmental assessment for green H_2 production by alkaline water electrolysis”, Journal of Environmental Chemical Engineering (2021) In Revision

7. **B. Lee**, H. Kim, A. Kim, C. Choe, H. Lim, “Economic parity analysis of green methanol synthesis using water electrolysis based on renewable energy” ACS Sustainable Chemistry & Engineering (2021) Under Review

6. **B. Lee**§, H. Lee§, D. Lim, H. Lim, “Integrative analysis for liquid organic H_2 carrier in terms of economic feasibility, environmental impact, and social acceptance”, International Journal of Hydrogen Energy (2021) Under Review

5. D. Lim [§], **B. Lee**[§], H. Lee, M. Byun, H. Lim, "Projected cost analysis of hybrid methanol production from tri-reforming of methane integrated with various water electrolysis systems: Technical and economic assessment" Renewable & Sustainable Energy Reviews (2021) Under Review

4. J. Haider[§], **B. Lee**[§], C. Choe, H. Lim, "Process enhancement for high energy efficiency and process economy with net zero CO2 outflow in an integrated energy system for SNG production", Journal of Cleaner Production (2021) Under Review

3. M. Tran[§], **B. Lee**[§], H. Lee, B. Brigljevic, E. Lee, H. Lim, "Sustainable biopolyol production via solvothermal liquefaction silvergrass saccharification residue: Experimental, economic, and environmental approach", Chemical Engineering Journal (2021) Submitted.

2. **B. Lee**, J. Haider, H. Kim, H. Lim, "Predictive analysis for green NH_3 production by the modified Haber-Bosch process with different water electrolysis types: scenario analysis", (2021) In Preparation

1. **B. Lee**, H. Lee, H. Kim, C. Choe, I.-B. Lee, H. Lim, "Priority assessment of renewable energy resources for green H_2 production under technical, economic, and environmental aspects", (2021) In Preparation

Conferences Attended

· **B.Lee**, H. Lee, H. Kim, C. Choe, I.-B. Lee, H. Lim, Technical, economic, and environmental assessment for PEM water electrolysis, International Conference on Applied Energy, December 2020 (Oral presentation)

· **B.Lee**, J.-C. Lee, Y. Ok, H. Lim, Techno-economic assessment for hydrogen production by biogas reforming over biochar catalyst, International Biochar Initiative, December 2019 (Oral presentation)

· **B.Lee**, H. Lee, H. Lim, Economic feasibility analysis of Power-to-Gas for H_2 production from renewable energy, International Partnership for Hydrogen and Fuel Cells in the Economy, October 2019 (Poster presentation)

· **B.Lee**, H. Lee, S. Ryi, H. Lim, Economic analysis for power to gas technology from renewable energy, The Korean Institute of Chemical Engineers, October 2019 (Poster presentation)

· **B.Lee**, H. Lee, H. Lim, Economic analysis: Power to gas technology based on renewable energy, The Korean Society of Energy & Climate Change, May 2019 (Poster presentation)

· **B.Lee**, B. Brigljevic, H. Lee, H. Lim, Economic analysis of hydrogen transportation using liquid organic H_2 carrier, The Korean Society of Clean Technology, March 2019 (Poster presentation)

· **B.Lee**, H. Lee, H. Lim, Economic analysis for power to gas technology, The Korean Society of Clean Technology, September 2018 (Poster presentation)

· **B.Lee**, S. Lee, S.-K. Ryi, H. Lim, Techno-economic analysis of methane steam reforming in a membrane reactor with Pd-Ru membranes, The Korean Society of Clean Technology, March 2018 (Poster presentation)

· **B.Lee**, S. Kim, J. Heo, S. Lee, H. Lim, Computational fluid dynamics (CFD) studies of CO_2 reforming of methane for H_2 production in a membrane reactor: Effect of a reactor geometry, International Conference on Alternative Fuels & Energy, October 2017 (Poster presentation)

· **B.Lee**, H. Lim, Heat management in multi-bed series reactors for simultaneous CF_4 abatement and utilization without HF effluent, The Korean Society of Clean Technology, October 2017 (Poster presentation)

· **B.Lee**, S. Lee, H. Jung, S.-K. Ryi, H. Lim, Hankwon Lim, Comparative studies of reactor systems for PFCs removal in multi-bed series reactors, The Korean Society of Clean Technology, September 2016 (Poster presentation)

· **B.Lee**, S. Lee, H. Jung, S.-K. Ryi, H. Lim, Process simulation and economic analysis of reactor systems for perfluorinated compounds (PFCs) abatement, March 2016 (Poster presentation)

Certifications

· The education certification of Aspen Process Economic Analyzer, AspenTech	Dec. 2018
· Engineer chemical industry certification, Human resources development service of Korea	May. 2017
· The certification of COMSOL (chemical reaction), Altsoft Co	Jan. 2017
· The certification of COMSOL (heat/momentum), Altsoft Co.	Jan. 2017
· The basic course certification of COMSOL, Altsoft Co.	Jan. 2017
· The education certification of Aspen Plus, AspenTech	Oct. 2016
· The education certification of Aspen Dynamics, AspenTech	Jun. 2016
· The education certification of Aspen HYSYS, AspenTech	Mar. 2016
· ITQ master certification, Korea productivity center	Jun. 2014

Awards

·Outstanding graduate student award, Ulsan National Institute of Science and Technology	Dec. 2020
· Best poster prize, The Korean Society of Clean Technology	Sep. 2019
· Best poster prize, The Korean Society of Energy & Climate Change	May. 2019
· DAELIM paper prize, Korean Institute of Chemical Engineers	Oct. 2017
· Grand prize of contest, Korea Gas Corporation	Oct. 2017
· Grand prize of paper presentation, Korea Gas Corporation	Oct. 2016
· University President's award for the highest honor, Catholic university of Daegu	Feb. 2016

Activity

· Presidential committee on KOGAS Innovation, Korea Gas Corporation	2018 ~

SKILLS

· Process simulation

- Aspen HYSYS®, Aspen Plus®, Aspen Dynamics, UniSim Design® Suite

· Computational fluid dynamics (CFD)

- COMSOL Multiphysics®

· Reactor analysis

- Polymath, MATLAB

· Economic analysis

- Cash flow diagram, Benefit cost analysis, Payback period, Profitability analysis, Monte-Carlo method

· **Environmental impact assessment**

- SimaPro, GREET(Greenhouse gases, Regulated Emissions, and Energy use in Transportation)

· **Multi-criteria decision analysis**

- Analytic hierarchy process

· **Material flow analysis**

- STAN (short for subSTance flow ANalysis)

· **Polymer synthesis**

- Polymethyl methacrylate (PMMA), Nylon, Aspirin

· **Organic/Inorganic synthesis**

- Graphene synthesis

· **Simple distillation**

- Ethanol distillation

· **Experimental equipment**

- Cyclic voltammetry (CV), Fourier transform infrared spectroscopy (FT-IR)
- X-ray Diffraction spectroscopy (XRD), Scanning electron microscope (SEM), Gas chromatography (GC)
- Ultraviolet-visible spectroscopy (UV-vis)

References

· **Dr. Hankwon Lim**

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· **Dr. Menachem Elimelech**

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· **Dr. In-Beum Lee**

Chair-Professor

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· **Dr. Wangyun Won**

Professor

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