KAIST

Department of

Chemical & Biomolecular Engineering

FOR CREATIVE INNOVATION

The Department of Chemical and Biomolecular Engineering at KAIST has successfully transformed itself into one of the best programs, not only in Korea, but also in the world. Currently, it is thriving with one of the largest undergraduate and graduate student bodies in its discipline with 26 full-time faculty members who are recognized as international leaders in their respective fields.

During the last few decades, we saw the emergence of biotechnology and nanotechnology, which have now become integral components of our department. Moreover, the rapid changes in society with AI and the 4^{th} industrial revolution have brought opportunities for significant ideas and innovative solutions at solving some of the most important energy and environmental issues. Your continued interest and support as well as constructive criticisms are most welcome. Thank you very much.

Head of Department

Jae Woo Lee

About Chemical and Biomolecular Engineering

Vision

KAIST CBE Department will foster the next-generation's Chemical and Biomolecular Engineers, and contribute to efficiently solving industrial and social problems through innovative education and research programs. KAIST CBE Department will continue to pursue this vision by proactively promoting innovations in the science and technology as well as the society.

Mission

To teach students scientific phenomena at all length scales as well as fundamental and state-of-the-art engineering skills to efficiently and effectively solve problems.

To contribute to addressing major socio-technical issues, namely energy, environment, and healthcare, through the core approaches of the KAIST CBE Department and through collaborations with industrial partners and international institutes.

To foster the innovation and entrepreneurial spirit as key characteristics of our faculty members and students.

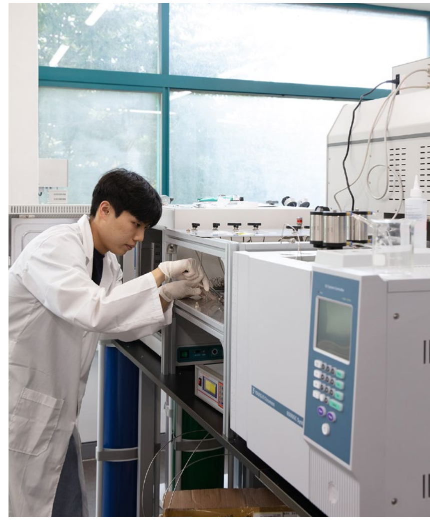
To improve the international visibility by playing as a leading institute in the international environment.

To encourage all the department employees to advance their professional careers.

Research Areas

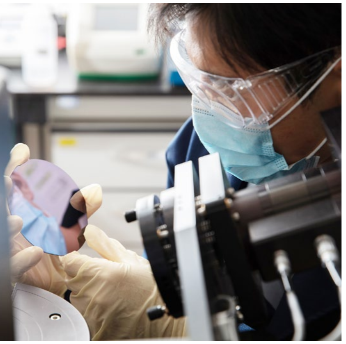
1 Nanomaterials

Nanotechnology is a multidisciplinary field that deals with materials and structures of nanometer scales. The combination of design, fabrication, and application of nanomaterials not only satisfy our scientific curiosity, but also significantly impact our daily lives. The fundamental understanding of the relationships among physical properties, chemical compositions, and dimensional structures enables the miniaturization of current devices and creation of new nanomaterials. We investigate various aspects of nanomaterials, which includes self-assembly of organic and inorganic components and the development of functional thin film structures. These nanomaterials find application in a wide range of industries including optoelectronics, semiconductor, and biomedicine.



2 Catalysis

Development of alternative energy sources and environmentally benign chemical processes are essential for sustainable development of human society. Catalysis is at the core of developing clean energy sources, including advanced petrochemistry, biorefinery, and hydrogen energy technologies. Paralleling the efforts to develop new energy sources, catalysis also plays an important role in developing clean environment technologies. Green catalyst encourages the design of products and processes that minimize the use and generation of hazardous substances and improve energy and resource efficiency. In order to derive the required functions of catalysts in such processes, understanding the kinetics and mechanism of the catalytic reaction as well as the relationship between the molecular structure of certain catalysts and the reaction rate in different ways is essential. In combination with such fundamental knowledge, cutting-edge nanotechnologies and highthroughput screening of catalysts are used to design advanced catalysts.



3 Energy & Environment, System

Energy/Environment/Systems research area addresses some of the most pressing challenges of our time: securing a stable base for the energy supply and halting the global warming trend. These challenges can be met by developing renewable energy sources and reducing carbon dioxide emission. No single approach will suffice, while an effective solution will require creative integration of several approaches including biofuel, photovoltaics, wind energy, hydrogen, and improved use of traditional fossil fuel sources (e.g., coal gasification). This field of study spans a broad range of length and time scales from atomic level molecules to process level factories. Research efforts in this area are both active and diverse, including the development of nanomaterials for energy storage, carbon capture and utilization, and smart plant design, optimization, and control.

4 Biotechnology

Biotechnology area seeks to apply chemical and biomolecular engineering principles to a broad range of scientific and technological applications using biological systems or bio-related materials. This research area is highly cross-disciplinary and encourages creative and innovative collaboration both within the department and with researchers outside. Essential efforts entail the application of traditional and emerging engineering practices to understand the fundamentals of complex living organisms and to address societal challenges through novel biotechnologies. Current research capabilities span metabolic engineering, protein engineering, nucleic acid engineering, drug delivery, and biosystem and bionetwork analysis.

5 Soft Materials

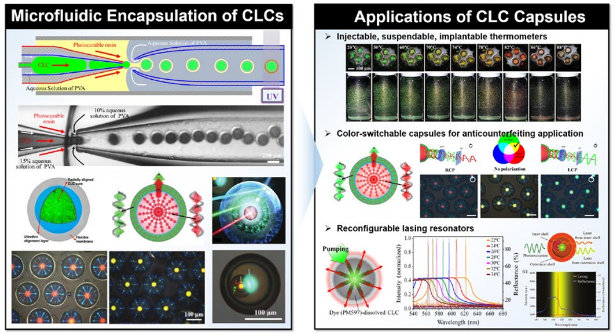
Soft Materials, in particular polymers, play a key role in major industries and serve as one of the main themes in chemical and biomolecular engineering. Soft materials extend from conventional rubber and plastics to functional polymers for advanced material applications. The research efforts in Soft Materials area include both fundamental studies to understand polymer morphology and physical properties and application development especially in the areas of polymer based solar cells, batteries, fuel cells, and polymer electroluminescence displays. Integration of polymer engineering and nanoscience is being actively pursued to address a wide range of traditional and advanced material challenges.

Research in CBE

Developing microencapsulation technology of cholesteric liquid crystals using droplet microfluidics for advanced photonic applications

2020.7. *Advanced Materials*
2018.12. *Science Advances*
2017.6. *Advanced Materials*
2015.12. *Angewandte Chemie*
2015.1. *Advanced Materials*

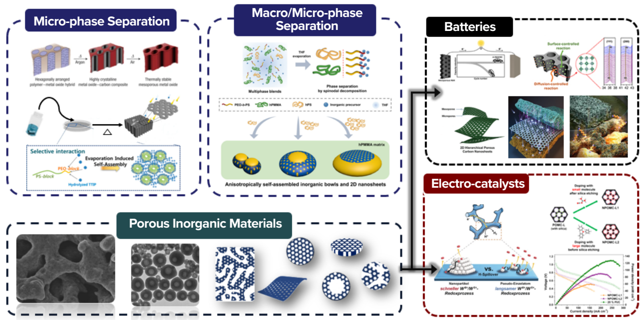
Prof. Shin-Hyun Kim has developed a microfluidic technology for microencapsulation of cholesteric liquid crystals (CLCs) in a highly controlled fashion. The LC molecules confined in droplet compartments take a planar alignment along spherical interface, which results in isotropic photonic bandgap property. The CLC microcapsules with various configurations have been designed to provide injectable, suspendable, and standalone microsensors, lasing resonators, and anti-counterfeiting inks.



Developing highly sophisticated control method of inorganic porous materials through macro/micro phase separation and its convergence with energy technology

2020.8. *Science Advances*
2020.5. *Journal of the American Chemical Society*
2019.1. *Advanced Materials*
2018.7. *Advanced Materials*
2018.7. *Advanced Materials*
2018.2. *Advanced Materials*
2008.1 *Nature Materials*

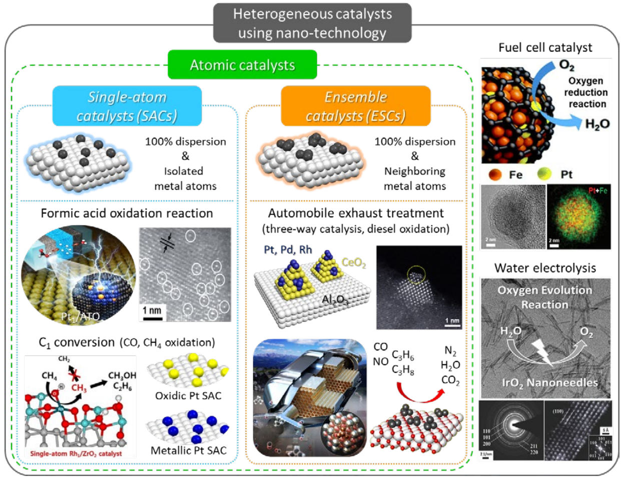
Prof. Jinwoo Lee has pioneered designing of inorganic porous materials by integrating micro-phase separation of block copolymer and macro-phase separation of spinodally decomposed multicomponent blends. Through new novel strategies, ordered mesoporous inorganic particles and hierarchically porous inorganic materials were elaborately synthesized, and these materials have been applied to electro-catalysts and battery electrodes to enhance electrochemical performance. The research outcomes have highly inspired the future research direction of porous materials and demonstrated the potential to overcome the current limits of electro-catalysts and batteries.



Development of high-performance heterogeneous atomic catalysts with minimum use of precious metals for energy and environmental applications

2020.7. *Energy & Environmental Science*
2020.7. *Angewandte Chemie International Edition*
2020.2. *Nature Catalysis*
2019.6. *Applied Catalysis B: Environmental*
2018.8. *Nature Communications*
2018.7. *Journal of the American Chemical Society*
2017.11. *Advanced Functional Materials*
2017.11. *Journal of the American Chemical Society*
2017.9. *Advanced Energy Materials*
2017.9. *ACS Catalysis*

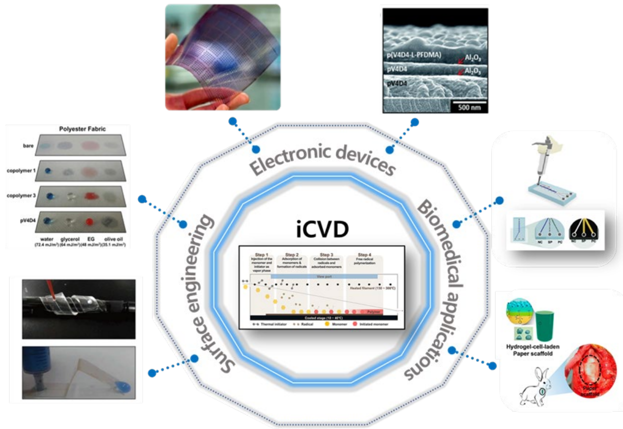
Prof. Hyunjoo Lee has investigated novel concepts of heterogeneous catalysts using nano-technology, and applied these catalysts for applications in renewable and environmentally friendly energy and chemical production, such as fuel cell catalyst, water electrolysis, automobile exhaust treatment, C1 conversion and CO2 reduction. Most recently, she has developed high-performance atomic catalysts to minimize the use of precious metals and to control the reaction pathways, opening a new paradigm in heterogeneous catalysis.



Dedicated to vapor-phase deposited functional polymer films for the application to soft electronics, biomaterials, and surface modifications

2020.8. *Advanced Functional Materials*
2020.7. *Science Advances*
2020.3. *Advanced Materials*
2019.6. *Nature Communications*
2018.3. *Advanced Energy Materials*
2017.2. *Journal of the American Chemical Society*
2015.6. *Nature Materials*

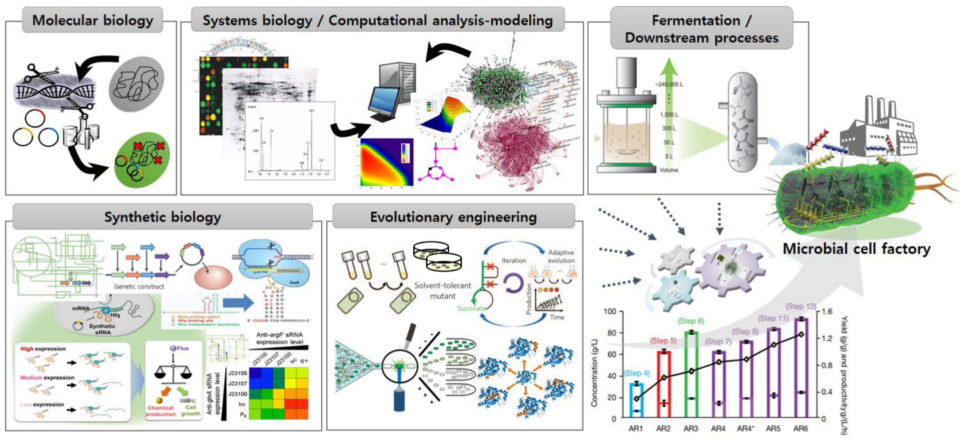
Prof. Sung Gap Im utilizes a new polymer deposition method, initiated chemical vapor deposition (iCVD) for developing novel thin film materials and structures. iCVD is a process that can deposit functional polymer films with the exceptional composition control and conformality. The solvent-free process provides many interesting coatings of anti-microbial, superhydrophobic, functionalizable, insulating, and bio-compatible polymers without damaging the substrates. With this versatile tool, the research team is exploiting the possibility of the functional polymer coatings to develop next-generation device applications including electronic devices, surface modifications, and biomaterials for tissue engineering.



Systems metabolic engineering for the development of industrial microbial strains

Prof. Sang Yup Lee has pioneered a research field called “systems metabolic engineering (SysME)”. SysME allows systems-level engineering of the metabolism of living organisms toward production of desired chemicals by considering the entire metabolic and regulatory networks as well as midstream (fermentation) and downstream (recovery and purification) processes. Applying the SysME strategy, numerous high performance microbial strains have been successfully developed for the production of various chemicals and materials including biofuels, engineering plastic monomers, biomedical plastics, recombinant proteins, and natural products.

2020.7. *Chemical Society Reviews*
2020.4. *Nature Communications*
2019.5. & 2019.7 *PNAS*
2019.6. *Nature Chemical Biology*
2019.1. *Nature Catalysis (Journal cover)*
2018.1. *Nature Communications (2 publications)*
2018.4 & 2018.6. & 2018.10. *PNAS (4 publications)*
2018.8 *Nature Catalysis*
2017.5. *Nature Communications*
2016.4. *Nature Biotechnology*
2015.3. & 2015.10. *Nature Biotechnology*
2015.9. *Nature Communications*
2014.8. *Nature Communications*
2013.10. *Nature (Journal cover)*
2013.8. *Nature Protocols (Journal cover)*
2013.2. *Nature Biotechnology*



Numbers in CBE

26 Faculty Members in CBE

11 Professor	10 Associate Professor	5 Assistant Professor

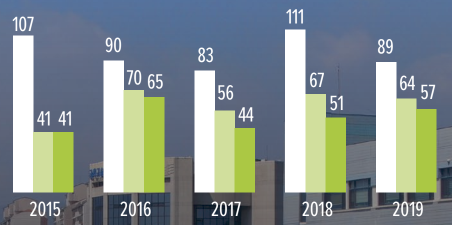
$20.3M

Research Grants Awarded in 2019; 85.6Million (accumulated from 2015 to 2019)

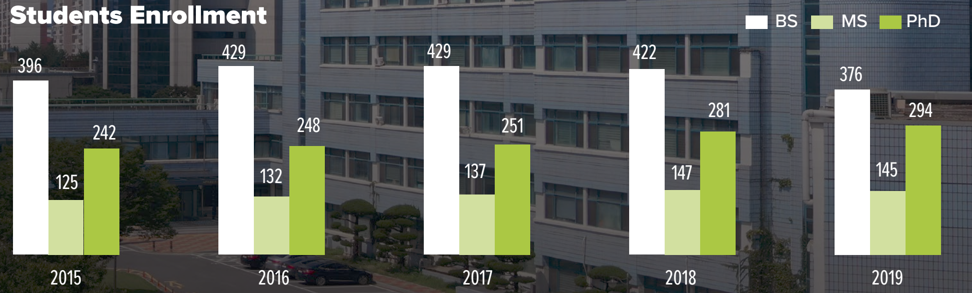
238 Average Number of Publication from 2015 to 2019

73 Average Number of Patents from 2015 to 2019

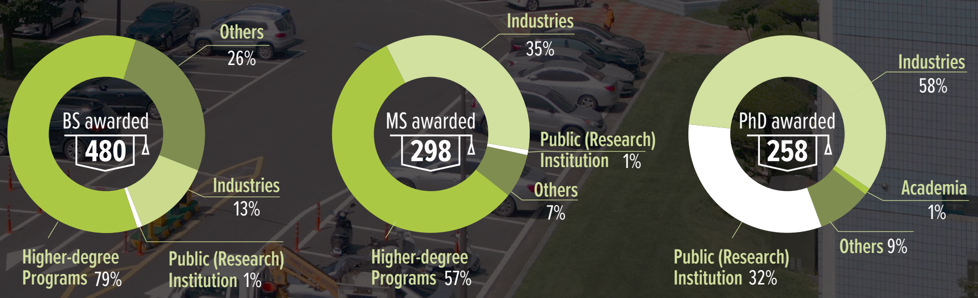
Degrees Awarded



Students Enrollment



Career Status after Graduation



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