### Online Live Symposium

**Oct. 15, 2020 (Thu.), 08:30~17:20**

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<td>Kyu Tae Lee (Seoul Nat’l Univ.)</td>
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### Speakers

- **Dae-Hyeong Kim**
  - 2009: Ph.D., Mat. Sci. and Eng., UIUC
  - 2014: Assoc. Director of Center for Nanoparticle Res., IBS

- **Jang Wook Choi**
  - 2007: PhD., Chem. Eng., Caltech

- **Sang Yup Lee**
  - Present: Distinguished Prof., Chem. and Biomed. Eng., Dean of KAST Institutes
  - Present: Chair of the Global Future Council on Biotechnology

- **Juyoung Yoon**
  - 2006: Ph. D., Chemistry, UIUC
  - Present: Distinguished Prof., Chem. and Biology, Ewha Womans Univ.

- **Nam-Gyu Park**
  - 2009: Director of Solar Cell Research Center, KIST
  - Present: SKKU Fellow, Prof., Chem. Eng., Sungkyunkwan Univ.

- **Jaephil Cho**
  - 1995: Ph.D., Ceramic Eng., Iowa State Univ.
  - Present: Distinguished Prof., Ener. and Chem. Eng., UNIST

- **Yang-Kook Sun**
  - Present: Distinguished Prof., Ener. Eng., Hanyang Univ.

- **Kyu Tae Lee**

- **Woo-Jae Kim**

- **Joon Jeong Hwang**
  - 2012: Ph.D., Chemistry, Univ. of California, Berkeley
  - Present: Principal Investigator, Korea Institute of Science and Technology
Dae-Hyeong Kim
Seoul Nat’l Univ.
(dkim98@snu.ac.kr)

Abstract Although recent research efforts in materials, device designs, and fabrication techniques have resulted in meaningful progresses in soft bioelectronics and thus many clinical issues have been solved by the novel soft biomedical devices, significant challenges still remain. In particular, treatment of brain tumours with high efficiency and development of high-performance artificial eyes require much more breakthroughs. Here, our recent achievement in soft bio-resorbable and bio-inspired electronics to solve such unmet goals will be presented. In the first part of the presentation, an intracranial drug delivery device using the biodegradable wireless electronics integrated with a flexible bioresorbable drug reservoir will be explained. Then, a high-density soft CurviS array inspired by a human eye and an advanced wide-field-of-view CurviS array inspired by a fish eye will be presented. These two results are representative examples of our continuing research and development efforts in soft bioelectronics, and are expected to create many new opportunities in wireless intracranial drug delivery as well as artificial vision technology.

Jang Wook Choi
Seoul Nat’l Univ.
(jangwookchoi@snu.ac.kr)

Connecting battery components: Advanced binder designs for emerging rechargeable batteries

Abstract Although Lithium-ion batteries (LIBs) have been successful as power sources of various applications, they are evolving continuously for further improved performance in many aspects, particularly in the transportation sector. All-solid-state-batteries (ASSBs) are drawing discernable attention due to their superior safety. In response to this upcoming trend, new binder designs are demanded. In the first part of this talk, I will present advanced binder designs for LIB electrodes that undergo huge volume change. Such binder designs emphasize a principle relying on supramolecular chemistries, including hydrogen interaction, ion-dipole interaction, and ring-sliding motion in molecular machines. In the second part of this talk, I will introduce some binder designs targeting sulfide-based ASSBs. I will first introduce the difficulty of finding solvent-binder pairs compatible with sulfide electrolytes and will then cover our recent process on how to avoid the given problem. Along this direction, I will introduce binder designs based on click and deprotection chemistry.

Sang Yup Lee
KAIST
(leeasy@kaist.ac.kr)

Systems metabolic engineering for sustainable chemical industry

Abstract Climate crisis is one of the biggest threats to humankind. One of the major causes is our heavy dependence on fossil resources including fossil oil, coal, and natural gas. It is thus imperative to move toward establishing sustainable chemical industry in order to avoid aggravation of climate crisis. Systems metabolic engineering that integrates systems biology, synthetic biology and evolutionary engineering with traditional metabolic engineering allows efficient development of microbial cell factories for the production of natural and non-natural chemicals and materials from renewable resources. In this lecture, I will overview various tools and strategies of systems metabolic engineering. Then, I will showcase how microbial strains can be developed for efficient production of desired chemicals for sustainable chemical industry.

Juyoung Yoon
Ewha Womans Univ.
(jyoong@ewha.ac.kr)

Recent progress on activatable photosensitizers and fluorescent probes

Abstract Switchable phototheranostic nanomaterials are of particular interest for specific biosensing, high-quality imaging, and targeted therapy in the field of precision nanomedicine. Here, we develop a “one-for-all” nanomaterial (NanopCTBs) that self-assembles from flexible and versatile phthalocyanine building blocks. Fluorescence and reactive oxygen species (ROS) generation could be triggered depending on a targeted, protein-induced, partial disassembly mechanism, which creates opportunities for low-background fluorescence imaging and activatable photodynamic therapy (PDT). We also reported a facile strategy to directly assemble a phthalocyanine photosensitizer (PcS) with an anticancer drug mitoxantrone (MA) to form uniform nanostructures (PcS-MA), which have the capability of undergoing nucleic acid-responsive disassembly. On the other hand, we demonstrated the first comprehensive molecular design of heavy-atom-free triplet PSs based on thio carbonyl naphthalimides with excellent potential in PDT. Finally, recent progress from our group on the fluorescent probes for enzyme and HOCI will be also presented.

Taeghwan Hyeon
IBS, Seoul Nat’l Univ.
(thyeon@snu.ac.kr)

Chemistry for nano, and nano for medicine & energy

Abstract For the last 20 years, I have been focused on the synthesis and medical & energy applications of uniform-sized nanocrystals and related nanomaterials. We reported that uniform 2 nm iron oxide nanoclusters are used as T1 MRI contrast agent for high-resolution MR angiography of monkeys. We demonstrated that ceria-based nanoparticles can work as therapeutic antioxidants to treat various nasty diseases, and as radioprotectants. We report a highly sensitive and selective K+ nanosensor that can quantitatively monitor extracellular K+ concentration in the brains of freely moving mice experiencing epileptic seizures. We present a synthesis of highly durable and active electrocatalysts based on nanoparticles of fct-PiFe and FeP. We reported highly active single atom Cu/TiO2 photocatalysts for hydrogen generation.
Perovskite solar cell

Abstract Since the first report on the 9.7% efficient and 500 h-stable solid-state perovskite solar cell (PSC) in 2012, perovskite photovoltaics has been surged swiftly due to high power conversion efficiency (PCE) obtainable via facile fabrication procedure. As a result, a PCE of 25.2% was recorded in 2019. According to Web of Science, number of publications on PSCs increases exponentially since 2012, leading to the accumulated publications of more than 17,500 as of August 2020, which indicates that PSC is considered as promising next-generation photovoltaics. High photovoltaic performance was realized by compositional engineering, device architecture and coating methodologies for the past 10 years. Toward theoretical efficiency over 30% and commercialization of PSC, further studies on recombination and developments of scalable technologies are required for next 10 years. In this talk, history, recent progress and perspective of PSCs will be presented.

Boosting reaction homogeneity in high-energy lithium-ion battery cathode materials

Abstract An intrinsic limitation of polycrystalline nickel-rich cathode materials in high-energy full-cells is discovered under industrial electrode fabrication conditions. Owing to their highly unstable chemo-mechanical properties, even after the first cycle, nickel-rich materials are degraded in the longitudinal direction of the high-energy electrode. This inhomogeneous degradation behavior of nickel-rich materials at the electrode level originates from the overutilization of active materials on the surface side, causing a severe non-uniform potential distribution during long-term cycling. In addition, this phenomenon continuously lowers the reversibility of lithium ions. Consequently, considering the degradation of polycrystalline nickel-rich materials, this study suggests the adoption of a robust single crystalline LiNi$_x$Co$_{1-x}$O$_2$ as a feasible alternative, to effectively suppress the localized overutilization of active materials. Such an adoption, can stabilize the electrochemical performance of high-energy lithium-ion cells, which demonstrates superior capacity retention above ~80% after 1,000 cycles at 45°C.

Photocatalysis for sustainable environment and energy

Abstract The photoinduced electron transfers occurring at the semiconductor surface are the key process of solar conversion processes. This phenomenon has been extensively investigated for the environmental remediation and the solar energy storage systems with interfacial heterojunctions and structural modifications will be introduced and discussed for photoelectrochemical and photocatalytic/photosynthetic applications.

A new series of Ni-rich layered cathodes for next generation electric vehicles

Abstract Li-ion batteries (LIBs) have been positioned as the main portable energy source for electric vehicles (EVs) based on their high energy densities, high power densities, and practical cycle lives. The increasingly strong demand for the higher energy density of LIBs has pushed the development of high-capacity cathodes. The specific capacity of Ni-rich cathodes increases with the Ni content, but the capacity gain from Ni enrichment is negated by the fast capacity fading. One of the effective methods is to control the microstructure of primary particles, such as an elongation of the primary particles with radial orientations. In this presentation, the changes in morphology and microstructure of Ni-rich NCM and NCA cathodes are introduced. This microstructural modification significantly improves cycling stability by suppressing the formation of microcrack.

Promises and challenges of Na-ion batteries

Abstract Na-ion batteries have been considered a promising candidate to replace Li-ion batteries for large-scale energy storage systems because of their low cost compared to Li-ion batteries. However, current Na-ion batteries have slightly lower energy densities than Li-ion batteries. The energy density limitations offset the cost savings due to the use of Na$^+$ as a charge carrier. As a result, the cost per energy ($/Wh) of current Na-ion batteries is not attractive yet. Therefore, it is necessary to improve the energy density of Na-ion batteries by developing high-capacity electrode materials with appropriately redox potentials.

In this presentation, we introduce promising high-capacity electrode materials that our group has recently developed. In particular, we demonstrate the reaction and failure mechanisms of phosphate- and oxide-based cathode materials and phosphorus-based anode materials. Our findings will provide fundamental insights into strategies to improve the electrochemical performance of Na-ion batteries.