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NanoEngineering

UCSD NANOENGINEERING/CHEMICAL ENGINEERING

SEMINAR SERIES

Thursday, June 1st, 2023
Seminar Presentation: 11:00am – 12:00pm
SME room 248

"Innovations in Nanomaterials Synthesis: Sensing and Energy Applications, from Lab to Commercialization"

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Abstract: Numerous techniques such as layer-by-layer coating, hydrothermal synthesis, sacrificial templating routes, and electrospinning etc., have been employed for synthesizing small, porous, and hierarchical nanomaterials. The field of nanoengineering is crucial in optimizing the performance and longevity of nanomaterials. Recent research efforts have focused on developing complex composition catalysts, including high entropy and multi-elemental nanoparticles, and anchoring stable single atom catalysts on robust supporting nanomaterials to enhance their stability and efficiency. Catalyst design is also critical for developing chemical sensors and energy devices like lithium-air batteries that require highly efficient oxygen evolution and oxygen reduction catalysts. The active nanomaterials, including the catalysts, should remain stable during repetitive reactions, minimize catalyst content while maximizing performance, and avoid agglomeration. This presentation will cover the optimal process for attaching catalysts on electrospun nanofiber backbone structures and the various applications of electrospun polymer fibers, semiconducting metal oxide fibers, and highly conducting carbon nanofibers. Moreover, metal-organic frameworks, which can be conformally covered on 1D nanofibers, can selectively transport specific gases, enhancing selective sensing capabilities. Furthermore, the electrode design for secondary batteries utilizing fiber structures and novel processing strategies for maximizing the lifespan of lithium-metal batteries will be presented. Finally, the commercialization process using homemade electrospinning equipment and a roll-to-roll machine (35 cm and 1.2 m width) with a multi-nozzle system will be highlighted as a case study from lab to commercialization. Electrospinning is a solution-based processing technique that enables easy material design of colorimetric fibers, thermochromic fibers, antivirus fibers, and more. This can be achieved by embedding specific functional dyes within nanofiber support, making it a versatile method for developing a wide range of functional nanofibers. With innovative material design insights, the our goal is to lead the implementation of various devices and technological commercialization. Several important case studies on device applications will be presented to share insights into innovative material synthesis.

Biosketch: Il-Doo Kim is Chair Professor of Department of Materials Science and Engineering at KAIST and Director of the Membrane Innovation Center for KAIST Institute. He received Ph. D degree from KAIST (2002). He was a postdoc. Fellow at MIT (Prof. Harry L. Tuller group). Prof. Il-Doo Kim's research group is dedicated to developing novel methods of synthesizing various organic/inorganic nanofiber materials that are optimized for use in ultra-sensitive chemical sensors, including those used for detection of environmental hazardous gases and for breath gas analysis to diagnosis diseases. Additionally, the group focuses on high performance energy storage devices that utilize nanofiber-shaped materials including catalyst-functionalized carbon electrodes, multi-elemental catalysts-loaded metal oxide fibers, and separators. Up to date, Prof. Kim has published over 387 articles (including 63 cove-featured papers), 5 book chapters, and holds 240 international patents. Moreover, a number of patents related to nanofiber synthesis and applications have been successfully licensed to 12 companies. Prof. Kim has been received numerous prestigious awards. Recent selected awards include the KAIST Grand Research Prize (2022), KAIST Grand Prize in International Cooperation (2021), Qian Baojun Young Scholar Fiber Award (2019 China, Donghua University). The Scientist of The Year from Korean Journalists (2019), Korea 10 Nanotechnology Award (2019), 2018 National R&D Excellence 100 Selection (Grand Prize, 2018), Songok Science Award (2018), KAIST Technology Innovation Grand Prize 2017. Presidential Commendation (National industrial development through invention promotion, 2017). Prof. Kim currently serves as an Associate Editor of the ACS Nano. He is a fellow of Korea Academy of Science and Technology (KAST).