

## Mechanical Engineering Seminar Series

February 18, 2025, 11:00AM

E-203E, Dean's Conference Room

### **Title: An electrowetting-driven liquid prism array: from material studies to optofluidic applications for tunable optics and solar energy**

**Dr. Sung-Yong (Sean) Park**  
San Diego State University

**Abstract:** Since Lippmann's pioneering study in 1875, electrowetting has emerged as a powerful technique for manipulating liquids at small scales by modulating surface tension through an applied electric field. The dominance of surface tension forces over body forces in micro/meso scales offers several advantages over conventional microfluidic mechanisms, including large force generation, rapid response time in the microsecond range, and energy-efficient operation. This talk provides a comprehensive overview of electrowetting, covering fundamental materials, mechanisms, and applications in tunable optics and solar energy via liquid prism technology. To enhance electrowetting performance, my focus was on developing a high-capacitance dielectric material, which exhibits capacitance several orders of magnitude higher than conventional dielectrics like SiO<sub>2</sub>. This enhancement arises from the formation of a nanometer-thick electric double layer (EDL) capacitor, where free counter-ions accumulate at the interface under an applied electric field. With this high-capacitance benefit, we developed a liquid-based prism device capable of achieving a beam steering range of  $\pm 19^\circ$ , the highest demonstrated performance in electrowetting-based optics. Expanding on this concept, we further explore the potential of arrayed liquid prism structures with large aperture areas for optofluidic applications, including a liquid-based Fresnel lens with 3D focal tunability and a solar indoor lighting system. These advancements introduce an innovative optofluidic approach for green and sustainable building technologies, paving the way for next-generation adaptive optics and energy-efficient lighting systems.

**Brief Bio:** Dr. Sung-Yong (Sean) Park is an Associate Professor in the Department of Mechanical Engineering at San Diego State University (SDSU). Prior to joining SDSU in 2019, he served as an Assistant Professor in the Department of Mechanical Engineering at National University of Singapore (NUS) from 2013 to 2019. He also worked as a Research Scientist at Teledyne Scientific Company (formerly known as Rockwell Science Center) for 2 years, leading multiple cutting-edge R&D projects funded by ARPA-E and NASA. Dr. Park received his Ph.D. in Mechanical Engineering from the University of California, Los Angeles (UCLA) in 2010 (advisor: Prof. Eric P.Y. Chiou). He continued as a post-doctoral researcher at the UCLA Optofluidic Systems Laboratory.

His research interests encompass optofluidic bio and energy systems, with applications in biosensors, lab-on-a-smartphone platforms, water/air quality detection, solar indoor lighting, and triboelectric energy harvesting. He received an NSF CAREER award in 2021. Additionally, he was honoured with the Harry M. Showman Prize from the Henry Samueli School of Engineering and Applied Science (HSSEAS) at UCLA in 2010 and received the Graduate Student Researcher Scholarship from the UCLA Mechanical Engineering Department in 2006.

