The adaption of needle-type electrochemical microsensor (or microelectrode) techniques to environmental science and engineering systems has transformed how we understand mass transport in biotic and abiotic processes. Their small tip diameter (5-20µm) makes them a unique experimental tool for direct measurements of chemicals in high spatial and temporal resolutions, providing quantitative analysis on flux, diffusion, and reaction rate at a microscale that cannot be obtained using conventional analytical tools. However, their applications have been primarily limited to understanding mass transport dynamics and kinetics in biofilms. With the advancement of sensor fabrication and utilization techniques, their potential applications can surpass conventional biofilm processes. In this dissertation, microsensors were utilized to elucidate mass transport and chemical reactions in multi-interdisciplinary research areas including biological nutrient uptake, oily wastewater treatment, photocatalytic disinfection, and plant disease management, which have not yet explored using this emerging technology.

The main objectives of this work were to develop novel microsensors and use them for a better understanding of various natural and engineered aquatic systems. These include; 1) investigating localized photo-aeration and algal-bacterial symbiotic interaction in an advanced algal-bacterial biofilm process for nutrient removals, 2) characterizing oil-in-water emulsions for better understanding bilge water emulsion stability, 3) evaluating sun-light driven photocatalytic reactions using a novel MoS2 coating for water disinfection and microcystins-LR removal, 4) developing zinc ion-selective microsensors and applying them for in situ monitoring the transport of zinc in citrus trees, and 5) integrating heavy metal detection using anodic stripping voltammetry (ASV) in a microelectrode platform for plant applications.

Overall, microsensors capable of measuring pH, oxidation-potential reduction (ORP), dissolved oxygen (DO), ammonia (NH3), hydrogen peroxide (H2O2), and zinc (Zn2+) were developed and applied to the systems described above to significantly contribute to a better understanding of interfacial transport mechanisms in various natural and engineered systems.

Major: Environmental Engineering

Educational Career:
Bachelor’s of Chemistry, BA, 2012, University of South Florida
Master's of Environmental Engineering, MS, 2015, University of Central Florida

Committee in Charge:
Woo Hyoung Lee, Chair, CECE
Andrew Randall, Department of Civil, Environmental, and Construction Engineering, University of Central Florida
Anwar Sadmani, Department of Civil, Environmental, and Construction Engineering, University of Central Florida
Karin Chumbimuni-Torres, Department of Chemistry, University of Central Florida

Approved for distribution by Woo Hyoung Lee, Committee Chair, on April 9, 2018.

The public is welcome to attend.