Texas Tech University
Department of Chemical Engineering
Seminar Schedule

On the Electrolysis of Urea: from Water Remediation to Biomedical Devices

Gerardine G. Botte, PhD
Ohio University

Bio

Gerardine (Gerri) Botte is a University Distinguished Professor and Russ Professor of Chemical and Biomolecular Engineering at Ohio University, the founder and Director of Ohio University's Center for Electrochemical Engineering Research (CEER), and the founder and Director of the Consortium for Electrochemical Processes and Technology (CEProTECH) -an Industry University Cooperative Research Center. She has served in leadership roles for the Electrochemical Society and is currently the Chair of the Electrochemical Processes Engineering and Technology Division of the International Society of Electrochemistry. She is also the Editor in Chief of the Journal of Applied Electrochemistry. In 2014, she was named a Fellow of the Electrochemical Society for her contributions and innovation in electrochemical processes and engineering. She became a Chapter Fellow of the National Academy of Inventors in 2012. In 2010, she was named a Fellow of the World Technology Network for her contributions on the development of sustainable and environmental technologies. Dr. Botte has 186 publications including peer-reviewed journals, book chapters, and 58 granted patents. She received her Ph.D. in 2000 (under the direction of Dr. Ralph E. White) and M.E. in 1998, both in Chemical Engineering, from the University of South Carolina. Prior to graduate school, Dr. Botte worked as a process engineer in a petrochemical plant; she was involved in the production of fertilizers and polymers. Dr. Botte received her B.S. in Chemical Engineering from Universidad de Carabobo (Venezuela) in 1994.

Abstract

The electrolysis of urea in alkaline medium has been pioneered and is being studied by Dr. Botte and members of her research group at the Center for Electrochemical Engineering Research at Ohio University for multiple applications including: hydrogen production, wastewater remediation, sensors, and biomedical devices. In the process, the electrochemical oxidation of urea to nitrogen and carbon dioxide takes place at the anode of the electrolytic cell in nickel-based electrodes, while hydrogen evolves at the cathodic compartment. The process, with a theoretical cell voltage of 0.37 V at standard conditions, is thermodynamically more favorable than water electrolysis. Because of its low energy consumption and the use of inexpensive catalysts, the technology finds applications for the production of hydrogen on demand requiring only the storage of urea.

In addition to direct production of hydrogen on demand, urea-rich wastewaters can be remediated via urea electrolysis to prevent toxic ammonia emissions and nitrate contamination that currently results from leaving these waters untreated.

The electrochemical response of the urea electrolytic cell is a function of the concentration of urea; therefore, sensors (at the micro and nano scales) can be designed to monitor the concentration of urea online. Urea sensors have numerous applications in different markets, including: food science, clinical diagnostics, wastewater treatment facilities, industrial processes (e.g., power plants and fertilizer industries), and in the diesel automobile/truck market, among others. For example, in clinical diagnostics, monitoring urea in blood provides information on kidney's disease (the normal range of urea level in serum ranges from 2.5mM to 7.5mM).

In this talk, Dr. Botte will present a summary of the technology including catalysts, oxidation rates, progress on understanding of the reaction mechanism, and the potential of the technology for the development of biomedical devices, e.g., sensors and portable dialysis machines.

Tuesday, April 16
1:00 pm
IMSE 121