Electrochemical Conversion of Nitrogen Containing Compounds

**Abstract:** Inorganic and organic nitrogen containing compounds play an important role in the chemical industry as well as many biological and environmental processes. For example, ammonia and urea are important chemicals of use for applications in the fertilizer industry, energy storage, hydrogen production, chemical synthesis, and emissions control technologies. However, these chemicals can also be seen as an environmental challenge.

Ammonia emissions into air (ambient ammonia) and water represent an environmental challenge. Ambient ammonia not only contributes to inorganic PM2.5 (particulate matter with an aerodynamic diameter of less than 2.5 µm) directly but also plays an important role in secondary organic aerosol formation by interacting with gaseous phase organic acids and forming condensable salts. Various industries and other operations are considered ammonia emitters. These are fertilizer manufacture industry, livestock management, coke manufacture industry, fossil fuel combustion, and refrigeration methods. In addition, ammonia emissions in water are associated with environmental problems such as algae bloom.

On the other hand, ammonia produced commercially via the Haber-Bosch (HB) process is usually known as one of the greatest inventions of the 20th Century. The HB process made it possible for the first time to produce synthetic fertilizers and produce sufficient food for the Earth’s growing population. However, the HB process requires high temperatures and pressures and as a result it can only be done in large plants which consume large amounts of power and generate large quantities of CO2 from the fuels used to power the process, such as natural gas. It is estimated that the HB process accounts for nearly 1% of the entire global power consumption. Due to the sheer scale of the HB process, distribution from the point of production to the point of use becomes an additional carbon and energy burden. Alternative methods of manufacturing ammonia that enable small scale, distributed generation at the point of use using renewable energy and sustainable feedstocks could have a great impact on global CO2 emissions.

To circumvent these problems, Dr. Botte and members of her research group have been working on different projects related to the electrocatalysis of nitrogen containing compounds for the production of hydrogen, wastewater treatment, synthesis of ammonia, recovery of energy from waste, and biomedical applications. In this talk, Dr. Botte will highlight some work on the fundamental understanding of the electrochemistry related to these compounds and the translation of fundamental science in electrocatalysis for the synthesis of ammonia, hydrogen production, and energy conversion and storage.

**Gerardine G. Botte**  
Professor and Whitacre Department Chair  
Chemical Engineering Department  
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3:30 p.m. – 4:30 p.m.  
Bell Engineering Center  
Room 2286

Dr. Gerardine (Gerri) Botte is a Professor and the Whitacre Department Chair in Chemical Engineering at Texas Tech University with over 21 years of experience in the development of electrochemical processes and advanced water treatment systems. She is a visionary and a recognized leader in electrochemical science and technology. 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. Previous to Texas Tech, Dr. Botte was 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. Dr. Botte has 189 publications including peer-reviewed journals, book chapters, and 58 granted patents. Dr. Botte and members of her research group are working on the foundation of applying electrochemical engineering principles for advanced and sustainable manufacturing, process intensification, food/energy/water sustainability, and nanomaterials with expertise in electro-synthesis, batteries, electrolyzers, sensors, fuel cells, mathematical modeling, and electro-catalysis. Example projects include: electrochemical extraction of and/or recovery of rare earth elements from solid fuels and produced water, hydrogen production from ammonia, biomass, urea, coal, and pet-coke, synthesis of carbon nanotubes and graphene, water remediation and disinfection, selective catalytic reduction, ammonia synthesis, electrochemical conversion of CO2 to high value products, novel electrolytes for thermal batteries, advanced electrowinning, and electrochemical microbial sensors. Dr. Botte is also an entrepreneur, she has been involved in the commercialization of technologies and has founded and co-founded companies. 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. She can be reached at Gerri.Botte@ttu.edu.