1-1-2019

Innovative Catalytic Ozonation for Water Treatment and Reuse

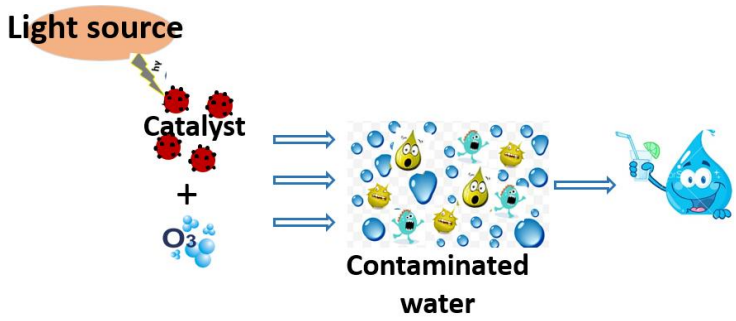
Tingting Wu
University of Alabama in Huntsville

INNOVATIVE CATALYTIC OZONATION FOR WATER TREATMENT AND REUSE

A Proposal for the Research and Creative Experience for Undergraduates
(RCEU) Program, Summer 2019

Faculty Mentor:
Tingting Wu, PhD
Department of Civil and Environmental Engineering, OKT S243.
Phone: 256-824-6423; E-mail: Tingting.Wu@uah.edu
Dr. Wu has participated in the RCEU previously.

Project Summary:



The world faces challenges surrounding water in terms of both quality and quantity due to rapid industrialization, environmental deterioration, population growth, and climate change. Contamination of aquatic environment with thousands of organic chemicals is one of the key water quality problems. Two major sources of such contaminants are wastewater treatment plants (WWTPs) effluent and agricultural runoff. Pharmaceuticals and personal care products (PPCPs) represent an important contaminant category of concerns as conventional wastewater treatment processes are not efficient in their removal. WWTPs effluent along with agricultural runoff can flow or seep into rivers, lakes, and groundwater and contaminate freshwater systems. However, conventional water treatment processes have limited efficiency in removal of pharmaceuticals and other organic contaminants. Furthermore, water shortage has increased the need for wastewater reclamation including direct/indirect potable reuse. As drinking water is supplemented with water sources of lower quality, it becomes more imperative to effectively degrade and remove these critical contaminants. Therefore, cost-effective treatment technologies and a fully understanding of the fate and transformation of critical chemical contaminants are in urgent need to help address the increasing demand for clean water.

Among available advanced treatment technologies, advanced oxidation processes (AOPs), involving generation of very powerful oxidants (e.g. $^{\cdot}OH$ or $SO_4^{-\cdot}$) to achieve organics oxidation, are particularly attractive, as contaminants are permanently destroyed, not merely transferred to a brine or other phase for further treatment/disposal. Ozone-based AOPs has the advantages of simplicity, strong oxidation potential, and no toxic residual in the treated water. In particular, heterogeneous catalytic ozonation has been increasingly studied for degradation and mineralization of refractory organic pollutants in recent years. The main advantage of heterogeneous catalysts (usually metal/mixed metal oxides) is easily separated from the treated water, making the process economically viable. On the other hand, metal nanoparticles such as Cu, Ag, and Au show strong photo-adsorption of visible light due to surface plasmon resonance (SPR) and have been used as plasmonic photo-catalysts in the studies of water splitting and pollutants degradation. The overarching goal of this project is to design and prepare new ozonation catalysts possessing SPR to enhance the removal of refractory organics from contaminated water in catalytic

ozonation processes. The student will actively involve in catalyst preparation, characterization, laboratory reactor design and fabrication, and catalytic ozonation experiments.

Student Prerequisites:

Students should have good background in General Chemistry, knowledge of water/wastewater treatment is advantageous but not required. Typically students with a major in Civil and Environmental Engineering, Chemical and Materials Engineering, Chemistry should be able to carry out the research work. Previous research/lab experience is a clear benefit.

Student Duties:

Under the faculty advisor's supervision, the student is expected to understand the general challenges related to water we are facing now, common treatment and pollution control technologies especially ozone-based advanced oxidation processes. The student duties include: literature review to gain necessary background information supporting this research; development of catalyst synthesis protocol; performance evaluation through a series of laboratory experiments; data analysis and reporting. The student will learn how to review scientific papers, understand the water quality challenges, gain hands-on experience of standard water chemistry analysis as well as advanced instrument such as ion chromatography, spectrophotometer, HPLC, and obtain training on a set of techniques of materials synthesis.

Mentor Supervision and Interaction:

The undergraduate student will work closely with the faculty advisor and other students in the research group. A graduate student will help get the RCEU student started. The student is encouraged to see the faculty advisor for advice and suggestions whenever needed. One-to-one meeting with the advisor will be set up on a weekly basis, reviewing the progress, discussing any problems encountered, and developing future work plan. Group meetings will also be held bi-weekly, where the students will make oral presentations to the whole group on their research work. In addition to the weekly progress report (oral or written), the student is expected to involve in manuscripts preparation together with other group members for publication. Upon mutual satisfaction, the student may continue working in the PI's research group as a student specialist after summer 2019.