

## MATERIALS ENGINEERING

### SEMINAR

#### “Two-Dimensional Materials Applications for the Detection of Volatile Organic Compounds”

By

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Purdue MSE Preliminary Exam

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#### ABSTRACT

The unique morphology and physiochemical properties of nanomaterials provide great potential for high-performance electronics and sensors related applications. Among them, two-dimensional materials, with only a few-atom thickness, exhibit an especially high surface-to-volume ratio. This provides highly active surfaces for molecular adsorption, thus increasing sensitivity and lowering the response times when these materials are incorporated into sensing devices. Among two-dimensional materials, transition metal dichalcogenides (TMDs) have an inherently tunable band gap from metallic to semiconducting properties and high surface-to-volume ratio, which make them attractive for applications that aim at enhanced volatile organic compounds (VOCs) detection. Thus, molybdenum disulfide (MoS<sub>2</sub>) stands out as a promising material, with excellent electronic properties, environmental stability, and mechanical properties, which are dramatically different from the practical gas sensing performance of devices that are using graphene-based nanomaterials with zero band gap, or MXenes, which lack long-term stability. In addition, to mitigate the higher electrical resistance of MoS<sub>2</sub> and improve sensitivity of electrochemical sensors, composites of single-walled carbon nanotubes and MoS<sub>2</sub> can form a hybrid network with optimized synergetic properties: electrical conductivity, sensitivity, response time, and signal noise reduction. Recently, the detection of VOCs showed significant potential in environmental toxicological analysis, early diagnosis of diseases, detection of crop-relevant pathogens, and food quality control. Chemiresistive sensors, consisting of active electrodes comprised of printed 2-D nanomaterials, have been reported for VOC detection and showed high sensitivity, the ability to operate at room temperature, portability, and low cost. Herein, a fully roll-to-roll manufactured chemiresistive VOCs sensing platform, composed of MoS<sub>2</sub>-SCNT hybrid nanomaterials deposited on flexible silver screen-printed electrodes opens up opportunities for increased reproducibility, low cost, and simple procedures for scalable production when compared to manual sensor fabrication.

**Date:** Monday, November 28<sup>th</sup>, 2022

**Time:** 10:00am

**Place:** ARMS 3109 or via WebEx <https://purdue.webex.com/meet/lstanciu>