Department of Chemical Engineering
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Ms. Aakanksha Jain (19102261) will deliver her Open Seminar as per the following schedule:

Date: **January 24, 2025**
Time: **9 AM**
Venue: **SCDT Seminar Room (105 SCDT)**

The details are as follows -

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Title: **Flexible Polyaniline-Based Gas Sensors: Fabrication and Evaluation for Environmental and Food-quality Monitoring**

Abstract:
Gas sensors are crucial for applications in healthcare, agriculture, food packaging, industrial safety, and automotive systems, where effective performance demands high sensitivity, fast response, stability, and selectivity. However, commercial metal oxide sensors, though highly effective, operate at elevated temperatures (~300-400°C), leading to safety risks, high power consumption, and incompatibility with flexible substrates like PET, fabric, and paper. This emphasizes the need for room-temperature sensing materials. Conducting polymers such aspolyaniline (PANI) can operate at room temperature but often face performance limitations. This challenge has been addressed by developing PANI-based composites for flexible, room-temperature gas sensors with improved performance and lower power consumption.

In the first study, a flexible PANI-metal oxide composite sensor was developed for NH3 detection at room temperature. The sensor showed a response of 9.88% against 2 ppm of NH3 at room-temperature within 10 seconds. Electrochemical Impedance Spectroscopy (EIS) provided detailed insights into the sensing mechanism, revealing contributions from bulk resistance, the grain boundary depletion region, and the electrode-film interface. The sensor response was further tested under varying temperatures and humidity, and its flexibility and durability were validated through 100 bending cycles, demonstrating mechanical robustness.

The second work delves into the development of a flexible, room-temperature NH3 sensor using a PANI/2D material composite, fabricated on a polyethylene terephthalate (PET) substrate. The sensor showed an 11% improvement in response to 10 ppm NH3 compared to pristine PANI, with a detection limit of 122 ppb and a response of 2.9%. The influence of composite morphology on sensing performance was examined, with key metrics such as sensor response, response time, limit of detection, and selectivity studied in detail. Further investigations included EIS, Bader charge analysis, and adsorption studies for a better understanding of the sensing mechanism. The sensor demonstrated stability under mechanical stress and varying humidity, confirming its suitability for wearable applications, with a working prototype developed for real-time NH3 monitoring.

In the third study, the developed gas sensor was applied for fish quality monitoring to ensure food safety and minimize spoilage-related economic losses. By detecting volatile gases from raw fish

species, the sensor-enabled real-time freshness assessment at room temperature. Both marine and freshwater species were tested, with spoilage patterns validated using traditional methods like Total Viable Count (TVC) and Total Volatile Base Nitrogen (TVB-N). Further, the experimental results were explained by the adsorption studies. The sensor thus provided rapid, non-invasive detection of spoilage, with a validated working prototype.

The fourth study relates to the development of a flexible gas sensor array to overcome the limitations of single-sensor detection. The array, fabricated on a flexible substrate, detected gases like NH_3, NO_2, CO_2, H_2S, acetone, and ethanol with varying sensitivity. Principal Component Analysis (PCA) was used to distinguish gases based on sensor response profiles. Each sensor in the array demonstrated mechanical stability, and the sensor array was further printed onto fabric, making it suitable for wearable applications such as armbands for real-time environmental monitoring.

The fifth study presents a PANI/Metal-Organic Framework (MOF) composite sensor engineered for VOC detection under ambient conditions. The composite exhibited superior crystallinity and thermal stability, enhancing its suitability for gas sensing applications. The formation of a p-n heterojunction and the enhanced surface area facilitated by MOF integration, significantly enhanced the sensing performance, ensuring high sensitivity.

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All interested are invited to attend.