Indian Institute of Technology Delhi

School of Interdisciplinary Research (SIRe)

SIRe Project Number

2024-01-25

(will be assigned by SIRe)

Project Proposal for Ph.D.

Project Details	
Project Title	Raman-based Gas Sensors for Breath Diagnosis
Project Summary (Minimum 500 and maximum 2000 characters)	Nitrogen dioxide (NOx) is an irritant gas that, at high concentrations, causes inflammation of the airways. Nitrogen Oxide consists of NO, N_2O, N_2O_2, N_2O_3, N_2O_4, etc. 630 million children under five are exposed to dangerously polluted air. However, many studies have shown the most vital link between Nitrogen dioxide concentration and the respiratory system. Chemiresistive gas sensors have a simple structure, and their operating principle is that their electrical conductivity can change by the presence or absence of some chemical species that come in contact with the device. Fully integrated chemiresistive gas sensors are a critical technological development for advancing the portability and performance of breath analysis devices. These sensors have a lower limit of detection (LOD) in parts-per-billion concentrations than most reducing or oxidizing analytes. They can be miniaturized and integrated with gas microsensors at low cost. During the past decade, innovation and efforts of material scientists have led to the development of a wide variety of two-dimensional with unprecedentedly promising properties. Nevertheless, 2D materials that feature order layered structure, ultra-lightweight, stronger in-plane chemical bonds, and outer plane surfaces allow unique properties like tuning electronic and surface properties, large surface area, and dense active metal sites of those materials. Recently, MXenes (transition-metal carbide and nitride layer materials) are a new family of two-dimensional (2D) materials analogous to graphene. Furthermore, their unique properties like hydrophilic surface, electrical conductivity, high ion adsorption capacity, and high density coordinatively unsaturated sites make them promising candidates for energy storage and conversion. However, these MXene materials lack practical surface area for energy and environmental applications, which are still moderate or low. Thus, they need to be extraordinarily improved to satisfy the requirements of practical applications. It is highly desirable to increase spacing between the Mxene sheets and generate interesting properties. From this perspective, the coupling with Mxnes with various functional organic linkers by covalent and noncovalent approaches is regarded as a feasible route for efficient activity improvement of MXene-based for environmental applications In this proposal, we try to use two-dimensional porous materials for FeNO detection to forecast asthma. The proposed sensor can detect levels of NO in the breath as low as 50 parts per billion (50 ppb).The developed prototype will undergo testing directly in clinical settings and these trials will validate the product's commercial potential for widescale deployment and usage.

Ph.D. Supervisors

Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Soumik Siddhanta	Chemistry, IIT Delhi	soumik@chemistry.iitd.ac.in
Supervisor 2	Jayaramulu Kolleboyina	Indian Institute of Technology Jammu	Jayaramulu.kolleboyina@iitjammu.ac.in

Project requirements (Student qualifications, experience required, etc)
***The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)**

- M Tech/ MSc in Chemistry/ Analytical Chemistry/ Biochemistry/Biomedical engineering (Prior experience in spectroscopy/optical instrumentation or machine learning will be appreciated)
- Other criteria as per the SIRe requirements

Source of fellowship/funding (CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)
Candidate with his/her own fellowship /institute assistantship

Role of Faculty Members involved:	
Supervisor-1	Dr. Siddhanta's research has led to multiple collaborative projects on biomedical and pharmaceutical applications of fluorescence, Raman, surface-enhanced Raman spectroscopy and other analytical techniques. Dr. Siddhanta's lab will develop the spectroscopic techniques for implementation in the sensors.
Supervisor-2	Dr. Jayaramulu's lab will be involved in the development and fabrication of sensors for gas detection.