**Title**: Nano-structure Based Optical Sensors Fabrication and Demonstration to Gas Sensing Applications

**Abstract**: The continuous demand for precise detection and discrimination of large classes of bio as well as gas molecules has led to the development of more sophisticated and reliable sensing devices. To meet this demand, novel photonic devices functionalized with specific materials are being exploited. Such photonic devices utilize a variety of nanostructures for effective detection and discrimination of molecules, such as plasmonics, photonic crystals, surface enhanced Raman scattering, meta-surfaces. Moreover, lab-on-a-chip platform has been realized by combining miniaturized optical sensors with microfluidics. Thus, researchers are encouraged to combine the nanophotonic sensors with an analyte recognition coating on a conventional or non-conventional fiber-optic platform, aimed at developing high-performance miniaturized sensors operating at visible to infrared region of electromagnetic spectrum. We present a different perspective of novel nano-resonant structures (nanoposts, nanoholes etc.) fabricated on either bulk substrate or micron size tip of optical fiber and one graphene oxide coated glass substrate for gas detection in visible or mid-infrared region of electromagnetic spectrum. Nanostructures provide an efficient way to control and manipulate light at nanoscale paving the way for the development of reliable, sensitive, selective and miniaturized gas sensing technologies. Moreover, the inherent light guiding property of optical fiber over long distances, their microscopic cross-section, their efficient integration capabilities with gas absorption coatings and mechanical flexibility make them suitable for remote sensing applications. The three nanostructure-based gas sensing techniques are based on the detection of surface plasmon resonance (SPR) wavelength shifts, guided mode resonance (GMR) wavelength shifts, and Rayleigh anomaly (RA) mode intensity variations. The SPR and GMR based sensors operate in the visible region of light spectrum. Later, we also integrate a heater with the GMR-based fiber-tip sensor to realize a reusable gas sensor having tunable sensor recovery time. The RA-based sensor is realized by solvent-casting of chalcogenide glass to work as mid-infrared optical resonator. Further, we utilize the dynamic variations in infrared values of graphene oxide in response to gas to realize a gas sensor.