A Comparative Study on Polarization Independent Broadband Germanium on Insulator (Ge-OI) Tapered Structure with Slot Waveguide for Multianalyte Sensing

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Abstract:

Group-IV photonics has gained a lot of interest in recent years due to its CMOS compatibility. Silicon on Insulator (S-OI) has dominated the optical and optoelectronics field for decades. On the other hand, the Germanium-based platform, Ge-OI, is another promising candidate for the abovementioned field. It has wide application in Mid Infrared Sensing due to its abundance, transparency, and high index contrast ($\Delta n = 2.6$ at 3 µm) with reference to silicon on insulator. To take advantage of the wide transparency of Germanium in the Mid Infrared applications like chemical sensing, where most hazardous chemical molecules have their fingerprints, we have designed a compact adiabatic tapered waveguide sensor structure based on evanescent wave coupling, which will be able to sense more than six analytes (Carbon dioxide (CO2), Nitrous oxide (N2O), Nitrogen dioxide (NO2), Nitric oxide (NO), Ammonia (NH3), Ethylene(C2H4), Acetylene (C2H2), Hydrogen Cyanide (HCN), and Methane (CH4) has absorption peaks between 2.5 to 3.5 µm. The proposed device provides a suitable method for label-free detection of target molecules. It can be integrated on-chip for industrial and environmental monitoring, health analysis, and food processing which can be leveraged over hefty conventional spectrometers like Fourier Transform Infrared Spectroscopy (FTIR). In this work, we have done a comparative coupling analysis of taper structure with a standard slot waveguide. The improvement due to phase matching in the taper structure can be visible in the field available for sensing application. Single mode slot waveguide, while designed for a wideband of 1 µm, showed a feeble TM field for wavelength beyond 3 µm, while taper can support both TE and TM modes throughout the band. The slot waveguide is gap dependent for the TM mode, while the taper structure supports both modes for different gap values(50 µm,90 µm,140 µm,190 µm). We have also analyzed three different taper lengths (30 µm, 40 µm, and 50 µm) by varying etch depth and reported an optimum taper length of 40 µm for the proposed geometry, having transmission of more than 80 % for both fundamental Transverse Electric (TE) and Transverse Magnetic (TM) mode making it polarization insensitive.

Biography:

Krishna Kant Rana is a post-graduate student at the National Institute of Technology Warangal in the Department of Physics after completing his Bachelors of Science (B.Sc.) from St. Xavier's College Ranchi. His primary research interests are the photonic integrated circuit for communication and sensing applications. In his free time, he reads novels of different genres and explores the city for diverse cuisine and instances of public art.