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Investigation on optical integration between LED mid-IR light sources and Si-based waveguide for spectroscopic sensing applications

Research on photonic integration using Silicon-based micron-scale optical waveguide for the development of spectroscopic sensing systems for portable and on-field usage has recently received great attention for several applications with the Mid-infrared (Mid-IR) regions [1, 2]. Nevertheless, all most of the previously-reported works are based on laser-based light sources, which might prevent the employment of integrated photonic technologies with low-power consumption and at reasonable cost [3]. For example, in agricultural usage such as precision farming, multi-gas, low-cost, and low-power spectroscopic sensing will be mandatorily required, and light emitting diode (LED)-based solutions should be one of the most viable potential options [4].
In this contribution, we will address one of the most crucial issues in using LED light source for spectroscopic sensing in photonic integrated circuits, which is how to achieve efficient optical coupling between a broadband low-cost LED mid-infrared light source and micro-scale optical waveguide. Simulation methods that can properly investigate optical effects from the macroscale optics (broadband LED light source) to the micro/nanoscale optics (optical waveguide) will be employed. Optical simulations based on Eigen Mode Expansion (EME) and FDTD methods will be used to obtain approximate and optimized parameters, respectively. The sensitivity of the optical sensors will be evaluated with respected to the required optical power at the optical sources, the lowest detectable optical power at the photodetectors, and all the possible optical loss within the photonic links. The ability to efficiently coupled light from a broadband low-power and low-cost LED light source into a micron-scale waveguide is presented, which could be beneficial for a wide range of application that is cost-sensitive.

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[3] L. Tombez et al., Optica 4 (11), 1322-1325 (2017)

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