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Technology for III-V-Based Integrated Optical Sensors

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The application of III-V technology and GaAs-based optoelectronic devices to the fabrication of both monolithically and hybridly integrated optical sensors is discussed. The fabrication of mutually compatible lasers, waveguides, modulators and detectors in the GaAs/AlGaAs material system is outlined. The monolithic integration of these optoelectronic components into a passive Mach-Zehnder interferometer sensor platform is addressed, as well as the issues of sensor layer design, hybridization and potential sensor performance.

1. Introduction

The use of silicon as a semiconductor sensor technology has a distinguished history,[1] with many advances for sensor applications taking advantage of the reduction in cost and concomitant increase in functionality which accompanies increased integration and the maturing of technologies.[2] At the same time, optical sensing techniques, primarily in the form of fiber sensors,[3] have reached an advanced state of development and application. The fusion of the two, semiconductors and optics, is now opening new opportunities in the field of integrated optical sensors as a result of improvements in performance, reliability and robustness of optical sensor systems.

III-V-based semiconductor technology, due to the direct band gap of the materials and the ability to fabricate heterostructures, has an edge on other material systems in that both light-emitting (lasers) and optically passive (waveguides, detectors, modulators) optoelectronic devices may be fabricated. For that reason, III-V semiconductors are being rapidly developed for photonic integrated circuits,[4] implying that the integration of lasers,[5]