Monolithically integrated terahertz optoelectronics (Invited Talk)

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Abstract

Terahertz waves offer groundbreaking potential in various fields, including healthcare monitoring, biomedical imaging, precision navigation, high-speed communication, security screening, industrial quality control, and space exploration. However, the widespread adoption of terahertz technology has been limited by the bulky, complex, and costly nature of existing systems. Here, we present a Monolithically Integrated Terahertz Optoelectronics (MITO) platform, which leverages quantum well (QW) structures to integrate all terahertz photonic system components onto a single chip for the first time. Utilizing photomixing in QW PIN photodiodes, we demonstrate frequency-tunable terahertz generation and detection with significantly improved power efficiency and sensitivity compared to previous devices. By integrating semiconductor optical amplifiers, lasers, modulators, filters, demultiplexers, and other passive optical components with photomixers using commercially available photonic integrated circuit foundry processes, the MITO platform supports the development of compact, scalable terahertz systems capable of high-speed data transfer, spectroscopy, and hyperspectral imaging. This advancement positions terahertz technology for widespread use, facilitating practical applications across remote sensing, communications, and medical diagnostics within portable devices.