Heterogeneous GaSb/SOI mid-infrared photonic integrated circuit for spectroscopic applications

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Abstract (250 words)
Mid-infrared spectroscopy has gained significant importance in recent years as a detection technique for materials whose absorption spectra appear in this spectral region. Traditionally, spectroscopic system consists of bulky equipments which are difficult to handle and incur high cost. An integrated spectroscopic system, on the other hand, eliminates all these disadvantages. The development of GaSb-based active devices offer improved mid-infrared light sources and detectors for such integrated systems. Silicon photonics, based on Silicon-on-Insulator (SOI) waveguide circuits, on the other hand, is a well established technology based on high refractive index contrast waveguides, enabling ultra-compact passive integrated photonic circuits. Moreover, SOI processing is compatible with CMOS processes. Hence, integration of GaSb active devices onto SOI passive waveguide circuits would potentially allow highly compact spectroscopic systems with flexibility in passive devices design to improve the system performance. This approach has great potential for several applications, e.g. an implantable glucose sensor and gas sensing devices.
In this paper, we report our work on the integration of GaSb-based epitaxy and SOI waveguide circuits. The realization of heterogeneous integration is based on a bonding process using the polymer divinylsiloxane-benzocyclobutene (DVS-BCB) as a bonding agent. The bonding process is performed by transferring the epitaxial layer to an SOI wafer through a die-to-wafer bonding process. With this approach, a bonding layer of 150 nm thickness is achievable. We also report our results on the integration of waveguide-based GaSb p-i-n photodetectors coupled to SOI waveguide circuits based on evanescent coupling, which show a responsivity higher than 0.4A/W. The design of active and passive structures and the overall fabrication process will also be discussed.

Summary (100 words)
We report our work on the integration of GaSb-based epitaxy on Silicon-on-insulator (SOI) waveguide circuit based on a die-to-wafer bonding technology with DVS-BCB used as bonding agent. We demonstrate the integration of GaSb-based photodetectors on SOI waveguide circuits (responsivity >0.4A/W). The device is designed based on an evanescent coupling approach, in which light is coupled from the SOI waveguide to the absorbing GaSb-based layer when phase matching occurs. We also show that with our bonding approach, ~150 nm bonding thickness is easily achievable.

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