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Variation of the Ion Beam for Si Photonics

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The optical equivalent of silicon (Si) nanoelectronics is silicon (Si) photonics. To accomplish high-level optoelectronic component integration on silicon using Si nanoelectronics, Si photonic research uses process technologies that are compatible with conventional integrated circuit fabrication techniques. When it comes to performance, power consumption, and cost, silicon photonics has a lot to offer. These factors are becoming more and more significant as the need for computing power and internet bandwidth increases. The lack of optically active components including optical emitters, modulators, detectors, and switches is one of the fundamental drawbacks of Si-based optical circuits. For semiconductor doping and the creation of SOI substrates from normal silicon, ion implanters have been common fabrication tools in the semiconductor industry and are still regarded as a key infrastructure in semiconductor manufacturing.

In Si photonics, integrated III-Vs, defect-mediated detection, and epitaxially grown Ge have all been investigated as potential detectors. Like the integration of light sources, which still present numerous difficulties for CMOS processing, III-V materials can be integrated either through wafer bonding or direct growth. By implanting an inert element like Si, which results in the production of mid-gap states in the band structure, defects are produced in the silicon lattice to enable defect-mediated detection. While these detectors require a big footprint and have lower detection sensitivity than Ge and III-V, they are compatible with CMOS processing. The lattice mismatch between Si and Ge is the cause of the current performance issues.

In the past, Si and Ge nanostructures have been created using a variety of experimental techniques. Several solid-state techniques are available, including Plasma-Enhanced Chemical Vapour Deposition (PECVD), co-sputtering, Molecular Beam Epitaxy (MBE), ion implantation, and porous silicon, if we concentrate on structures with dimensions comparable to the Bohr radius and the 3-dimensional (3D) confinement case (quantum dots). A material must have a band gap big enough for quantum confinement and permittivity that permits a variation in the refractive index for photonic circuits to be considered a host material. These requirements are met by Al_2O_3, and it also has the benefit of being optically transparent, which would make transparent devices easier to make. Si-QDs in Al_2O_3 have a limited publication history because researchers have had trouble producing Si-QDs in these materials.

For the fabrication of new materials for Si photonic systems, ion beam modification techniques are useful tools. Here, reviewed several innovative materials made for light emitters and detectors using ion implantation. Si quantum dots (QDs) can be created via ion implantation and high-temperature annealing in the matrices SiO_2, Si_3Nx, and Al_2O_3. Briefly, increased diffusion can improve the creation of Si quantum dots in a disordered matrix. Future optoelectronic devices can investigate situations where bright emission flaws dominate luminous lifetimes. In the second case study, ion implantation was used to create Si-Ge-Sn alloys, which had strong SWIR absorption coefficients and low light penetration depths.

JOURNAL REFERENCE

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KEYWORDS

Si photonics, ion beam implantation, quantum dots, short-wave infrared detectors