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Composition and optical properties of ion beam fabricated SiGeSn layers in Si (001)
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Abstract

SiGeSn compounds, a unique class of semiconductors with the ability to engineer both the lattice parameter and band structure, have been investigated for their potential in monolithic integration of electronic and photonic devices. These materials have demonstrated potential in diverse applications, including lasing, thin-film waveguide fabrication, high electron mobility transistors, and fully depleted-MOSFETs. The study focused on the optical and electronic properties of a 200-400nm SiGeSn layer in a Si (001) substrate. Various characterisation techniques, including Spectroscopic Ellipsometry (SE), Channeling Rutherford Backscattering Spectroscopy (c-RBS), Positron Annihilation Spectroscopy (PAS), and Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Analysis (EDX), were employed. The RBS elemental depth distribution of SiGeSn was characterised, revealing successful implantation of Ge and Sn to their intended doses 5-80nm below the surface, as well as different Ge and Sn distributions at various annealing temperatures and times. SE modelling, based on RBS compositional data, was conducted to investigate observed Ψ, Δ plot features. The models, indicated an average implanted volume thickness of ~63nm, and increase near-IR absorption properties as compared to crystalline Si. Growth defects were identified and quantified via c-RBS. The data showed increased substitutionality of Ge and Sn in annealed samples. This research underscores the promise of SiGeSn alloys in cost-effective and CMOS-compatible optoelectronic devices.

Keyword-1

Optoelectronic

Keyword-2

Photonic

Keyword-3

Semiconductor

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