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Silicon nitride waveguide-integrated Ge/SiGe quantum wells optical modulator

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Silicon-based photonics has generated a strong interest in recent years, mainly for optical telecommunications and optical interconnects in integrated circuits. The main rationales of silicon photonics are the reduction of photonic system costs and the increase of the number of functionalities on the same chip combining photonics and electronics. Waveguide-integrated silicon based-optoelectronic modulators have been particularly studied as a key building block for silicon photonics. In term of active devices, Ge-rich Ge/SiGe quantum well (QW) waveguides are promising for compact and low power consumption electro-absorption modulators, thanks to the demonstration of direct gap related optical transitions in these structures. For passive functionalities, silicon nitride (SiN) waveguide could be studied as a promising alternative to Si waveguide for future dense wavelength division multiplexing (WDM) system. The refractive index of SiN is low enough to provide good fabrication tolerance and compact photonic circuit. Moreover, SiN thermo-optical coefficient and two photon absorption are much less significant than those of Si. Previous works focused on integration of such passive SiN component with active Germanium (Ge) optoelectronic components such as Ge photodetector through Si waveguides on SOI wafer. This paper studies a new integration approach between passive SiN waveguide and Ge/SiGe multiple quantum wells (MQWs) optoelectronic modulators. Photocurrent measurements at different bias voltages demonstrated strong optical modulation within the O-band telecommunication wavelength (1.26 –1.36 μm) from Ge/SiGe MQWs, while 3D-FDTD calculations confirm a compact and efficient integration with SiN waveguide using butt coupling approach on Si wafer.

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