Group IV functionalization of low index waveguides

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Low fabrication error sensitivity, integration density, channel scalability, low switching energy and low insertion loss are the major prerequisites for future on-chip WDM systems and interfacing with optical fibres. A number of device geometries have already been demonstrated that fulfil these criteria, at least in part, but combining all of the requirements is still a difficult challenge.

Two contenders that could fulfil these criteria are the low loss nitride waveguiding platform and the high index group IV compounds for active photonic devices.

Silicon Oxynitride (SiON) and Silicon Nitride (SiN) based waveguides are extremely powerful and central to today's optical communications networks. The intermediate refractive index provides low footprint devices but eases the fabrication demands that can result in phase errors and repeatability problems in the all silicon approach. This enables multiplexors and demultiplexors with very low crosstalk and insertion loss and extremely low loss long range waveguides, making them very attractive for the optical backplanes and rack to rack links inside supercomputers and data centers. Group IV Photonics GeSi has a number of attractive optical characteristics for modulation, absorption and detection in a small volume area enabling low power and high density integration.

Here, we propose and demonstrate a novel architecture consisting of the interfacing of a range of deposition method using low temperature PECVD and HWCVD nitride waveguides, Photonic crystal modulators [1] but also detectors [2] connected by a silicon nitride bus waveguide. The architecture features very high scalability due to the small size of the devices (~100 micrometre square) and the modulators operate with an AC energy consumption of less than 1fJ/bit.

1. Debnath, K., et al., *Cascaded modulator architecture for WDM applications.* Opt. Express, 2012. **20**(25): p. 27420-27428.
2. Debnath, K., et al., *Dielectric waveguide vertically coupled to all-silicon photodiodes operating at telecommunication wavelengths.* Applied Physics Letters, 2013. **102**(17)