Investigation of Silicon Photonics pn junctions for fast Electro-Optical Switching

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With the rapidly increasing aggregate bandwidth requirements in Data Centers (DCs) there is a demand to route the data at all hierarchy levels without optical-electrical-optical conversions. This task can be accomplished with high-radix, transparent and broadband optical switch fabrics based on the Silicon Photonics technology (SiP). Switching in SiP is achieved through the modulation from an external electrical control signal, of the electron plasma in a Si pn junction that forms a waveguide. The accumulated phase change induced from the carrier plasma in the propagating optical wave dictates if there will be constructive or destructive interference at the output port of an interferometric device and accordingly defines the switch's state. The junction is operated in a forward or reverse biasing with the injection or depletion of carriers. The injection scheme offers the advantage of lower losses at the expense of lower speed coming from the ns rate recombination rate of the carriers. Carrier Depletion switches on the other hand can operate with timing constants in the ps regime that is highly advantageous for fast reconfiguration of the DC network.

In this work we are presenting a model that verifies the experimental data recorded from a recently fabricated Mach Zehnder Interferometer (MZI) in the frames of the EU FP7 project PhoxTrot. The MZI employspnjuctions as phase shifters on both arms and is characterized in static conditions in depletion mode. The model fits very well the I-V curve, the propagation losses and the phase shift vs. applied voltage of the device. Further investigation reveals that optimization of the losses is possible with the right modification of the junction's p and n regions implantations.