Pockels Effect in Strained Silicon Waveguides

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With the increasing demand of data current chip-scale communication systems based on metallic interconnects suffer from rate limitations and power consumptions. In this context, Silicon Photonics has emerged as an alternative solution replacing the classical copper interconnects by silicon waveguides while taking advantage of the well-established CMOS foundries techniques to reduce fabrication costs. Silicon is now considered as an excellent candidate for the development of integrated optical functionalities.

Among all photonic devices required for an optical link, optical modulator is one of the main building blocks. One of the main challenges of Silicon Photonics is the reduction of both power consumption and swing voltage of optical silicon modulators while increasing the data transfer rate speed. However silicon is a centrosymmetric crystal, vanishing the second order nonlinear effect i.e. Pockels effect which is intrinsically high speed.

Nevertheless it has been showed [1] that mechanical stresses, provided by depositing a strained overlayer, can break the crystal symmetry and eventually unlock Pockels effect in silicon. Since then several studies have been performed [2-4] in order to improve the later. But a recent investigation [5] demonstrated that carrier effects have a drastic influence on the measured electro-optic effect. Indeed both plasma dispersion effect and Pockels effect act together under an electric field in strained silicon which have led to an overestimation of the second order nonlinear susceptibility. One way to separate these effects consists in the increasing of the modulation speed [6] in order to minimize the impact of free carriers.

In this work, we have studied the effect of the stress layer in the modulation characteristics based on Mach-Zehnder interferometers (Fig. 1) in the microwave range. DC and high speed characteristics (Fig. 2) will be presented and discussed.

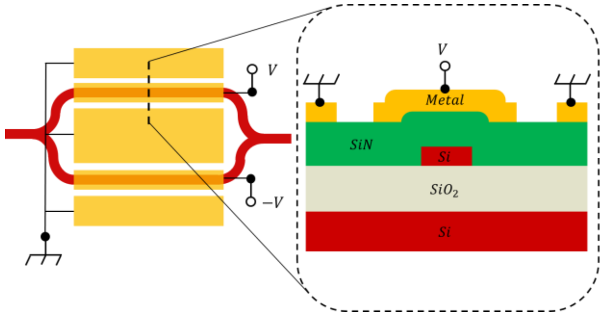

Fig. 1. Top view (on the left) of one Mach-Zehnder modulator. Cross-section view (on the right) of one arm of our Mach-Zehnder interferometer.

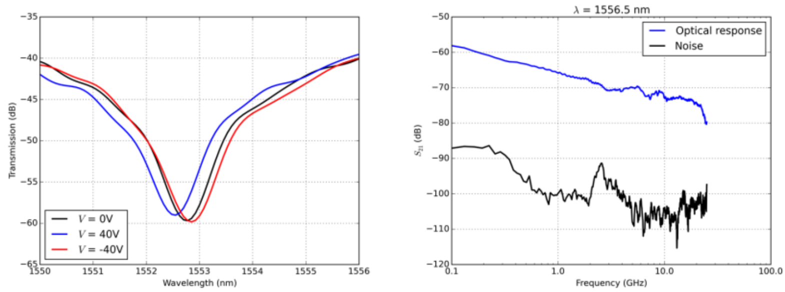

Fig. 2. DC characteristics (on the left) and high speed characteristic (on the right) of our Mach-Zehnder interferometer.

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