**ABSTRACT**

Recently there has been increasing interest in plasmonics for manipulating light at deep subwavelength scale below the diffraction limit which is useful for advancement of next generation of photonic integrated circuits (PICs). This thesis presents design and analysis guideline for compact and high speed optical modulators using electro-optic polymer-assisted hybrid plasmonic /silicon photonic technologies. Two types of modulators are addressed here for optical communication systems, binary ring modulator and 16-QAM Mach-Zehnder modulator (MZM). The theoretical predictions are supported by simulation results obtained using COMSOL 4.3b and Optisystem 12 software packages. The first part of the thesis presents analysis and investigation of 1550 nm and 1310 nm ring optical modulators employing an electro-optic polymer infiltrated silicon-plasmonic hybrid phase shifter. A theoretical modeling framework and performance assessment of this modulator is introduced. Analytical expressions are derived to characterize the coupling effect in the hybrid phase shifter, transmission function of the modulator, and modulator performance parameters for different phase shifter slot widths. The performance of intensity modulation/direct detection of short range and long range optical communication systems incorporating the designed modulator is simulated for 40 and 100 Gbs⁄ data rates for 50 nm slot width. The results reveal that an average energy per bit as low as 0.05 fJ can be obtained when the 1550 nm modulator is designed with a phase shifter of length equal to twice the coupling length. This result is about half that reported in the literature for a similar structure configuration. Extinction ratio higher than 40 dB was obtained at 1 V applied voltage for both 1550 nm and 1310 nm modulators. With 1310 nm modulator, longer transmission distances could be achieved at BER=10−9 compared with 1550 nm modulator.

**II**

The second part of the thesis presents the design and investigation of

1550 nm 16-QAM optical modulator based on plasmonic-polymer hybrid slot

waveguides. The design is CMOS-compatible and uses dual-parallel Mach-

Zehnder modulator (DPMZM) followed by a phase modulator (PM). Careful

consideration is given to design of low loss photonic-plasmonic interfaces to

ensure efficient coupling between silicon and plasmonic waveguide. The effect

of slot widths on device performance is investigated using software simulation

along with theoretical analysis for both gold and silver contact. The plasmonic

modulators designed are characterized by very small footprint and voltagelength

product when compared with other nonplasmonic and plasmonic

modulators reported in the literature. For a 25 nm polymer slot width, a device

footprint of 25 m and a voltage-length product of 0.02 V. mm is obtained.