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Hybrid plasmonic electro-optical ring resonator based modulator based on electrically tuning the ITO's properties

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This work presents the study and the design of optical ring modulator based on silicon-on-insulator ring resonator topped with silicon dioxide. The input and the output waveguides are separated from the ring resonator by a hybrid plasmonic waveguides in the coupling regions. The power-splitting mechanism is applying the external electric field to the hybrid plasmonic waveguides. The tuning mechanism takes the advantage of changing the refractive index of the modes and attenuating the power. The proposed ring modulator designed to operate under the telecommunication wavelength (1550 nm). A finite difference time domain method with perfect matching layer (PML) absorbing boundary condition is taken up to simulate and analyze the ring modulator. The main operations in digital signal processing are modulation and switching. The growing demand for high capacity signal processing systems made the assimilation of photonic circuitries into electronic circuitries. Optical signal processing systems and components concerned a lot of research. Optical ring resonators are among the fundamental components in optical systems since they can be used as modulators, filters, and sensors. Integrating indium-tin-oxide (ITO) with silicon electro-optic modulator has received enormous attention in the past few years because it's electrically-induced epsilon-near-zero (ENZ) characteristics. The proposed modulator is based on silicon-on-insulator ring resonator topped with silicon dioxide. The input waveguide and the ring resonator are separated by a hybrid plasmonic waveguide in the coupling region, the same with the ring resonator and the output waveguide. The operation principle of this device is based on coupling the power from input waveguide to the ring resonator to the output waveguide. Tuning the optical power at the output waveguide is through applying electric field to the hybrid plasmonic waveguides, the generated carrier at the ITO layer results in changing the refractive indices of the even and odd modes of the input waveguide and the ring resonator. Moreover, it attenuates the coupling power to the ring resonator.

Biography

M A Swillam is Received his Ph. D from McMaster University, Hamilton, Canada in 2008. After graduation he worked as post-doctoral fellow in the same group. In October 2009, he joined the photonic group and the institute of optical sciences at the University of Toronto where he works as a research fellow. In September 2011, he was appointed as an assistant professor at the Department of Physics, the American university in Cairo (AUC). He is now an associate professor at the Department of physics at AUC, His research interests include design optimization and fabrication of active and passive nanophotonic and plasmonic devices and systems, silicon photonics, optical interconnects, integrated on- chip optical systems, lab on chip, nano-antenna, metamaterials, and solar cells. The main applications include biomedical systems, energy harvesting, and telecommunications. He authored more than 200 technical papers in highly ranked journals and conferences. He also hold 2 patents, a book, and book chapter in these areas.

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