INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

The ever increasing data traffic due to technological advancements as well as increase in the number of users has ignited tremendous interest in the research and development of high performing computing systems. However, the performance increase is limited by the usage of electrical interconnects, as it suffers from high power dissipation and propagation delay. To overcome these issues optical interconnect has emerged as a viable solution owing to its low power consumption and potential for link capacity improvement by employing various multiplexing techniques such as wavelength division multiplexing (WDM), polarization division multiplexing (PDM), and mode-division multiplexing (MDM). Silicon photonics platform has attracted a lot of attention as it has enabled monolithic integration of photonics and microelectronics due to its compatibility with the standard complementary metal oxide semiconductor technology. Considering the demands of high-link capacity in the future, research is in progress to combine multiple multiplexing schemes to realize a multi-dimensional hybrid multiplexing technology. This thesis explores the design of such hybrid (de)multiplexers, which are based on the contra-directional coupling principle using periodic grating structures. To the best of our knowledge, for the first time, a grating assisted collaterally contra-directional coupled TE and TM MDMs are introduced using silicon slab waveguides. Then by cascading the TE and TM MDMs, a hybrid MDM-PDM device has been reported on silicon-on-insulator platform. The theory of supermodes has been utilized to determine a suitable gap between the waveguides such that contra-directional coupling occurs with low reflection at the input. Mathematical models of the proposed devices are presented with coupled-mode equations and their solutions. A hybrid MDM-WDM device is demonstrated using the buried strip waveguides and silicon grating structures by integrating the wavelength and mode division multiplexing schemes. To further increase the link capacity, PDM is combined with the MDM-WDM structure to realize a hybrid MDM-PDM-WDM device. The devices are designed and analyzed using the numerical finite-difference time-domain method.