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光学精密工程 2012, 20(12) 2626-2632 ISSN: 1004-924X CN: 22-1198/TH

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现代应用光学

基于自准直效应的硅基光子晶体 $1 \times 4$ 光复用器

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摘要: 利用光子晶体的自准直效应进行光束的控制, 实现了基于自准直效应的二维光子晶体 $1 \times 4$ 光复用器(OMUX)。在结构中放置两个腔长不同的马赫-曾德干涉仪, 利用光束干涉原理推导出光复用器各个出口的透射谱理论公式, 然后利用时域有限差分软件对其进行数值模拟。结果显示: 模拟结果与理论分析一致, 实现了 $1 \times 4$ 光复用器的功能。当工作波长为 $1\ 550\ \text{nm}$ 时, OMUX的自由光谱区为 $34.1\ \text{nm}$ , 覆盖了整个光通信C波段。由于结构大小只有 $40 \sim 35\ \mu\text{m}$ , 并且有较高的输出功率, 该光复用器在光集成电路中有潜在的应用价值。

关键词: 光子晶体 自准直 马赫-曾德干涉仪 光复用器

$1 \times 4$  optical multiplexer based on self-collimation effect in silicon photonic crystals

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Abstract: An  $1 \times 4$  Optical Multiplexer (OMUX) based on the self-collimation effect of a two-dimensional photonic crystal was proposed and its performance was numerically demonstrated. Two Mach-Zehnder Interferometers (MZIs) with different cavity lengths were placed in the structure. Firstly, the theoretical transmission spectra at different output ports of the cascaded MZI were analyzed with the theory of light interference, then they were investigated with the Finite-difference Time-domain (FDTD) simulation technique. The simulation results agree well with the theoretical prediction, so the cascaded Mach-Zehnder interferometer can work as a  $1 \times 4$  optical multiplexer. When the wavelength is  $1\ 550\ \text{nm}$ , the free spectral range of the OMUX is about  $34.1\ \text{nm}$ , which almost covers the whole optical communication C-band window. The presented device shows a compact size within  $40\text{-}35\ \mu\text{m}$  and a high output efficiency, and has potential application values to photonic integrated circuits.

Keywords: photonic crystal self-collimation Mach-Zehnder interferometer optical multiplexer

收稿日期 2012-10-19 修回日期 2012-11-02 网络版发布日期

基金项目:

福建省自然科学基金资助项目(No.2011J01017)

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