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Terahertz filter and demultiplexer with photonic crystal waveguide

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Abstract

Terahertz (THz) wave is finding growing applications in various important fields such as space science, communications, and security screening [1]. Besides sources and detectors, development of THz technologies also requires devices to guide and manipulate THz waves. The demand for high performance quasi optic components such as frequency filters, demultiplexer, attenuators, splitters, and polarizers is increasing [2]. We theoretically propose and investigate a magnetically tunable narrow-band terahertz filter and a multi-channel THz wavelength division demultiplexer based on photonic crystal waveguide. The optical properties of the filter have been analyzed in detail. It is found that a single resonant peak with the central frequency of ~1 THz is existed in the transmission spectrum, which has a narrow full width at half maximum of <2 GHz. Moreover, under the control of an external magnetic field, transmission frequency and width of passband are adjustable, which reveals that the 2-D silicon photonic crystal waveguide with point and line defects can serve as a continuously tunable bandpass filter at the terahertz waveband. THz division demultiplexer consists of an input waveguide that perpendicularly coupled with a series of defects cavities, each of which captures the resonance frequency from the input waveguide. Coupled-mode theory and finite element method are used to analyze the transmission properties of the structure. It is found that the transmission wavelength centered around 1 THz can be adjusted by changing the geometrical parameters of defects cavities, which equals to THz waves generated by optical methods such as difference frequency generation and optical rectification.

References

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