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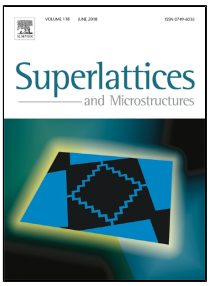

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Design of a solar-blind ultraviolet band-pass filter based on frequency domain superposition

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Abstract

In this paper, a band-pass filter based on photonic crystals is designed by using the principle of frequency domain superposition. The influence of the heterostructure position, period numbers and incidence angles on transmission spectrums are analyzed. The filter can achieve efficient filtering in 240-280nm solar-blind ultraviolet band, with an average transmittance of 72.2%. Simultaneously, a good band-stop appears in near ultraviolet and visible region (300-700nm) and its average transmittance is below 3.4%. It provides a choice in the application of solar-blind ultraviolet detection technology.

Keywords: Photonic crystal; Band-pass filter; Transfer matrix method; Solar-blind ultraviolet detection

1. Introduction

Ultraviolet between 240-280nm will be absorbed by ozone layer when sunlight passes through the atmosphere. Such light, which can't reach the surface of the earth, is named the Solar-blind ultraviolet (SBUV) [1, 2]. SBUV is widely applied in the detection of corona [3-5], tail flame from missile [6, 7], fires [8, 9] and many other area for the influence of the sunlight can almost be ignored. SBUV technology [10-12] makes the most of the characteristics of the atmosphere absorbing ultraviolet radiation so that it has a good working background of small interference and less false signals. However, the signal of ultraviolet radiation source is generally weak and the ultraviolet detector is required to have high sensitivity and low noise. Therefore, it is very important to improve the filtering performance of SBUV filter.

Photonic crystals (PCs) [13-16] have drawn intense attention due to their unique electromagnetic properties and potential applications. Owing to simple structure, easy preparation, and convenient tuning mode, many studies choosing one-dimensional (1D) PCs as ultraviolet filters have been reported. Wang [17] designed a multilayer structure of metal medium to realize the pass band with 260nm being the center, and the band gap from 280nm to the near infrared band. J.D. Hoyo [18] introduced the AlF_3 material in the structure to enhance the reflection of Al and realized the band-pass in Lyman-Alpha band (100-130nm). Fu [19] introduced metal Al in the structure in order to design a deep cut-off feature in the visible band. Although containing the metal medium in structure can achieve a better cut-off in the visible band, it has low transmittance in the SBUV band, which leads to unobvious improvement effect on the SBUV filter.

In this paper, we devise a 1D band-pass filter based on PC. By using the principle of frequency domain superposition [20, 21], we obtained the filter structure $(PC_1)^6(PC_2)^6(PC_3)^6(PC_4)^6(PC_5)^{10}$ and realized high transmittance in SBUV band and