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Design of a passband optical filter in a one-dimensional photonic crystal based on a reconfigurable Sb_2S_3 nanodefect

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Abstract

In this article, the optical response of a symmetric one-dimensional photonic crystal incorporating a central defect layer of Sb_2S_3 nanomaterial in the near-infrared region is simulated and analyzed using the transfer matrix method. The effects of the amorphous-to-crystalline phase transition of the defect layer, as well as variations in the incident angle of the incoming light, on the transmission characteristics of the structure in both TE and TM polarizations are investigated. The results show that the amorphous-to-crystalline phase transition of Sb_2S_3 induces a pronounced red shift in the defect mode wavelength, whereas increasing the incidence angle leads to a blue shift of both the photonic bandgap and the defect mode in both polarizations. For TE polarization, the defect mode linewidth decreases with increasing angle, resulting in a higher quality factor; however, for TM polarization, at angles close to the Brewster angle, the defect mode merges with the bandgap edge, leading to a degradation of the filter performance. The analysis of the transmittance difference between the two phases further reveals the high angular and polarization sensitivity of the structure. These findings confirm the strong potential of Sb_2S_3 for the design of angle-sensitive optical filters and reconfigurable photonic devices with spectral switching and modulation capabilities.

Keywords: One-dimensional photonic crystal, Sb_2S_3 nanomaterial, Amorphous–crystalline phase transition, Defect mode, Angle-sensitive optical filter

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