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Light polarization and color from guided-mode resonance filter

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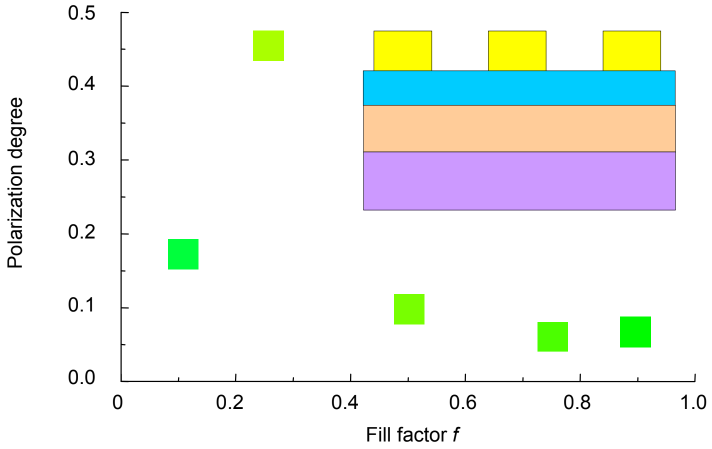

Color and polarization degree with different fill factors.

Abstract: Color filters are useful for image sensors, display devices, and many other applications. Traditional color filters use colorant-based materials to achieve a desired color spectrum, which transmit a particular color while absorbing the undesired surrounding spectrum under white light illumination. Problems with colorant-based filters include low transmission efficiency, heating due to absorption of light, and imperfect color purity. Technologies to improve color filter have led to researches on diffractive gratings color filters. The guided-mode resonance filter (GMRF) is a significant candidate for a wide variety of applications because of its feasible of fabrication and super wavelength-selecting ability. The GMRFs with different resonance wavelengths are feasibility to be integrated on the same substrate by changing the grating period. However, the reflectance of a 1-D grating structure depends greatly on polarization modes of the incident light, and the resonance wavelength of TE polarized light is generally different from that of TM polarized light. As natural light can be considered as the superposition of TE polarization and TM polarization, the reflection spectra for both TE and TM polarizations are different. Thus the color of reflected light from a 1-D GMRF is a combination of TE and TM polarizations, and the reflected light becomes partially polarized light. Unfortunately, previous research results can not weaken reflectance from TE and TM polarizations by altering the period of GMRFs. The characteristics of light polarization and color reflected by a 1-D GMRF are studied. By numerical calculations and simulations using the finite difference time domain (FDTD) method, a triple-layer GMRF is designed under non-polarized light illumination. Further researches show that the reflectance spectra of TE polarization and TM polarization can be changed by altering the fill factor of the GMRF. After the reflectance spectra of TE polarization and TM polarization of the GMRF are calculated by using the FDTD method, mixed color of TE and TM reflection spectra can be studied by the chromaticity theory. The color of the reflected light can be calculated by RGB values and we can find that the reflected light color becomes pure when f is 0.9. Moreover, by calculating the polarization degree of the reflected light, we find that the polarization degree drops to 0.1 or lower when f is larger than 0.5. The results show that the color and polarization degree of the reflected light from a GMRF are tunable by altering the fill factor. The results can provide references for the design and fabrication of GMRF.

Keywords: guided-mode resonance filter; fill factor; polarization degree; resonance wavelength

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