

Design and Application of Titanium Dioxide Thin Films Guided Mode Resonance Filter

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Abstract: A guided-mode resonance filter is a photonic crystal resonant reflector with perfect resonant reflection of incident light with specific polarizations in arbitrarily narrow bands, while allowing the light in other wavelengths passing through. The Titanium dioxide photonic crystals can be applied to prepare guided-mode resonance (GMR) filters that allow gratings to have high reflectance at resonant wavelengths. In this work, a guided-mode resonant filter is prepared by depositing a thin film of titanium dioxide on a two-dimensional patterned photonic crystal grating structure as an optical waveguide layer by atomic layer deposition (ALD). The titanium dioxide films were prepared on two-dimensional patterned quartz glass by ALD technique and annealed at different temperatures. The XRD and AFM test results showed that the titanium dioxide films with anatase structure and surface roughness less than 0.4 nm at an annealing temperature greater than 200°C. Different anneal temperatures changes the refractive index of titanium dioxide films. The effect of the refractive index on the resonance wavelength was analyzed by the rigorous coupled wave algorithm. By changing the refractive index of the titanium dioxide film of the optical waveguide layer, the position of the resonant peak can be effectively controlled. We design a guided-mode resonant filter that can control resonant wavelength in the range of 946.9-967.9 nm, and a narrow linewidth (less than 0.8 nm) is always maintained within the scope of usage. This method enables precise control of the resonant wavelength peak.

Key words: titanium dioxide; guided mode resonant; resonance wavelength

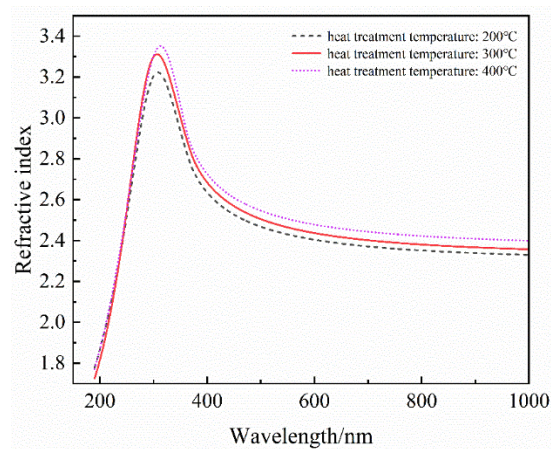


Fig. 1 refractive index image of TiO₂ samples after heat treatment at different temperatures

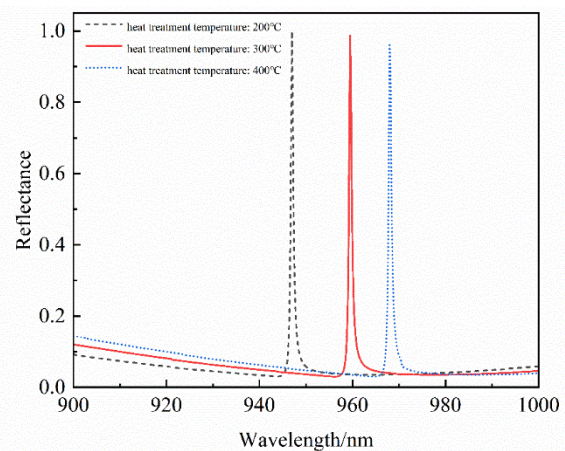


Fig.2 Variation curve of resonance wavelength of TiO₂ samples with refractive index after different heat treatment temperatures