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Polarization-independent broad-band nearly perfect absorbers in the visible regime

by

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Abstract

We investigate the feature of enhanced absorption for polarization-independent broad-band absorbers in the visible regime. The absorbers are three-layered structures consisting of a lossy dielectric grating on top of a low-loss dielectric layer and a substrate of the same lossy dielectric placed at the bottom. Enhanced absorption in the underlying structure is attained over a broad frequency range for both TE and TM polarizations. In particular, a nearly perfect absorbance (over 99.6%) is achieved around $\lambda \approx 600$ nm, the absorption spectra showing a substantial overlap between the two polarizations. The enhanced absorption is attributed to the cavity resonance and its hybridization with a weakly bound surface wave. This feature is illustrated with the electric field patterns and time-averaged power loss density associated with the resonances.

The absorber under study consists of a top layer of tungsten (W) grating, a middle layer of polysilicon (p-Si) slab, and a bottom layer of tungsten substrate. The underlying structure serves as a nearly perfect absorber in the visible regime for TE and TM polarizations. In particular, the pattern of electric field associated with the nearly perfect absorption for TE polarization is shown to be a TE11-like mode. The field is strongly confined within the slits of the grating and depicts a typical feature of cavity resonance. The electric field associated with the nearly perfect absorption for TM polarization, on the other hand, shows a typical feature of TM02-like mode in the cavity. In the present problem, the tungsten behaves as a lossy dielectric since its dielectric constant has a positive real part in the optical regime. The corresponding mode is weakly bound to the surface and known as the Zenneck wave, rather than the surface plasmon that usually occurs on the metal surface. This wave is also termed as structured surface plasmon or surface charge density wave. As the enhanced absorption is attained for both polarizations, the present structure is considered a polarization-independent absorber.

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