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Broadband extraordinary optical transmission in a narrow subwavelength gap of infrared wire-grid-polarizers

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Wire-gird polarizers (WGPs) have placed central roles in a variety of applications such as imaging system, display, and spectroscopy. However, traditional WGPs show low transmission efficiency in midwave infrared (MWIR) and longwave infrared (LWIR) spectral regions, which is attributed to a large index contrast between air and IR-transmitting substrates such as silicon (Si) and germanium (Ge). In this study, we demonstrate the WGPs, where a metallic film is selectively deposited on a Si nanograting substrate by utilizing oblique angle deposition (OAD), with the capability to reach ~80% transmission efficiency over a broad range of the IR spectrum from 3 μm to 8 μm. It is noticeable that increasing a duty cycle of the nanogratings leads to higher transmission efficiency, which is obviously different from those observed in existing WGPs where an array of the metallic wires is directly patterned on a flat substrate. Optical properties of the proposed WGPs are thoroughly explored by studying the field distribution into the WGP structures using a finite-difference time-domain (FDTD) simulation and an admittance diagram employing effective medium approximation with a thin film simulation. A significantly enhanced electric field is formed in a narrow subwavelength gap, which is found to be responsible for achieving the broadband extraordinary optical transmission. The presented approach may open the door to various applications including recognition, remote sensing, and target tracking.

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