Abstract: A plasmonic infrared (IR) filter assisted by localized surface plasmon polaritons (LSPPs) in an Ag/SiO2/Ag T-shaped array was theoretically and experimentally investigated. By using a Fourier transform infrared (FTIR) spectrometer, an angle-independent LSPP resonant mode caused by a Fabry-Pérot resonance in the structure was observed in agreement with the prediction from the rigorous coupled-wave analysis (RCWA) simulation. The resonant wavelength of the mode can also be controlled by modifying the geometry of the T-shaped structure. Such LSPP property can be used as an IR reflection-type band-stop filter with a single spectral bandwidth and an ultrahigh immunity to incident angles.

Introduction

Localized surface plasmon polaritons (LSPPs) are electromagnetic waves localized and coupled to the surface plasmon oscillations at the metal-dielectric interface. By using the LSPP property, many applications were developed. For the application in plasmonic filters, large incident angle tolerance is in demand. However, most of reported plasmonic filters are angle-dependent [1-5]. In the poster, we demonstrated the T-shaped array in Ag/SiO2/Ag platform, showing an angle-independent LSPP mode. The structure can be as a reflection-type angle-independent band-stop filter. The stop-band can also be adjusted by varying the structure geometry. The T-shaped structure is able to offer a single, narrow, angle-independent LSPP band. The angle-independent feature makes the designed filter more flexible than a guided-mode resonance (GMR) dielectric filter [1-3] and a surface plasmon-polariton (SPP) filter [4] as well as a plasmonic multilayer filter related to our previous work [5].

Designed structure and simulation

Fig. 1. (a) The illustration of T-shaped array structure where \( \lambda_g = 3000\text{nm}, t_{Ag} = 100\text{nm}, t_{w} = 50\text{nm}, w_T = 800\text{nm}, \) and \( W_{Ag} = 1500\text{nm}. \) (b) A sketch of light response reflected back from the designed structure, showing a band-stop filtering function on the output spectrum.

Fig. 2. (a) 45° angle and (b) Cross-sectional SEM (scanning electron microscope) image of the T-shaped structure.

Fig. 3. (a) Stimulated reflectance spectra in x-z plane. (b) \(|\text{Hy}|^2\) at 0.35eV in x-z plane, showing the spatial response of the first Fabry Pérot resonance mode.

Measurement results

The spectra of the T-shaped array was observed by using a Fourier transform infrared (FTIR) spectrometer with an IR unpolarized source and a resolution of 3nm.

Summary

In summary, we have demonstrated a plasmonic IR filter with a localized, angle-independent LSPP mode by using the Ag/SiO2/Ag T-shaped array. The resonance wavelength can be shifted by varying the geometry, and the angle-independence of LSPP mode was also verified. The T-shaped structure with the LSPP resonance has a strong advantage in the application as angle-independent band-stop filters. The current filter could be much improved with further design and studies.

Reference


