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Nanoantenna on remote plasmonic excitation nanostructures

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1. Introduction

The surface plasmon has been researched for many years and there are several methods to excite the surface waves [1, 2]. One way to generate a narrow spectral bandwidth is to use remotely exciting surface plasmon polaritons (SPP) grating nanostructures, e.g., r-grating structures [3]. Because of the character of the narrow spectral bandwidth and high near field intensity, r-grating structures are very facilitated useful for sensing applications. In the sensing regime, the directivity of nanoantenna attracts more attentions nowadays [4]. In this paper, we consider the stripe nanoantennas on the r-grating structures and simulate their electric field enhancements and analyze their far field properties.

2. Results and discussions

In our study, the structure contains the nanoantennas atop the remote grating structure. The stripes with a width of 130 nm, a gap of 20 nm and a depth of 50 nm lay on the gold film. The r-grating nanostructure consists of a periodic gold grating which is embedded in a dielectric material under the gold film. The distance between the gold film and the periodic gold grating is chosen for the effect of fabry-perot cavity enhancement. In this case, the surface wave can be excited by the remote-grating and propagates on the gold thin film. Then, the light can be coupled into the nanoantennas. The structure was simulated by Lumerical FDTD Solutions software based on finite-difference time-domain method [5]. Fig. 1 is the cross-section view of the electric field distribution in logarithm scale of one r-grating structure with stripes at resonance. The light wavelength for the maximum filed enhancement for this r-grating structures is 715 nm.

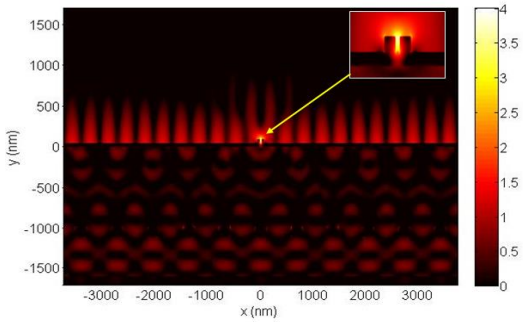

Fig. 1. The electric field intensities (in logarithm scale) for the structure we study. The nanoantenna is located at the origin of the coordinate. The wavelength is 715 nm.

The electric field intensity at the observed field point for the structure without nanoantenna versus wavelength is plotted as the blue line in Fig. 2 and the wavelength for the maximum field appears at 707 nm. The red line in Fig. 2 corresponds to the electric filed at the gap center of stripes on r-grating and it maximum value is at 715 nm, which shows slight red-shift. The structures are designed to prove the concept that remote-grating structure can be used to excite the surface wave into stripe nanoantennas and boosts the localized electric field at the gap of nanoantennas.

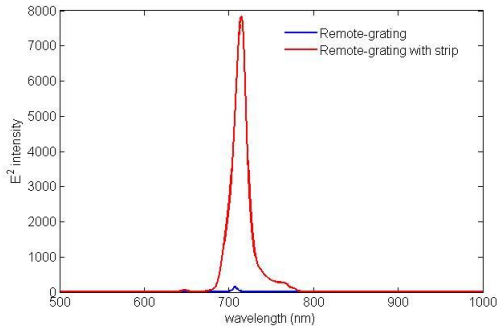

Fig. 2. The strongest electric intensity versus wavelength for the remote grating with and without the strip nanoantenna.

3. Conclusions

The simulation results show that the proposed stripe nanoantennas on remote-grating structure can enhance the exciting surface plasmon and guide the light illuminated into the gaps of the stripes. The effect of constructive interference appears on gold film surface. Based on the physical concepts described in this paper, further improvement can be obtained by optimizing the remote-grating structures with nanoantennas

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