Surface Plasmons in Double Layer Remote-grating System

Chang-Lin Wu[1], Jia-Han Li[1], and Chun-Hway Hsueh[2]

[1] Department of Engineering Science and Ocean Engineering, National Taiwan University
[2] Department of Materials Science and Engineering, National Taiwan University
E-mail: R05525110@ ntu.edu.tw, jiahan@ntu.edu.tw, hsuehc@ntu.edu.tw

1. Introduction

Exciting the surface plasmons with large near-field intensity enhancement is important for the nanophotonic applications. There are several ways to excite the surface plasmon polaritons (SPPs) [1]. In 2010, a remote-grating structure to excite the SPPs was proposed and studied [2]. By this way, the features and benefits of SPP excitations are the narrow spectral bandwidth and the large near-field intensity. In this paper, we consider the double layer remote-grating structure to excite SPPs and compare our simulation results with single layer remote-grating structures. The effects of structure parameters on field enhancements and bandwidths are studied.

2. Results and discussion

In our study, the structure contains the double layer periodic gold gratings which are embedded in the glass under the gold thin film. The incident light is the TM wave illuminated from the bottom to the structures, and the diffracted light generated by the remote gratings can couple as the SPPs into the gold thin film. For simplicity, we fix the length and thickness of the grating as 200 nm and 100 nm, respectively. The thickness of gold thin film is 40 nm in this work. It is the air above the gold thin film. By arranging the distance between the top and bottom grating structures and tuning the distance between the gold thin film and double layer grating structures, the exciting SPPs can be found for specific illuminate light wavelengths. The simulations are performed by the Lumerical FDTD Solutions, a commercial software based on the finite-difference time-domain method. Figure 1 shows the simulation results of the electric field intensity distribution in logarithmic scale of a double layer remote grating structure where period of grating is 800 nm and wavelength is 815 nm.

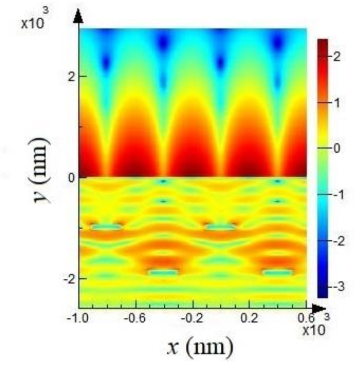

Fig. 1. Electric field intensity at the peak wavelength 815 nm. The color scale is the light intensity normalized by the incident light intensity in logarithmic scale.

Figure 2 shows the electric field intensity verse wavelength for double layer remote-grating and single layer remote-grating. The wavelengths of maximum field intensity in two different grating system are both 815 nm. The maximum electric field intensities are 239 and 138 in double layer and single layer grating systems, respectively. It is about 70% higher when we use the double layer grating instead of single layer grating. The bandwidths are 3.9 nm and 3.7 nm for double layer and single layer grating systems, respectively. By tuning the distance between the top layer and bottom layer grating, we can enhance the diffraction efficiency of the double layer remote grating as compared to the single layer remote grating.

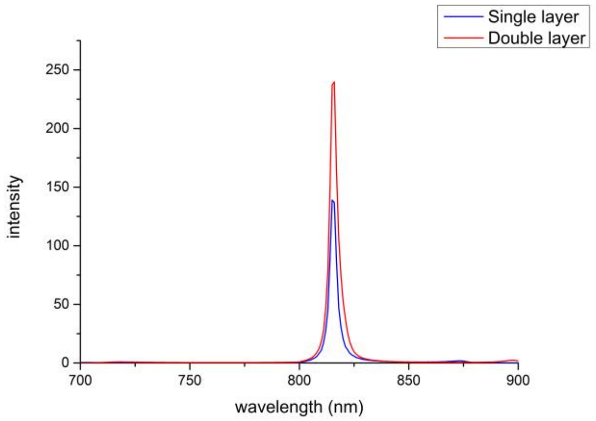

Fig. 2. Electric field intensity verse wavelength for the double layer remote-grating structure (red line) and single layer remote-grating structure (blue line).

3. Conclusions

It is found that the double layer remote-grating system can enhance higher electric field intensity than single layer remote-grating system. Further work of this study can be used in the sensing applications.

Acknowledgements

This work was supported by the Ministry of Science and Technology (104-2221-E-002-079-MY3) and NTU Project (107L7829).

References

[1] S. A. Maier, Plasmonics: Fundamentals and Applications, Springer, 2007.
[2] T.-W. Lee and S. K. Gray, Opt. Express. **18**(2010) 23857.