Simulate Sub wavelength holes in metallic film

Introduction

It is generally accepted that the enhanced transmission is mediated by surface plasmon polaritons (SPPs) that exhibit resonances set up by the periodicity of the array. We will calculate the transmission through sub-wavelength holes in a gold film deposited in SiO_2 substrate. Surface Plasmon wave that results from the periodic array of holes will enhance the transmission in a certain wavelength region. Simulation results will be compared to the experimental results published by K. L. van der Molen et al.

Related Publication

[1] K. L. van der Molen, et al. "Influence of hole size on the extraordinary transmission through subwavelength hole arrays", *Applied Physics letters*, Vol, 85, No8, 2004, pp.4316-

Original project

The periodic hole arrays were created by ion milling in optically thick Au films (200 nm) deposited on glass. All arrays investigated have a period of 425 nm. The width of the square holes is varied in the range of 150 to 290 nm[1]

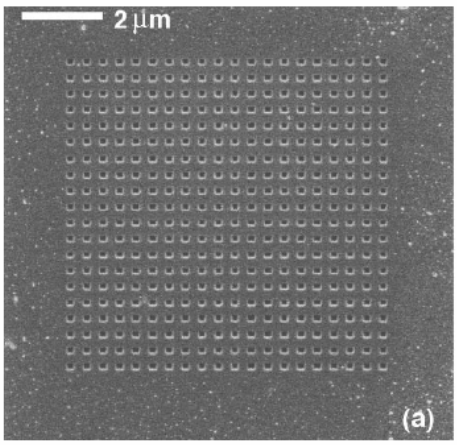


Figure 1 Layout sketch in reference [1].

Layout Setup in OptiFDTD

- OptiFDTD uses the time domain Lorentz_Drude model for metallic layout and surface plasma simulation
- For periodic layout, if the input wave is in z-direction straight forward, we can just pick up one unit cell with x and y edge set as the periodic boundary condition (PBC) to perform the analysis. This way can save the CPU time and Memory usage.

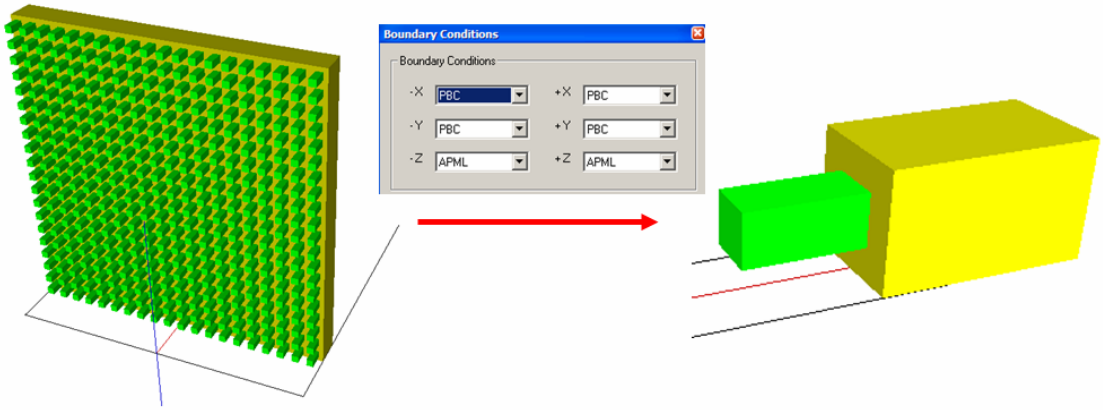


Figure 2 Layout Setup in OptiFDTD

Results

Simulations were performed for different holes width with VB scripting scanning simulation by OptiFDTD. The transmittances as a function of wavelength was obtained (see Figure 3). Far-field based on the near field was calculated. When considering the array factor, the far-field for the whole array can be obtained (see Figure 4).

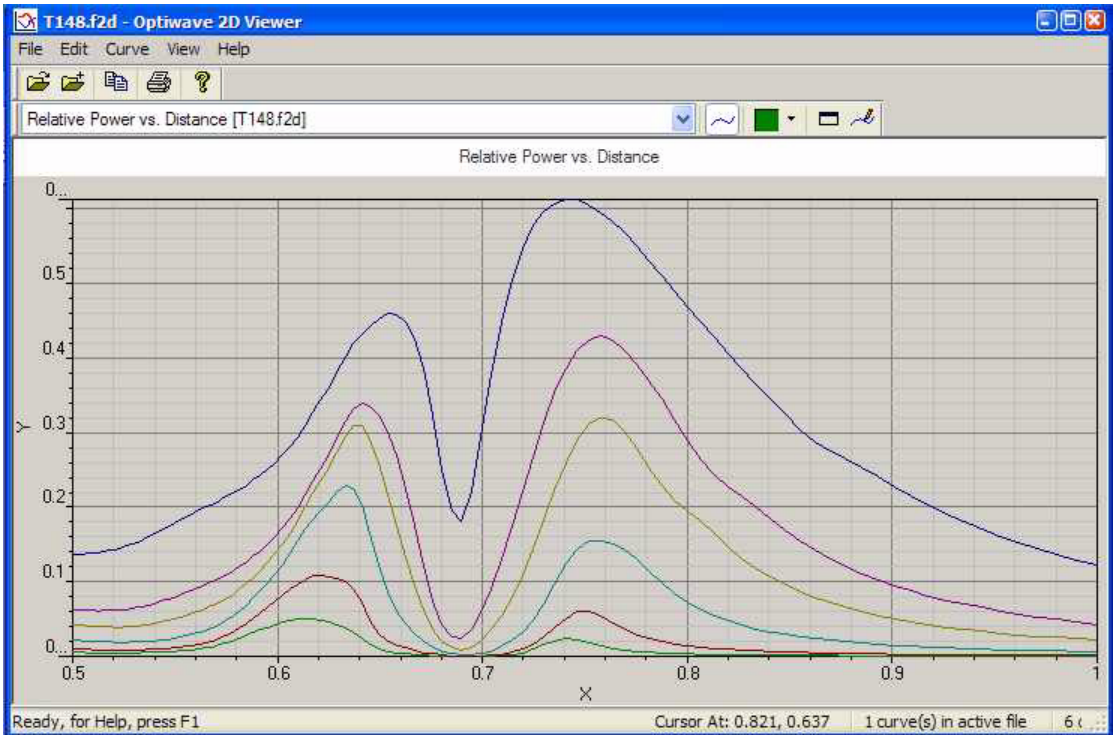
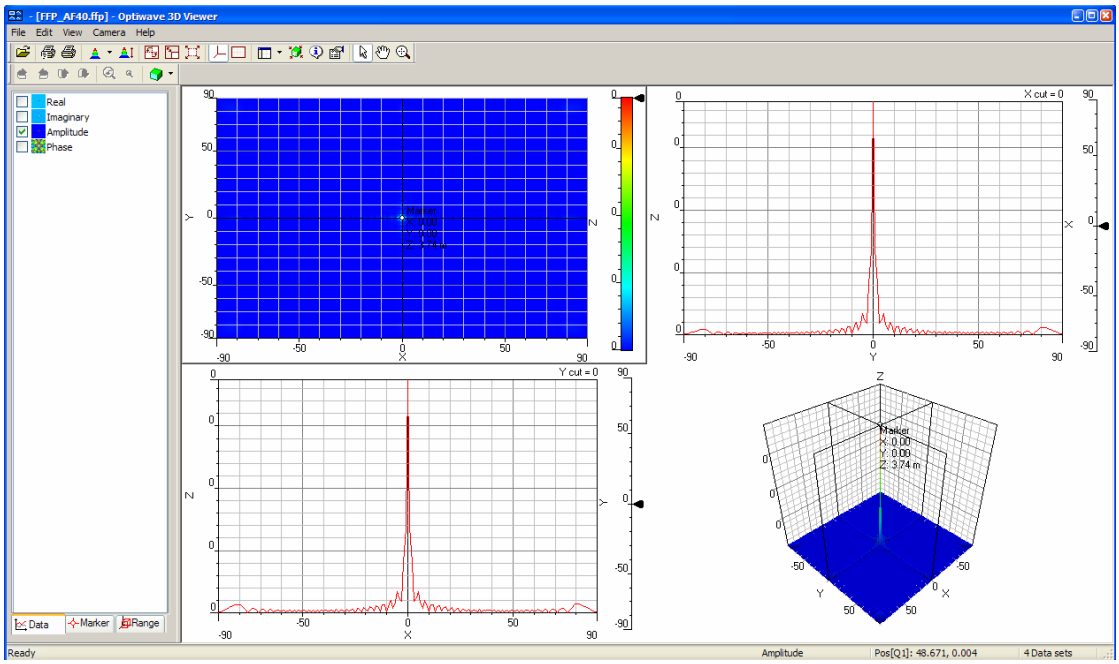


Figure 3 The Transmittance as a function for wavelength for square hole arrays with different hole width (the curve is for the hole width 148nm, 165nm, 200nm, 231nm, 247nm, 286nm started from the bottom)



Far field pattern for 40*40 holes arrays