

Plasmon Nano Probe for Semiconducting Nanodevices and Bio/Chemical Sensors

Products: FullWAVE FDTD

Applications: Plasmonics, Nanophotonics and
Nanostructures, Photonic Sensors and Sensing

Introduction

SPM (Scanning probe microscopy) nanoprobes have been increasingly required for the electrical evaluation of semiconducting nanodevices, biochemical measurement of DNA and/or protein molecules, and nanoscale material property investigations [1]. To obtain strong enhancement effect, the Plasmon Resonance Wavelength (PRW) of the metallic probe and the excitation wavelength need to be spectrally matched with each other. Considering the cost and limited number of laser sources, it is necessary to design the right combination and size of Si/SiO₂ in the probe tip to guarantee the best PRW match.

FullWAVE FDTD is very suitable for simulating nano-scale devices and surface plasmon effects. FullWAVE's enclosed launch feature allows for measurement of the probe's scattering only properties.

Structure and Simulation Steps

Fig.1(a) shows the Ag-coated oxidized Si probe that consists of Si, SiO₂ and Ag layers. Fig.1(b) is the set up in **RSoft CAD** of the probe structure. Please note that the green box is the volume monitor (a monitor includes width, height and length) which is set a little larger than the launch area indicated with the orange lines. When the enclosed launch is turned on in launch dialog, the power measured with volume monitor is the pure scattering power.

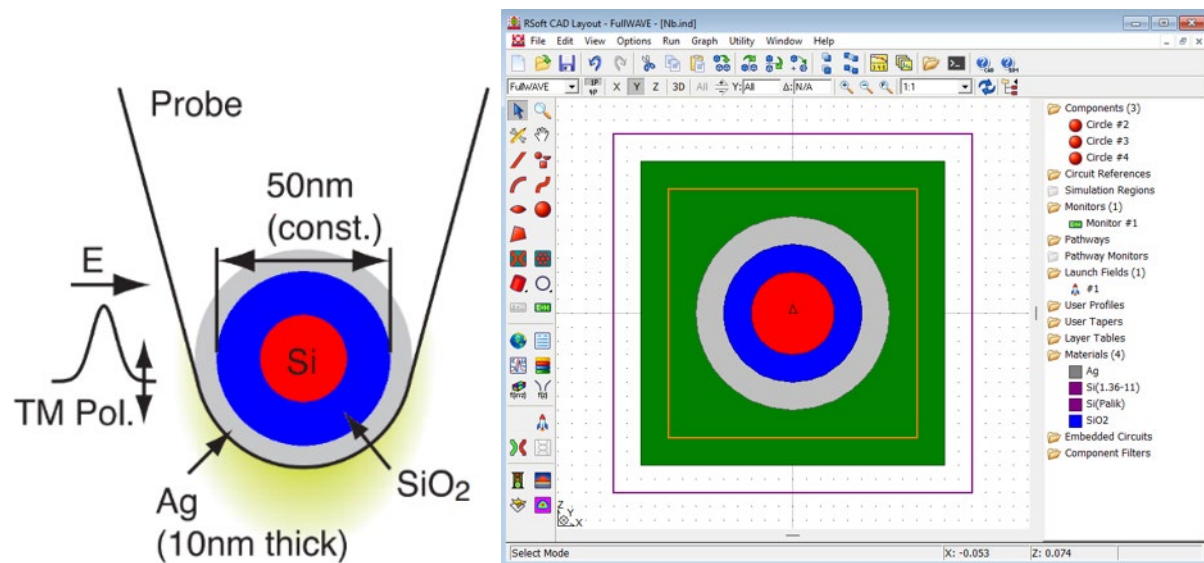


Figure 1. (a) Schematic for Ag-coated oxidized Si probe; (b) Structure set ups in RSoft CAD

We have investigated the scattering power in 400 nm to 900 nm wavelength range with pulse simulations. MOST scans are set to obtain the spectrum for different SiO₂ thicknesses and the background index.

Simulation Results

The calculated scattering spectra in air were shown in Fig. 2, which matches with Fig.1(b) very well. When increasing the thickness of the SiO₂ layer, the peak wavelength gradually shifted toward the shorter wavelength.

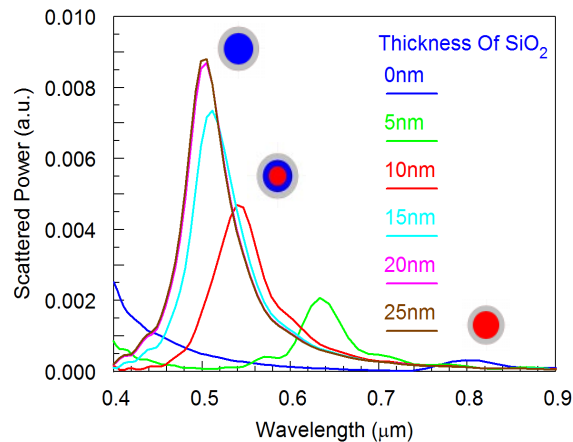


Figure 2. Calculated near-field scattering spectra of the Ag-coated oxidized Si probes in air with different SiO₂ thicknesses.

Fig.3 is the contour map of the scattering spectra vs background index at 10 nm thick SiO₂ layer. The scattering peak is shifted to longer wavelength if we put the probe in different environments.

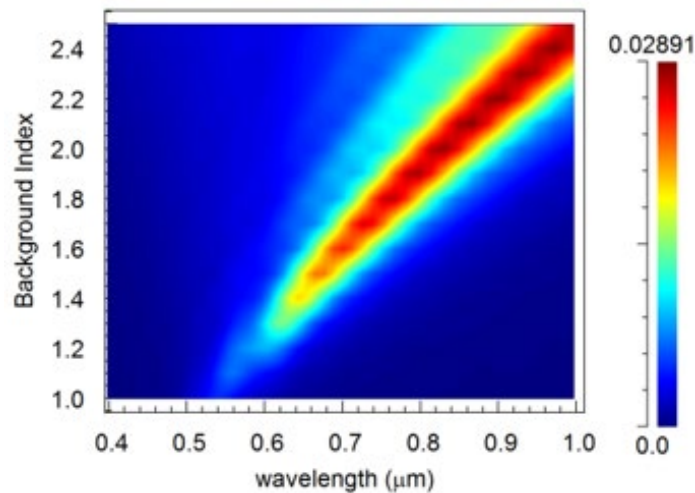


Figure 3. Calculated near-field scattering spectra of the Ag-coated oxidized Si probes vs background index at 10 nm SiO₂ layer

Example files

Supporting Files for RSoft Application Note "Plasmon Nano Probe for Semiconducting Nanodevices and Bio/Chemical Sensors"

References

1. 13 April 2009 / Vol. 17, No. 8 / OPTICS EXPRESS 6510