Simulation of Split Ring Resonator (SRR) at Optical Frequencies
Split Ring Resonator (SRR)

Glass substrate: 15nm, $\varepsilon=2.25$
ITO film: 5nm, $\varepsilon=3.8$
Gold: Drude model:

$\omega_p=1.367\times10^{16}$ (rad/sec)
$\omega_c=6.478\times10^{13}$ (rad/sec)

The parameters are based on the work of Enkrich et al [1] and Burger et al [2]
Simulation Setup

• Drude model used (via “drude” command, version 4.6) to calculate the complex permittivity of gold

\[ \varepsilon(\omega) = 1 - \frac{\omega_p^2}{\omega(\omega + i\omega_c)} \]

• PML2 command (“pml2”, version 4.6) used to terminate the absorbing boundaries in z direction
  • Enhancements to standard PML command: (1) automatically optimize PML parameters, (2) run faster in FDTD iterations
  • Allowing boundaries to be placed closer to scattering objects to reduce simulation domain size and, therefore, save memory and run time

• Yee cell size = 5nm

• The following effects are simulated
  • Angle of incidence (theta, phi)
  • S-polarization
  • Dimension b (80nm, 90nm)
Transmission Calculation

• The transmission through SRR is calculated as follows

\[ T = \frac{I_{SRR}}{I_{NoSRR}} \]

\( I_{NoSRR} \) is the e-field intensity of 0-order transmitted planewave w/o gold SRR. 
\( I_{SRR} \) is the e-field intensity of 0-order transmitted planewave w/ gold SRR.

• The “scat_func” command with “ft=true” option is used to compute 
diffraction orders of the transmitted field
Effects of b

Mie resonance [1,2]  Magnetic resonance [1,2]
Effects of Incident Angles

phi = 90 degree, b = 90 nm

Magnetic resonance [1,2]

phi = 0 degree, b = 90 nm

phi = 90 degree, b = 90 nm

theta = 0 degree
theta = 60 degree
References
