

Exercise 15:

A cylindrical silver scatterer ($r = 100\text{nm}$) is placed in a 3 layered medium. The specifications of the geometry is given in Fig. 1. Solve the scattering problem when a plane wave with $\lambda_0 = 600\text{nm}$ impinges the structure with the incidence angle of 45° .

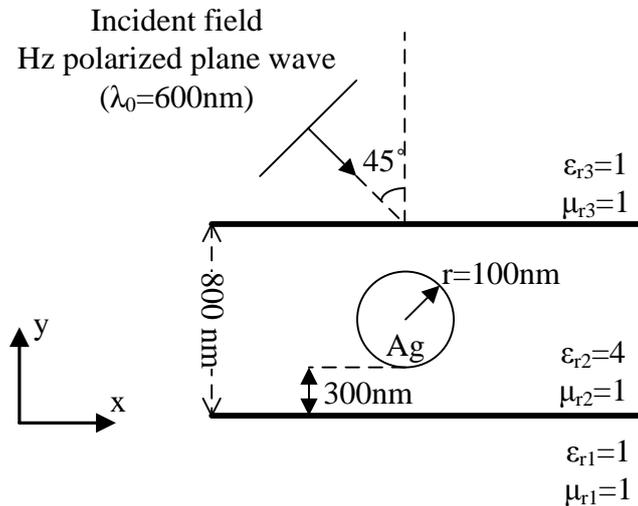


Figure 1: The schematic of the layered geometry, the cylinder and the incident field.

STEPS and HINTS:

1. Continue working on the file you created last week for the plane wave propagation in layered media. Draw the circle inside and a PMLs around the geometry (the material properties of the PML should be the same as the neighbor domain).
2. The permittivity value of silver is strongly dependent on the frequency of the incoming wave in the optical spectrum. Introduce the frequency dependent behavior of silver by the provided data table. (Download the file http://www2.ifh.ee.ethz.ch/~aytaca/physicalmodelling/silver_eps.zip, the first entry is the free space wavelength and the second entry is the real or the imaginary part of the permittivity, depending on the file name. Since Comsol uses $e^{j\omega t}$ convention, the imaginary part of the permittivity value should be always negative, since silver is a passive material.)
3. Introduce another Wave Equation Solver by adding **Electromagnetic Waves 2** in the Model dialog.
4. In the plane wave solver (Electromagnetic Waves) dialog add another **Wave Equation** and override the permittivity and permeability values of the scatterer with medium 2.
5. Transfer the first solution (Electromagnetic Waves) as the incident field for the scattering problem (Electromagnetic Waves 2) by setting Scattered Field in **Solve for** dialog and enter **emw.Ex**, **emw.Ex** and **0** in the **Eb** components. By this trick both the solvers (1) Plane wave 2) Scattering) are nested into one problem. Comsol first solves the plane wave propagation and uses the result as the input for the scattering problem.

Exercise 16:

Consider the 1D heat equation:

$$\frac{\partial u}{\partial t} - \alpha \frac{\partial^2 u}{\partial x^2} = f(x, t) \quad (1)$$

with the boundary conditions $u(0, t) = 283$ K, $u(1, t) = 283$ K and initial state $u(x, 0) = 353$ K.

Answer the following questions:

- a) Describe the behavior of the solution as time increases, for the source-free case ($f(x, t) = 0$), and discuss the influence of the constant α in this behavior. (Hint: Remember separation of variables technique)
- b) Give an example of a physical situation that can be analysed with this 1D heat equation.
- c) Solve the problem by COMSOL