

Plasmonic Solar Cell Simulation

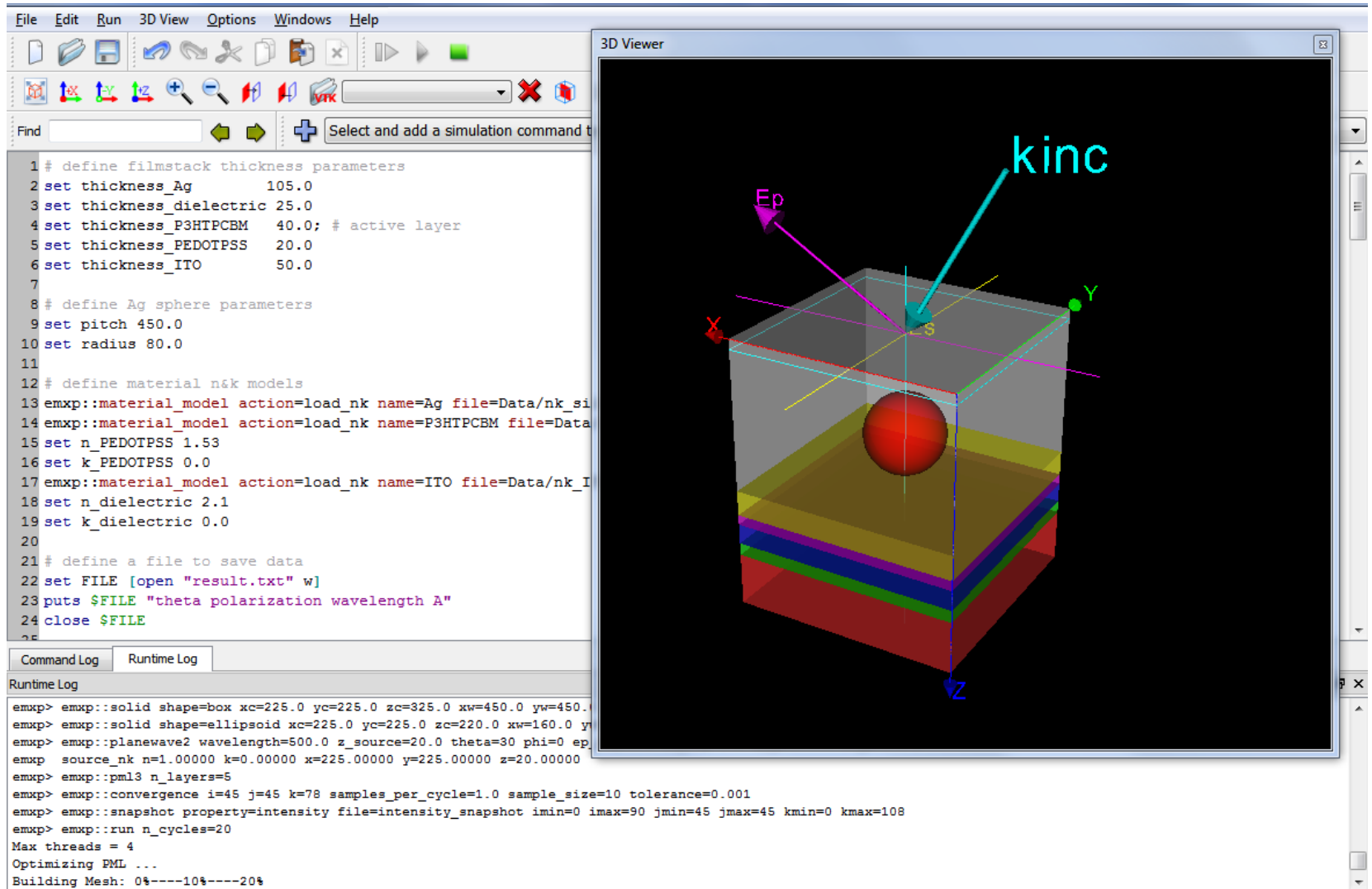
Overview

- This simulation example is based on reference [1]
 - Oblique incidence effect is also investigated in this work in addition to the normal incidence studied in the reference
- It demonstrates the use of the following new EM Explorer commands [2]
 - “poynting_flux” for source power calculation
 - “loss” for calculation of active layer absorption

[1] Wenzhen Ren et al, “Broadband absorption enhancement achieved by optical layer mediated plasmonic solar cell,” 19 December 2011/Vol. 19, No. 27/Optics Express 26536

[2] “EM Explorer User Guide,” January 2012, www.emexplorer.net

Simulation Setup Screenshot



The screenshot displays the interface of a simulation software, likely EM Explorer. The main window is divided into two primary sections: a command window on the left and a 3D viewer on the right.

Command Window: This window contains a series of commands for defining simulation parameters and material models. The commands are as follows:

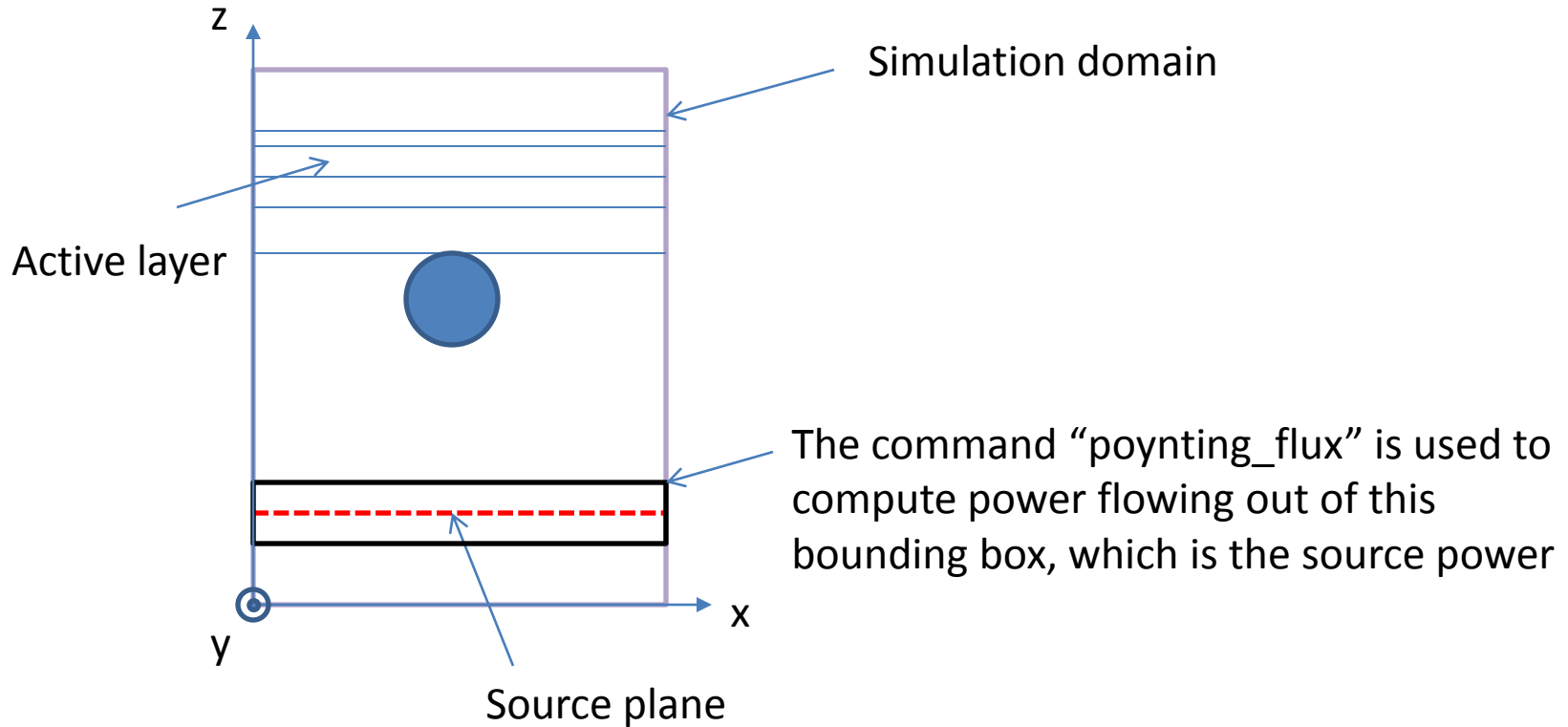
```
1 # define filmstack thickness parameters
2 set thickness_Ag 105.0
3 set thickness_dielectric 25.0
4 set thickness_P3HTPCBM 40.0; # active layer
5 set thickness_PEDOTPSS 20.0
6 set thickness_ITO 50.0
7
8 # define Ag sphere parameters
9 set pitch 450.0
10 set radius 80.0
11
12 # define material n&k models
13 emxp::material_model action=load_nk name=Ag file=Data/nk_si
14 emxp::material_model action=load_nk name=P3HTPCBM file=Data
15 set n_PEDOTPSS 1.53
16 set k_PEDOTPSS 0.0
17 emxp::material_model action=load_nk name=ITO file=Data/nk_I
18 set n_dielectric 2.1
19 set k_dielectric 0.0
20
21 # define a file to save data
22 set FILE [open "result.txt" w]
23 puts $FILE "theta polarization wavelength A"
24 close $FILE
25
```

Below the command window, there are tabs for "Command Log" and "Runtime Log". The "Runtime Log" shows the execution progress of the simulation, including the creation of a mesh and the optimization of the PML (Perfectly Matched Layer) boundaries.

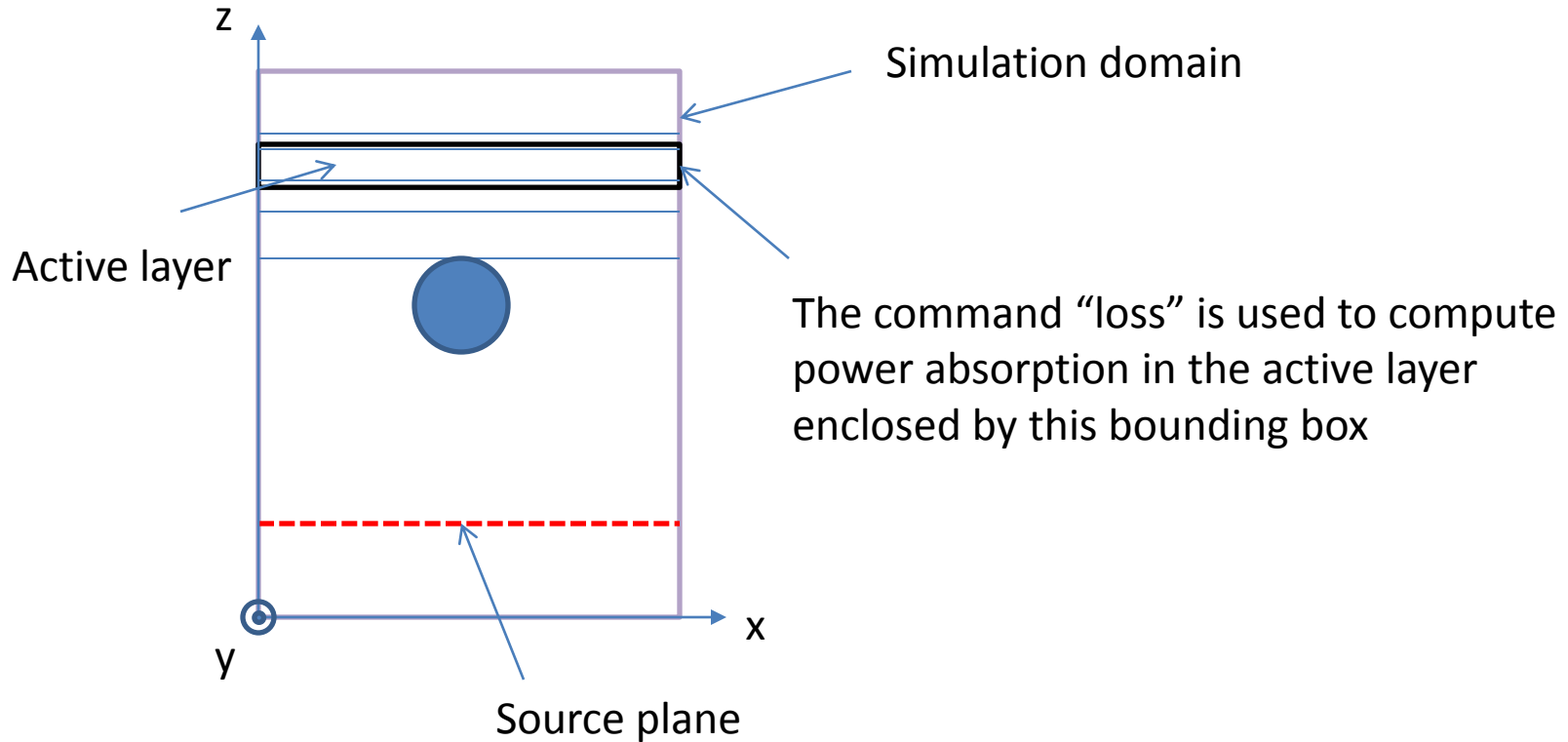
```
emxp> emxp::solid shape=box xc=225.0 yc=225.0 zc=325.0 xw=450.0 yw=450.0
emxp> emxp::solid shape=ellipsoid xc=225.0 yc=225.0 zc=220.0 xw=160.0 yw=160.0
emxp> emxp::planewave2 wavelength=500.0 z_source=20.0 theta=30 phi=0 ep
emxp source_nk n=1.00000 k=0.00000 x=225.00000 y=225.00000 z=20.00000
emxp> emxp::pml3 n_layers=5
emxp> emxp::convergence i=45 j=45 k=78 samples_per_cycle=1.0 sample_size=10 tolerance=0.001
emxp> emxp::snapshot property=intensity file=intensity_snapshot imin=0 imax=90 jmin=45 jmax=45 kmin=0 kmax=108
emxp> emxp::run n_cycles=20
Max threads = 4
Optimizing PML ...
Building Mesh: 0%----10%----20%
```

3D Viewer: The 3D viewer displays a 3D model of the simulation setup. It shows a central red sphere (Ag) surrounded by a layered structure (dielectric, P3HTPCBM, PEDOTPSS, ITO) within a box. The coordinate system (X, Y, Z) is visible, and a cyan arrow labeled "kinc" points towards the sphere, indicating the incident wave vector. A purple arrow labeled "Ep" points towards the sphere, indicating the electric field polarization.

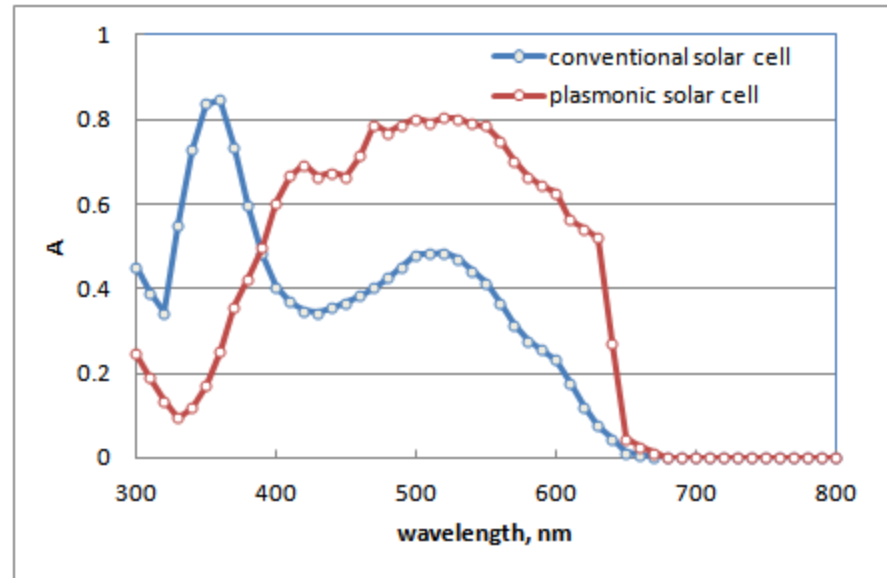
POYNTING_FLUX Command



LOSS Command

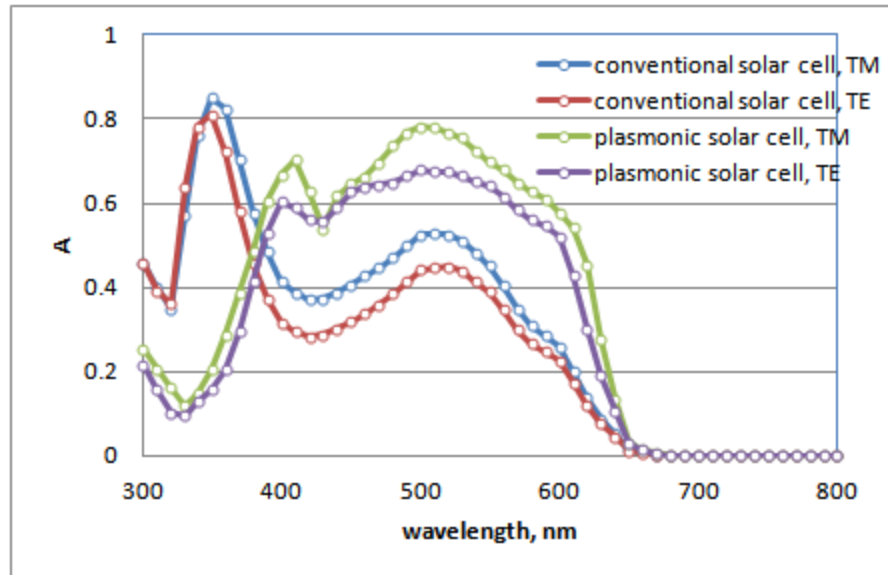


Absorption at Normal Incidence



$$A = \frac{P_{loss}}{P_{source}}$$

Absorption at 30° Oblique Incidence



$$A = \frac{P_{loss}}{P_{source}}$$