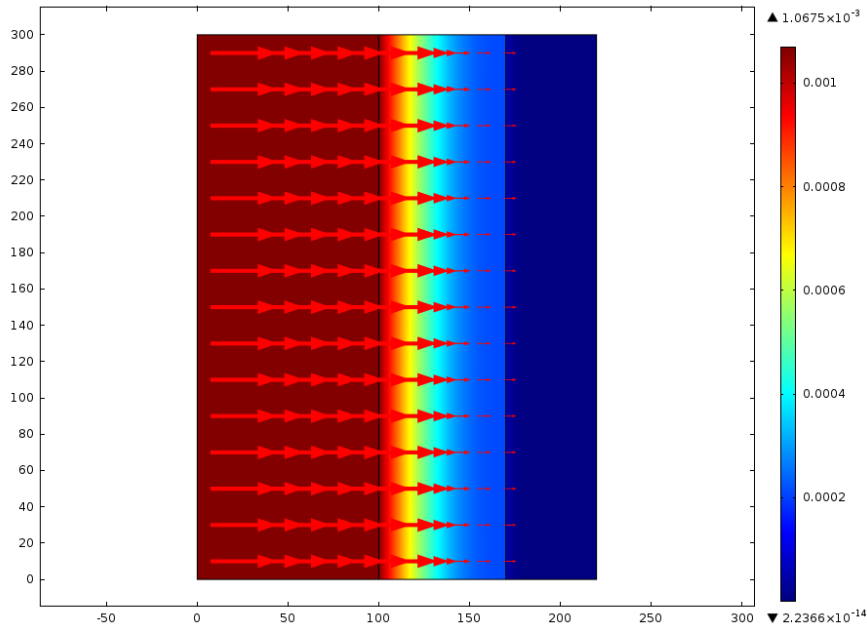


# 0degree incidence

## Air : 100nm

A(1)=0 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average

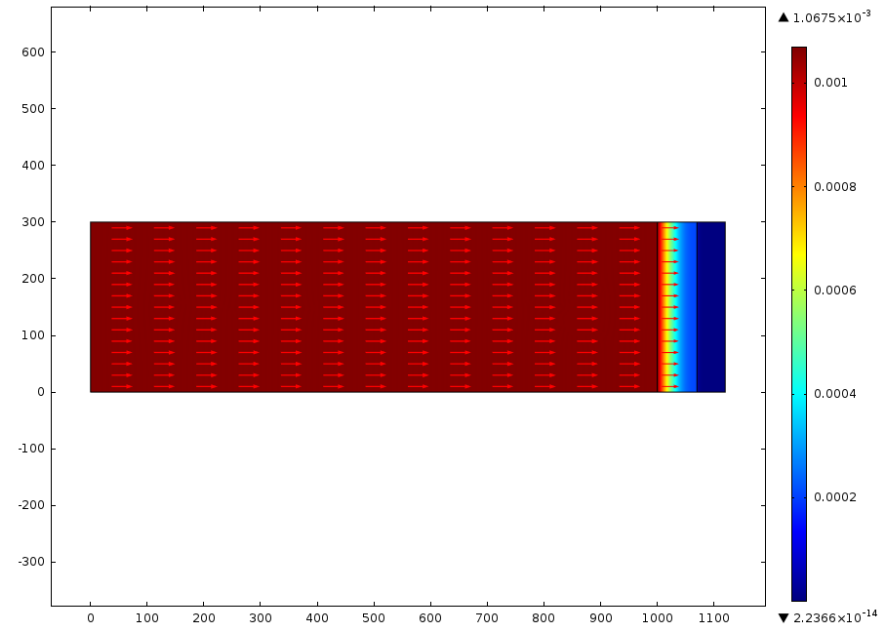
COMSOL  
MULTIPHYSICS



## Air : 1000nm

A(1)=0 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average

COMSOL  
MULTIPHYSICS



Oblique  
incidence,  
 $A=30^\circ$

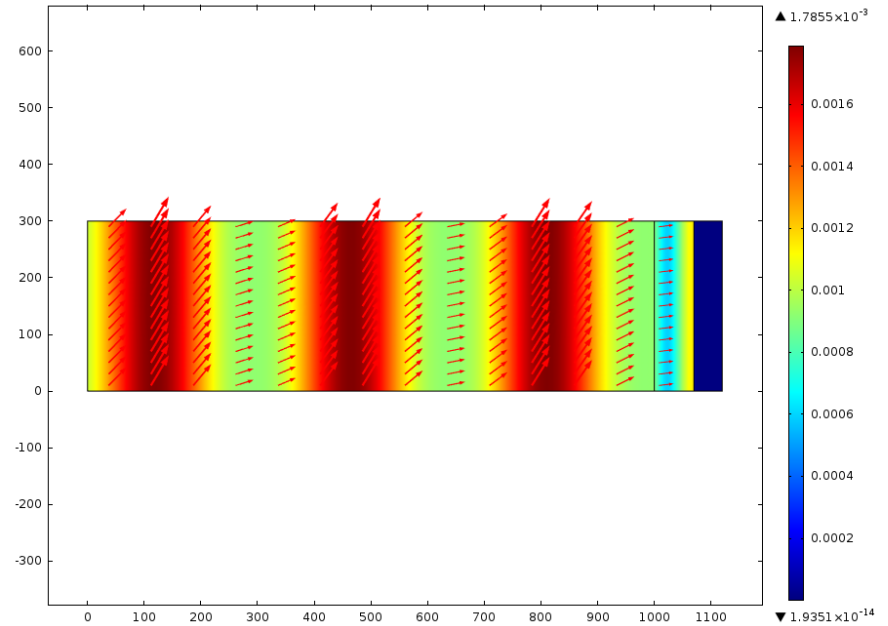
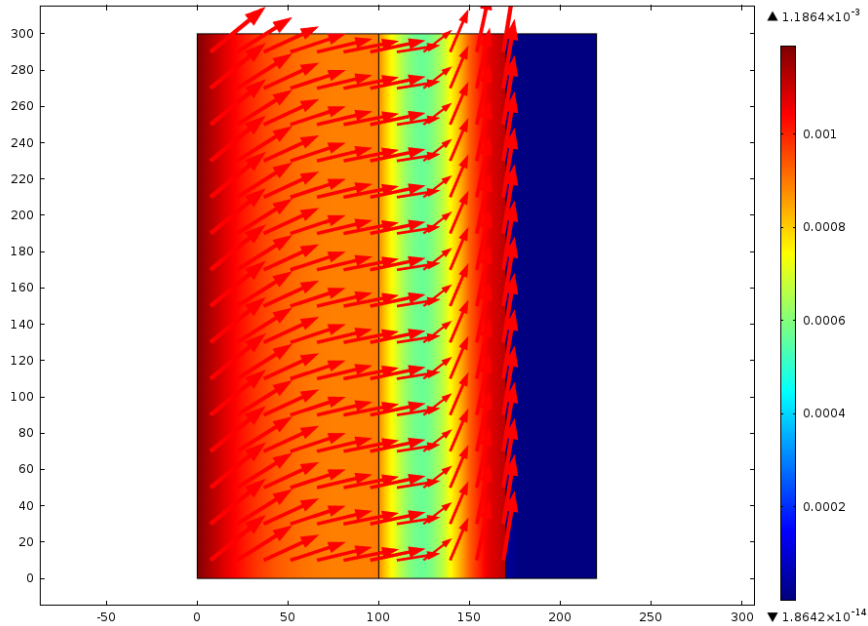


Air : 100nm

Air : 1000nm

$A(2)=0.523599$  Surface:  $\sqrt{\text{emw.Poavx}^2+\text{emw.Poavy}^2+\text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average

$A(2)=0.523599$  Surface:  $\sqrt{\text{emw.Poavx}^2+\text{emw.Poavy}^2+\text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average

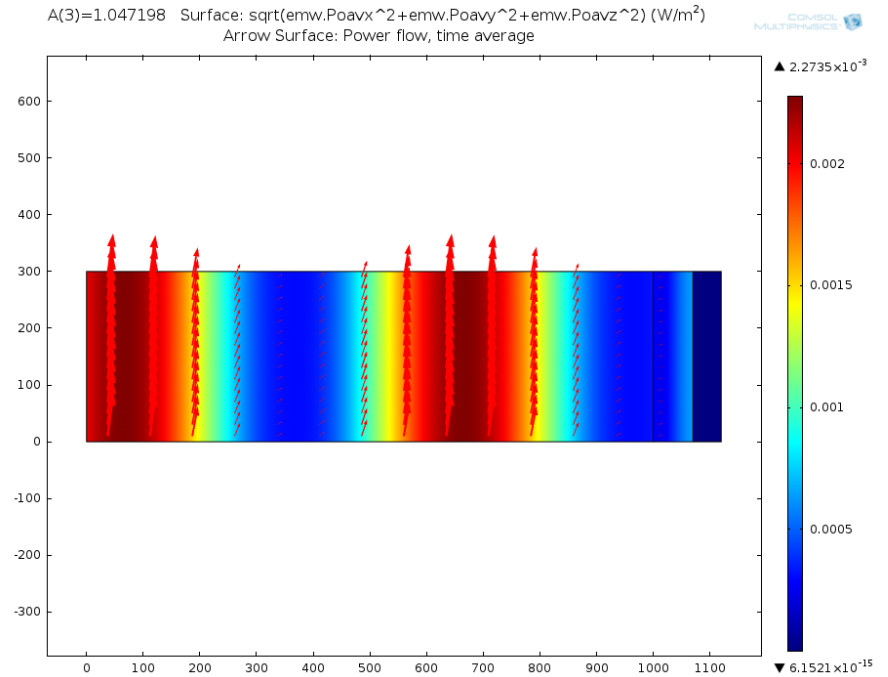
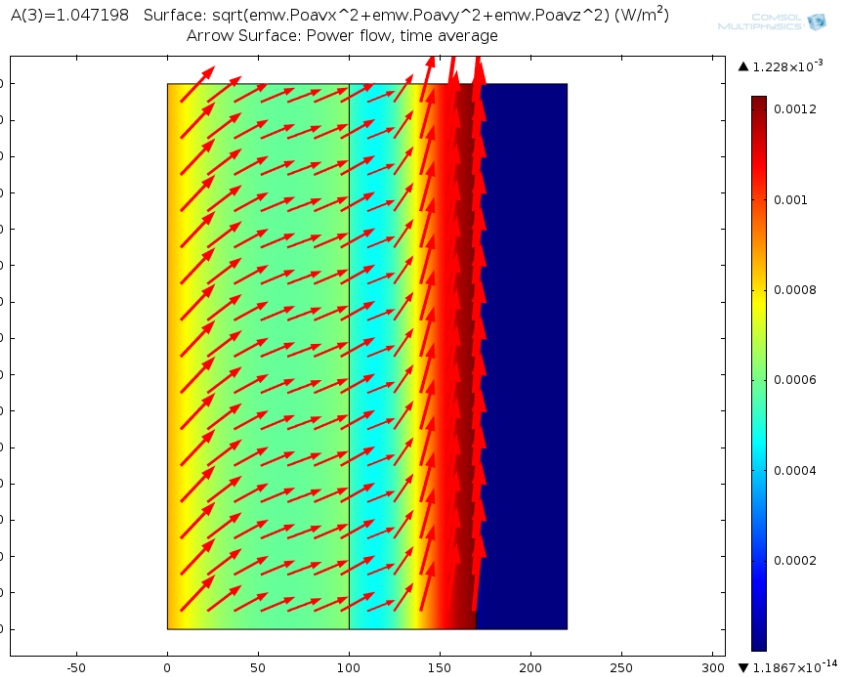


Oblique  
incidence,  
 $A=60^\circ$



Air : 100nm

Air : 1000nm

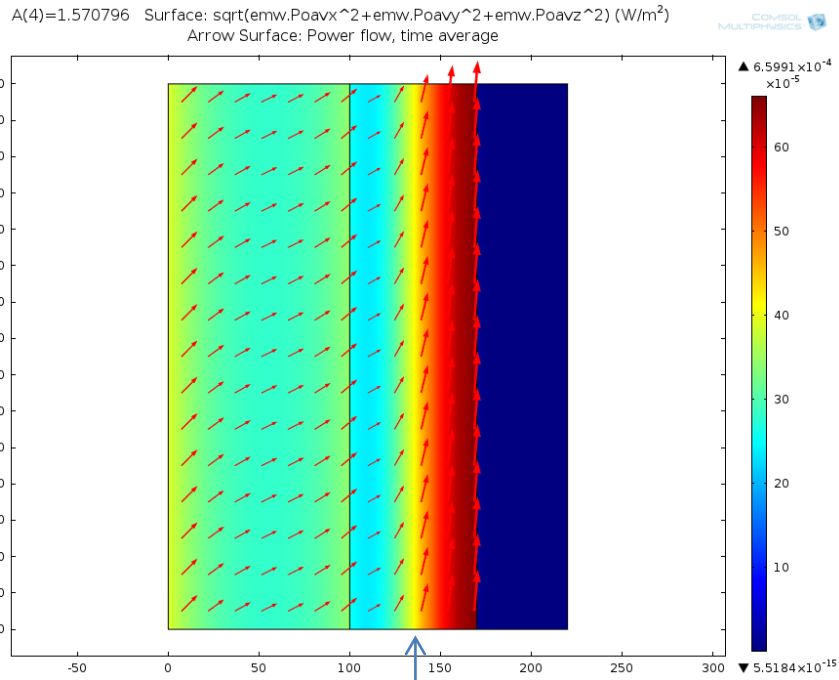


Oblique  
incidence,  
 $A=90^\circ$

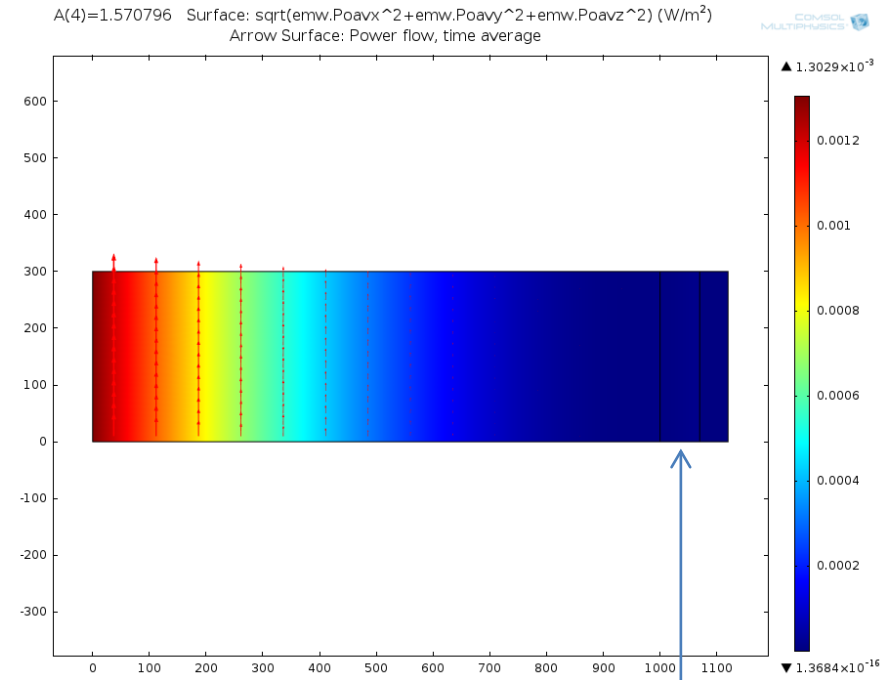


Air : 100nm

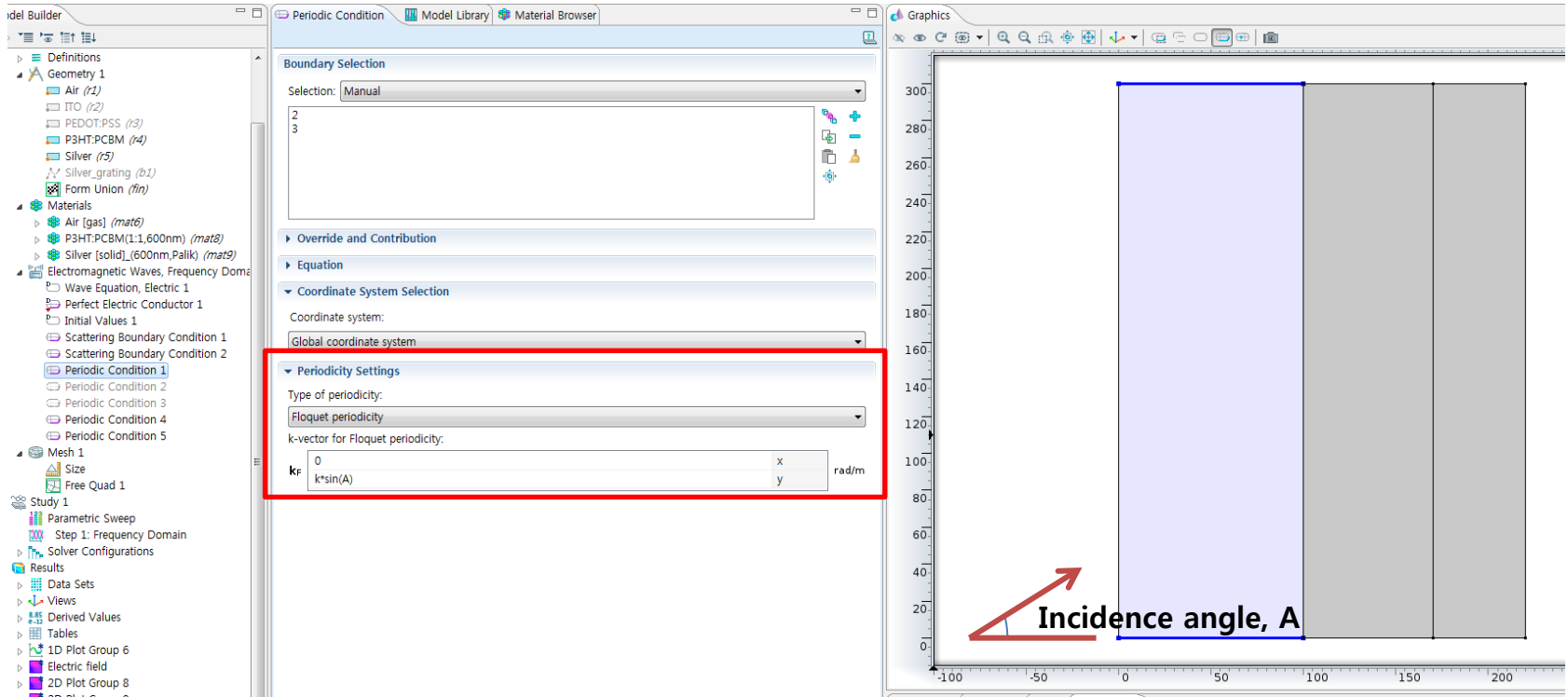
Air : 1000nm



Active layer absorbance : 0.15 정도



Active layer absorbance : 0.004 정도



lsl Builder    Scattering Boundary Condition    Model Library    Material Browser    Graphics

**Definitions**

- Geometry 1
  - Air (r1)
  - ITO (r2)
  - PEDOT:PSS (r3)
  - P3HT:PCBM (r4)
  - Silver (r5)
  - Silver\_grating (b1)
  - Form Union (fin)
- Materials
  - Air [gas] (mat6)
  - P3HT:PCBM(1:1,600nm) (mat8)
  - Silver [solid]\_(600nm,Palik) (mat9)
- Electromagnetic Waves, Frequency Domain
  - Wave Equation, Electric 1
  - Perfect Electric Conductor 1
  - Initial Values 1
  - Scattering Boundary Condition 1**
  - Scattering Boundary Condition 2
  - Periodic Condition 1
  - Periodic Condition 2
  - Periodic Condition 3
  - Periodic Condition 4
  - Periodic Condition 5
- Mesh 1
  - Size
  - Free Quad 1
- Study 1
  - Parametric Sweep
  - Step 1: Frequency Domain
  - Solver Configurations
- Results
  - Data Sets
  - Views
  - Derived Values
  - Tables
  - 1D Plot Group 6
  - Electric field
  - 2D Plot Group 8

**Boundary Selection**

Selection: Manual

1

**Override and Contribution**

**Equation**

**Coordinate System Selection**

Coordinate system: Global coordinate system

**Scattering Boundary Condition**

Incident field: Wave given by E field

Incident electric field:

|       |            |   |     |
|-------|------------|---|-----|
| $E_0$ | $-\sin(A)$ | x | V/m |
|       | $\cos(A)$  | y |     |
|       | 0          | z |     |

Wave type: Plane wave

Wave direction:

|           |           |   |
|-----------|-----------|---|
| $k_{dir}$ | $\cos(A)$ | x |
|           | $\sin(A)$ | y |

**Graphics**

oblique incidence\_simple - HO.mph (root)

- Global Definitions
  - Parameters
- Model 1 (mod1)
  - Definitions
    - Explicit 1
    - Explicit 2
    - Explicit 3
    - Explicit 4
    - Explicit 5
    - Boundary System 1 (sys1)
      - View 1
  - Geometry 1
  - Materials
    - Air [gas] (mat6)
    - P3HT:PCBM(1:1,600nm) (mat8)
    - Silver [solid]\_(600nm,Palik) (mat9)
  - Electromagnetic Waves, Frequency Domain
    - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
      - Scattering Boundary Condition 1
      - Scattering Boundary Condition 2
      - Periodic Condition 1
      - Periodic Condition 2
      - Periodic Condition 3
      - Periodic Condition 4**
      - Periodic Condition 5
  - Mesh 1
  - Study 1
  - Results

**Boundary Selection**

Selection: Manual

5  
6

**Override and Contribution**

Equation

**Coordinate System Selection**

Coordinate system:  
Global coordinate system

**Periodicity Settings**

Type of periodicity:  
Floquet periodicity

k-vector for Floquet periodicity:

|       |               |   |       |
|-------|---------------|---|-------|
| $k_x$ | 0             | x | rad/m |
|       | $k^* \sin(A)$ | y |       |



- Parameters
- Model 1 (mod1)
  - Definitions
    - Explicit 1
    - Explicit 2
    - Explicit 3
    - Explicit 4
    - Explicit 5
    - Boundary System 1 (sys1)
  - View 1
  - Geometry 1
  - Materials
    - Air [gas] (mat6)
    - P3HT-PCBM(1:1,600nm) (mat8)
    - Silver [solid]\_(600nm,Palik) (mat9)
  - Electromagnetic Waves, Frequency Domain
    - Wave Equation, Electric 1
      - Perfect Electric Conductor 1
      - Initial Values 1
      - Scattering Boundary Condition 1
      - Scattering Boundary Condition 2
      - Periodic Condition 1
      - Periodic Condition 2
      - Periodic Condition 3
      - Periodic Condition 4
      - Periodic Condition 5
  - Mesh 1
  - Study 1
  - Results

Selection: Manual

8  
9

Override and Contribution

Equation

Coordinate System Selection

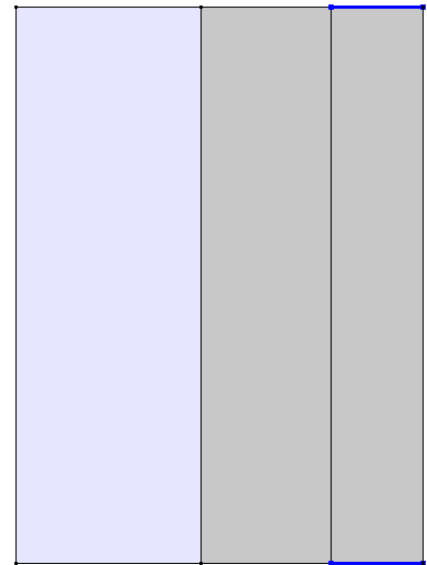
Coordinate system:  
Global coordinate system

Periodicity Settings

Type of periodicity:  
Floquet periodicity

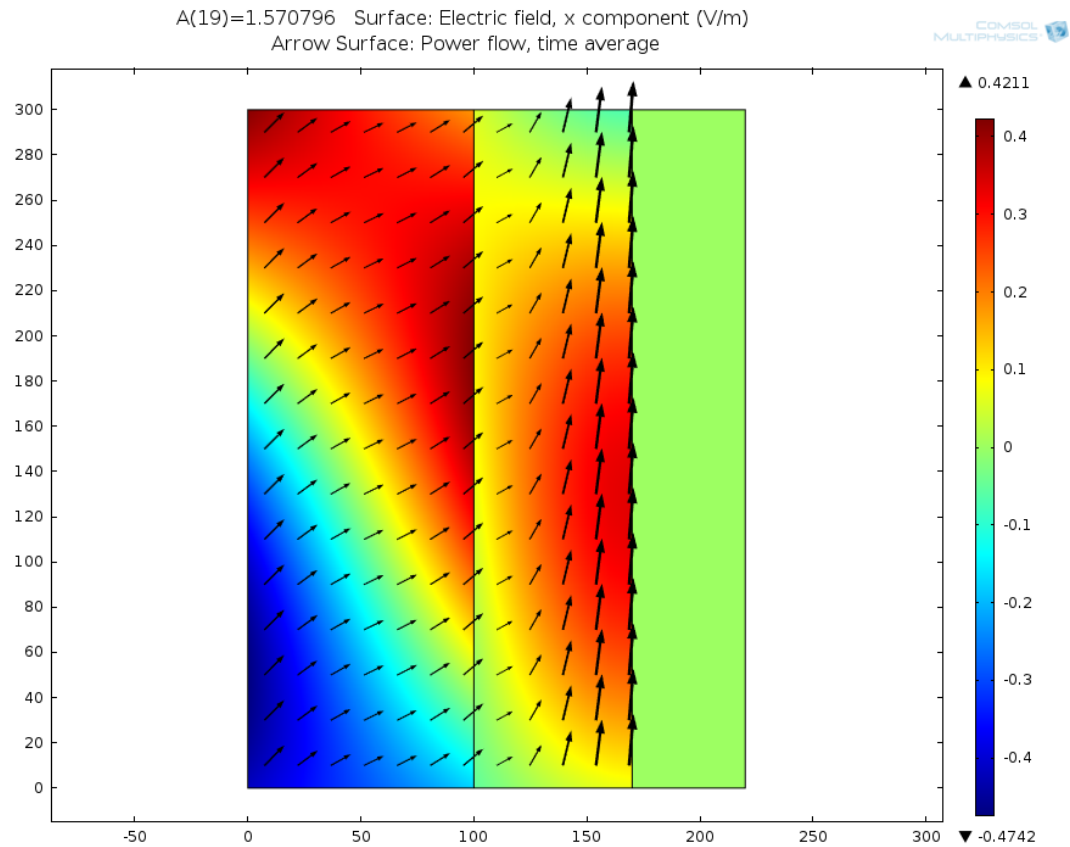
k-vector for Floquet periodicity:

|                   |   |       |
|-------------------|---|-------|
| 0                 | x | rad/m |
| $k \cdot \sin(A)$ | y |       |



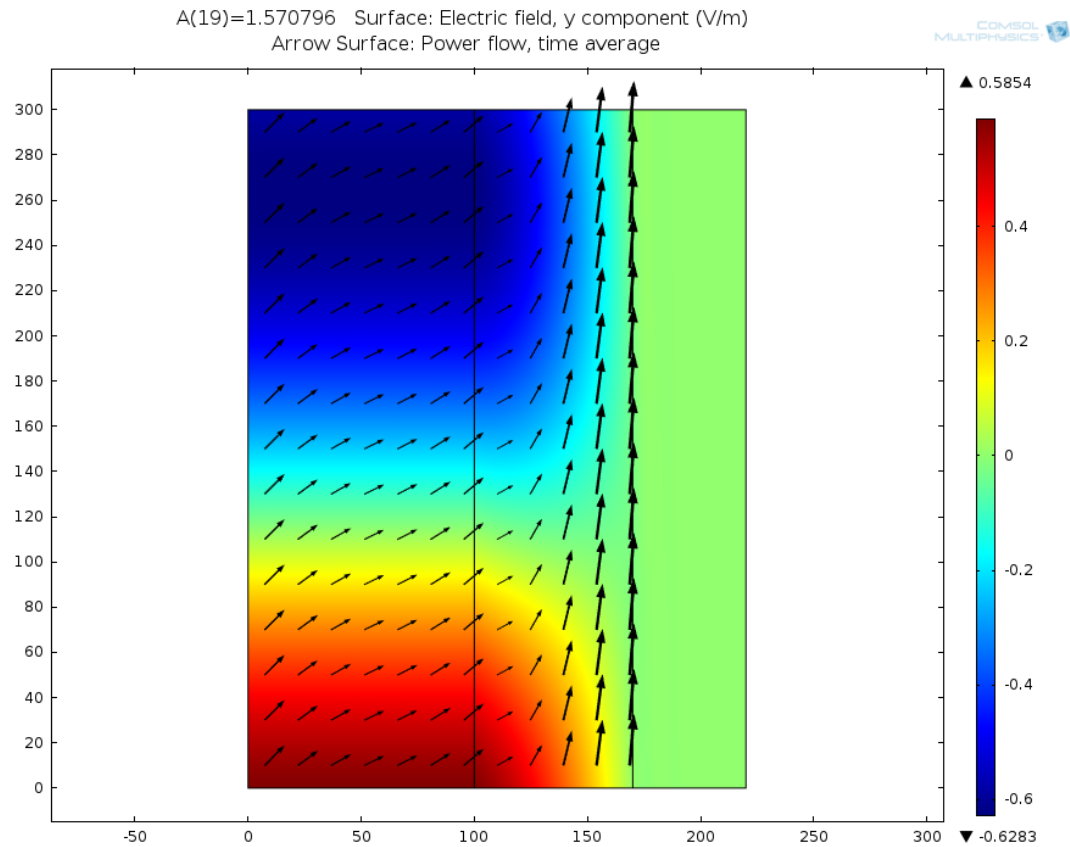
# Arrow Surface: Power flow Surface: Electric field, x component

Oblique  
incidence,  
 $A=90^\circ$



# Arrow Surface: Power flow Surface: Electric field, y component

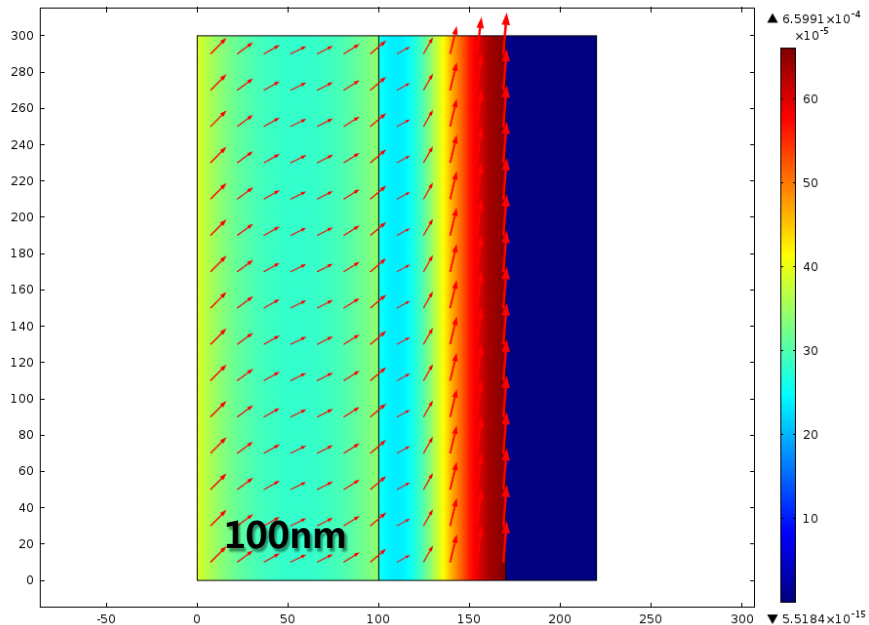
Oblique  
incidence,  
 $A=90^\circ$



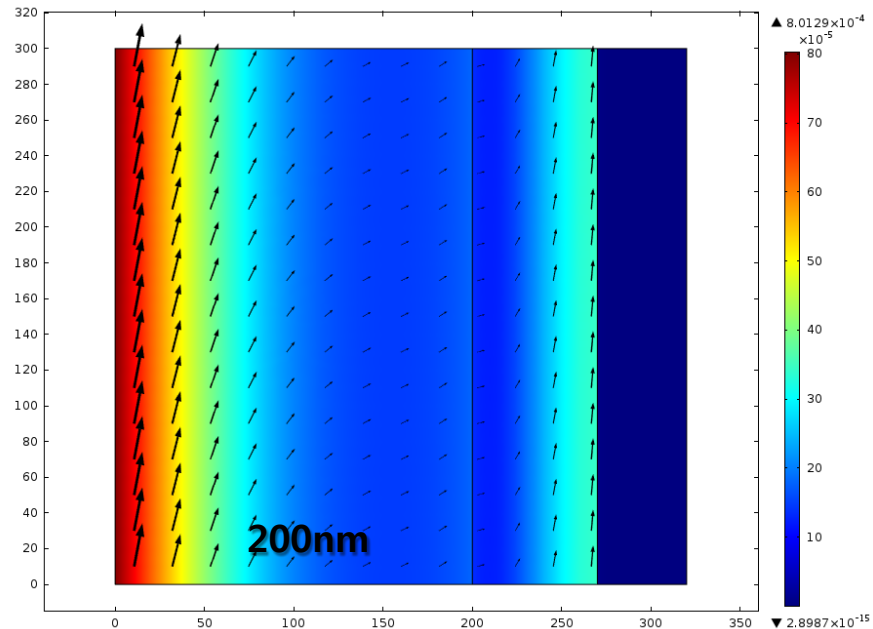
A=90°

# Varying the thickness of air layer

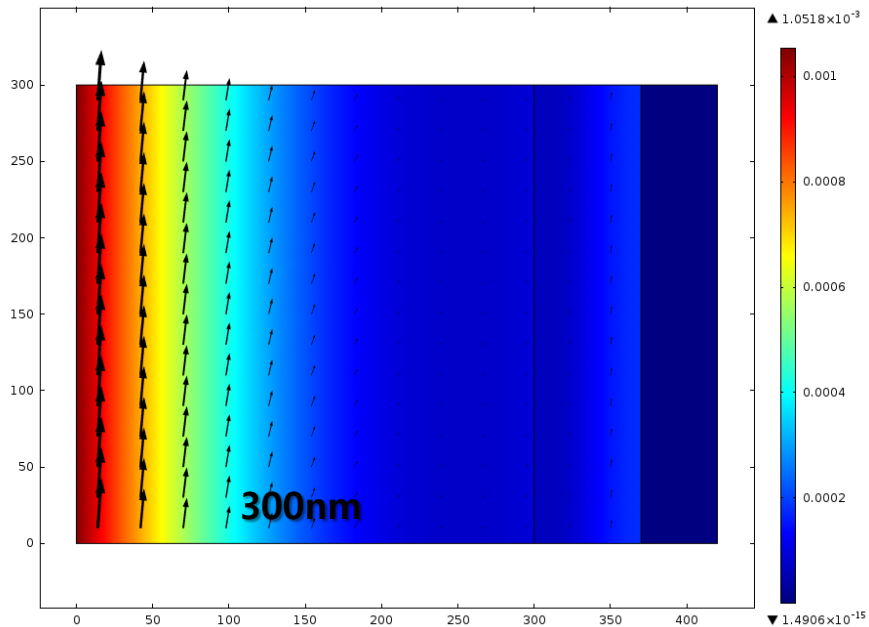
A(4)=1.570796 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average



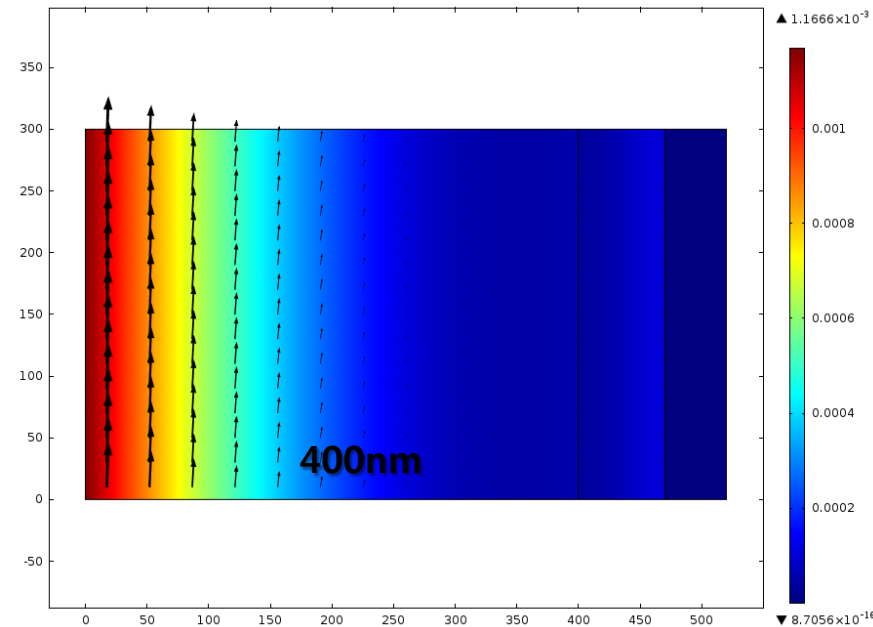
A(19)=1.570796 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average



freq(1)=4.996541e14 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average



freq(1)=4.996541e14 Surface:  $\sqrt{\text{emw.Poavx}^2 + \text{emw.Poavy}^2 + \text{emw.Poavz}^2}$  (W/m<sup>2</sup>)  
Arrow Surface: Power flow, time average



# Plasmonic wire grating (comsol model library)

Oblique  
incidence,  
 $A=90^\circ$

