External Light Source-Transmission Reflection

-TRACmd.pyc

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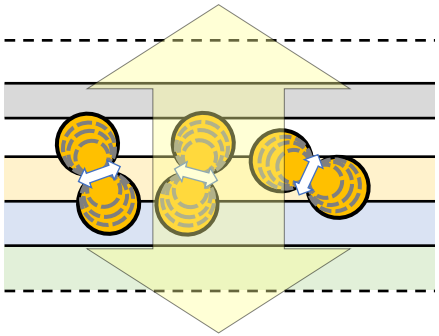
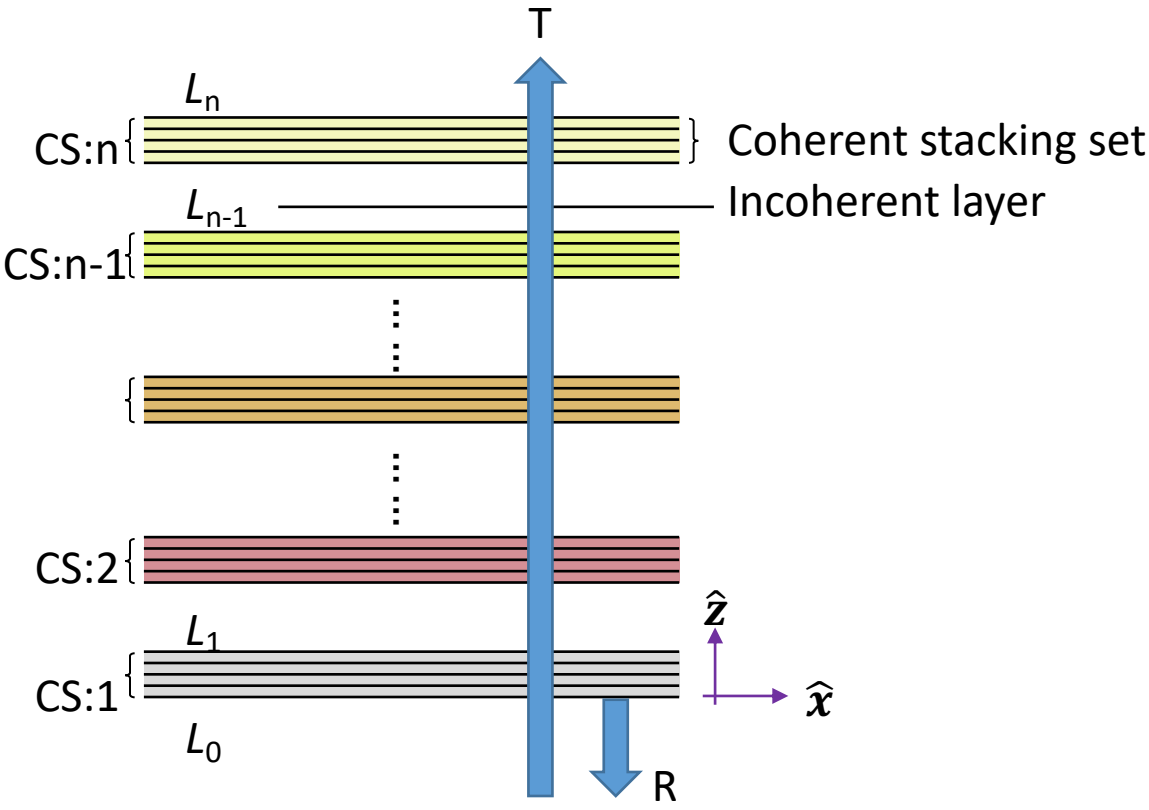


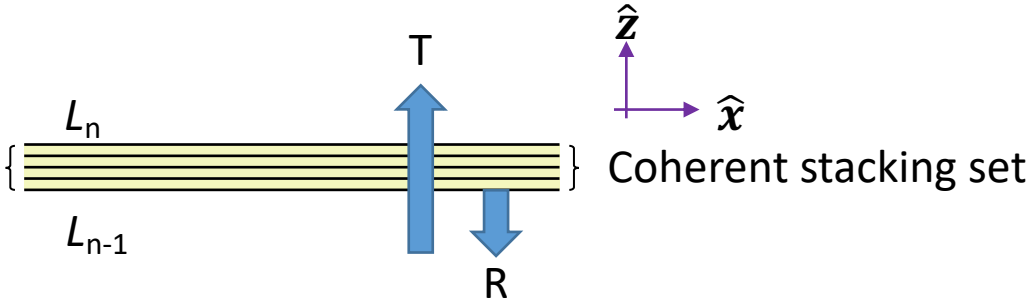
Objective

- This program calculates the total transmittance and the reflectance.



T, R of a coherent set

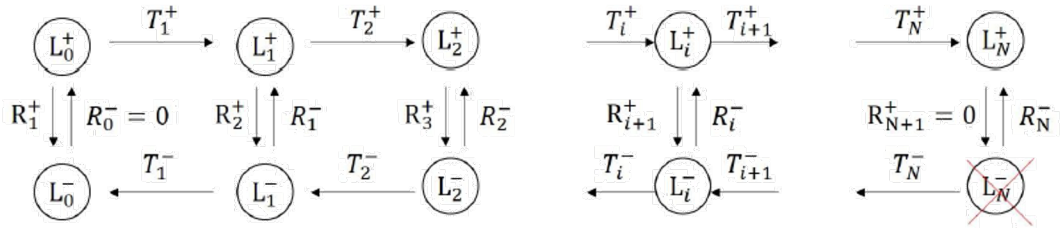
TMM ✚ Coherent stacking



External Light Source

Finite State Machine Method

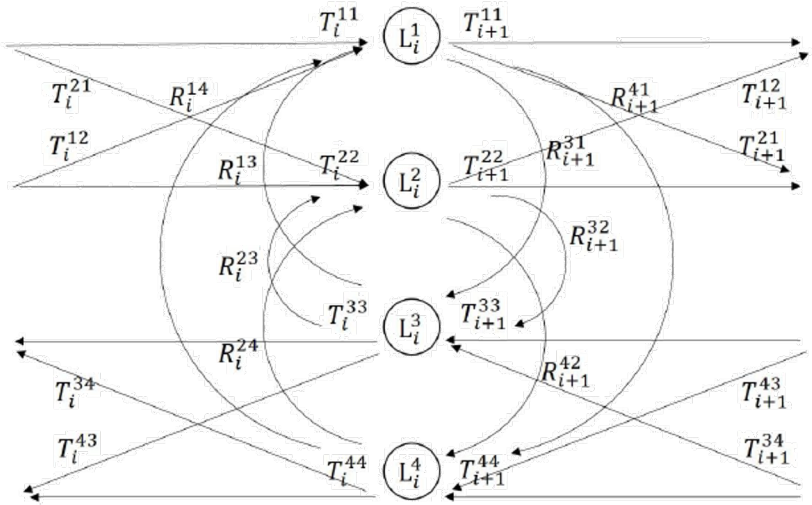
(a) Isotropic Case/ Uniaxial and $\hat{c}$ // $\hat{z}$ case



$$L_i^+ = T_i^+ L_{i-1}^+ + R_i^- L_i^-$$

$$L_i^- = T_{i+1}^- L_{i+1}^- + R_{i+1}^+ L_i^+$$

(b) General Case



$$L_i^1 = T_i^{11} L_{i-1}^1 + T_i^{12} L_{i-1}^2 + R_i^{13} L_i^3 + R_i^{14} L_i^4$$

$$L_i^2 = T_i^{21} L_{i-1}^1 + T_i^{22} L_{i-1}^2 + R_i^{23} L_i^3 + R_i^{24} L_i^4$$

$$L_i^3 = T_{i+1}^{33} L_{i+1}^3 + T_{i+1}^{34} L_{i+1}^4 + R_{i+1}^{31} L_i^1 + R_{i+1}^{32} L_i^2$$

$$L_i^4 = T_{i+1}^{43} L_{i+1}^3 + T_{i+1}^{44} L_{i+1}^4 + R_{i+1}^{41} L_i^1 + R_{i+1}^{42} L_i^4$$

How to execute TR calculator

python: windows
python3: mac, linux

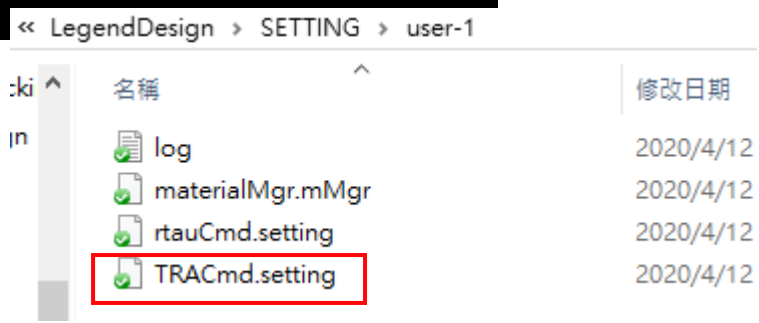
```
>python TRACmd.py
```

Execution file

```
>>> Please insert username : user-1
```

Type user name

```
TRA Setting is not built in ../../SETTING/user-1
Now saving the default TRA setting.
<TRACmd>
```



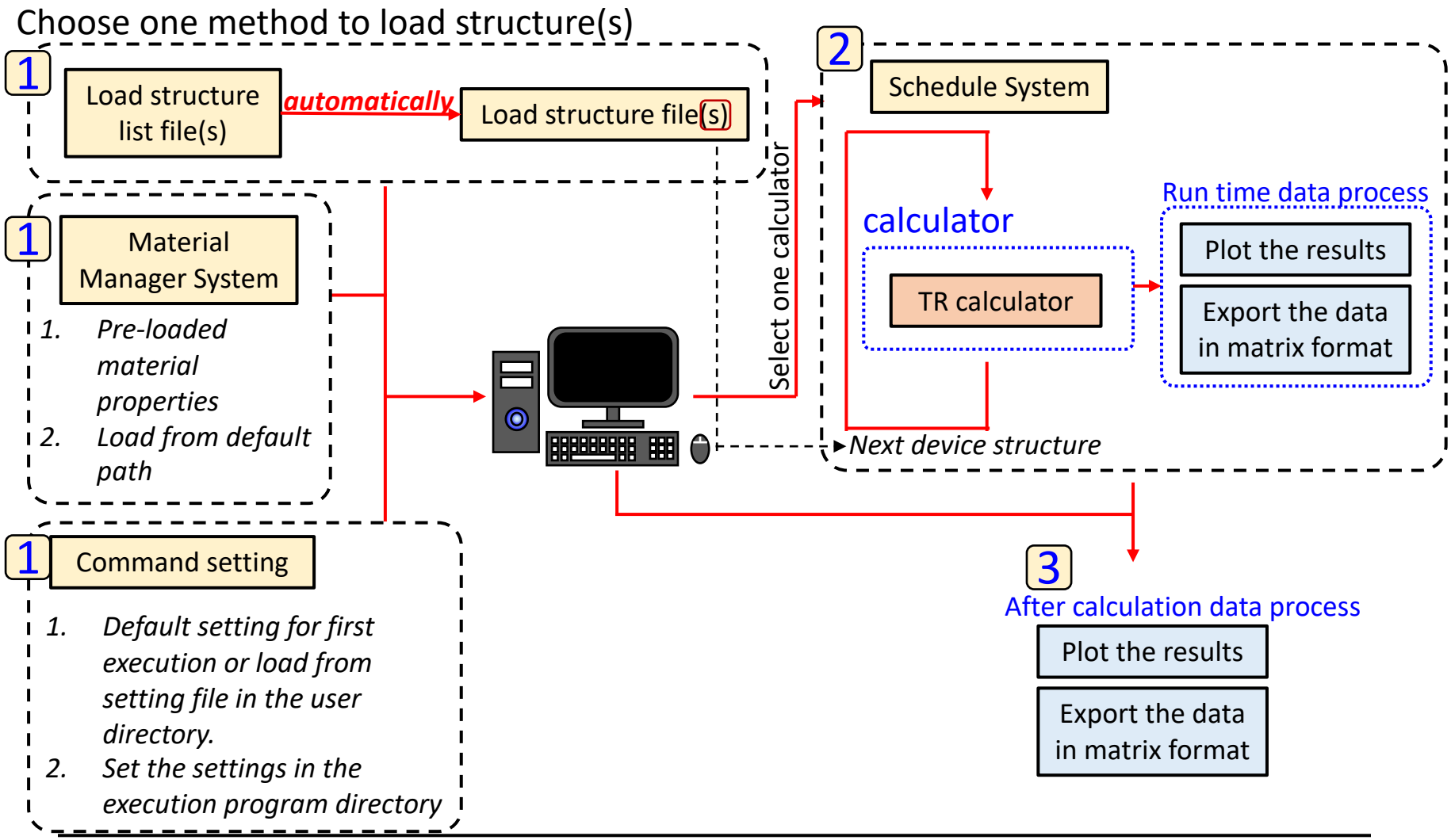
Help

```
<TRACmd> ?
User Control Command
========================================
1. Settting Command:
changeUser              exit

Material Manager Command
========================================
1. Settting Command:
printMgr                saveMgr

Structure/Structure List Command
========================================
1. Structure List Command:
ReadStructListPath      ReadStructListName
SaveStructListPath      SaveStructListName
readStructList          saveStructList

2. Structure Command:
ReadStructPath          ReadStructName
SaveFilePath            SaveFileName
readStruct              deleteStruct

3. Print Information Command:
printStructInfo         printStructSettingInfo
printListInfo

4. Result Command:
ResultFilePath          ResultFileName
deleteResult
save_run_time_result_Bool
resetSN
```

Help

```
Transmission/Reflection Command
=======================================
1. Settting Command:
SettingFilePath      SettingFileName
setDefaultSetting    printTRAInfo
loadTRASETTING       saveTRASETTING

2. kxky:
kxko                 kyko                Wavelength          ----Parameter
IncidenceWaveDirection ----Parameter
runTRA_kxky          readResultskxky
plotTRAvsWV_kxky     plotTRAvskxky
plotTRAContourkxky   writekxkyMatrix

3. angle:
Theta                Phi                 Wavelength          ----Parameter
IncidenceWaveDirection ----Parameter
runTRA_Angle         readResultsAngle
plotTRAvsWV_Angle    plotTRAvsAngle
plotTRAContourAngle  writeAngleMatrix

4. Plot Bool:
changefigshowBool

5. Run Time Bool:
runtime_write_matrix runtime_plotvsWV
runtime_plotvsXY     runtime_plotvsContour
```

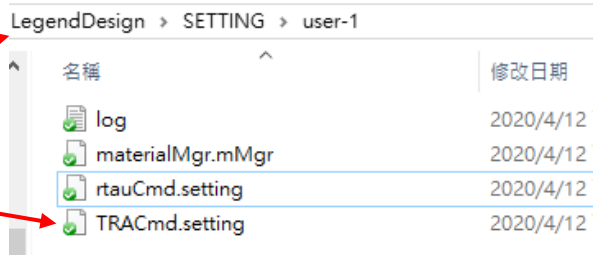
Calculating Workflow



Default Setting

Print setting

```
>>> printTRAInfo

Setting file path : ../../SETTING/user-1
Setting file name : TRACmd.setting
Wavelength (nm) : 380.00000:10.00000:780.00000
Theta (degree) : 0.00000:1.00000:90.00000
Phi (degree) : 0.0
kx/ko : 0.00000:0.10000:1.00000
ky/ko : 0.00000:0.10000:1.00000
Incidence Direction    : TOP
Save-run-time result bool       : True
Run-time-write-matrix bool      : False
Run-time-plot-TRA-contour bool : False
Run-time-plot-TRA-vs-Wavelength bool : False
Run-time-plot-TRA-vs-Angle or -kxky bool : False
Figure Show Bool : True
```



All the setting would **automatically** saved into the setting file when the program **finished**. The user can set the setting at first or share the setting files with others.

Setting

```
Wavelength (nm) : 380.00000:10.00000:780.00000
```

The wavelength of the incident light. The format of the wavelength is the same as in the parameter scan. (i.e. value/start:space:end/(value1,value2,value3))

Wavelength setting method

```
<TRACmd> help Wavelength
Set wavelength (nm). (Empty for delete setting)
[Usage] Wavelength [wavelength] - single value, start:spacing:end, (v1,v2,v3,v4)
```

Setting

```
Theta (degree) : 0.00000:1.00000:90.00000
Phi (degree) : 0.0
```

The angle of the incident wave.

Angle setting method

```
<TRACmd> help Theta
Set theta (degree). (Empty for delete setting)
[Usage] Theta [theta] - single value, start:spacing:end, (v1,v2,v3,v4)

<TRACmd> help Phi
Set phi (degree). (Empty for delete setting)
[Usage] Phi [phi] - single value, start:spacing:end, (v1,v2,v3,v4)
```

```
kx/ko : 0.00000:0.10000:1.00000
ky/ko : 0.00000:0.10000:1.00000
```

The tangential components of the incident wave.

kx/ko and ky/ko setting method

```
<TRACmd> help kxko
Set kx/ko. (Empty for delete setting)
[Usage] kxko [kxko] - single value, start:spacing:end, (v1,v2,v3,v4)

<TRACmd> help kyko
Set ky/ko. (Empty for delete setting)
[Usage] kyko [kyko] - single value, start:spacing:end, (v1,v2,v3,v4)
```

Only one would be used in a calculation.

Run Time Setting

```
Save-run-time result bool      : True
```

Whether to save the data in the memory after the calculation. If the user would like to execute plot or other data manipulation commands, the save-run-time-result bool should be “True”. However, the user should notice the memory usage when scanning a lot of parameters.

```
Run-time-write-matrix bool  : False
```

Whether to save the matrix format when calculation.

```
Run-time-plot-TRA-vs-Wavelength bool : False
Run-time-plot-TRA-vs-Angle or -kxky bool : False
```

Whether to plot the TRA results when calculation.

Calculate TRA

MATERIAL	THICKNESS(nm)
1.0	X
1.5	X

wavelength(nm) : 480.0:10.0:600.0

Calculate TRA

Structure file (DBR)

MATERIAL	THICKNESS(nm)
air	X
1.5	100
2.5	60
1.5	100
2.5	60
1.5	100
2.5	60
air	X

wavelength(nm) : 480.0:10.0:600.0

Name	readfilename	readfilepath	savefilename	
#sds1	sfile-1.txt	./Example/structure/DielectricStacking	sfile-1	../../E
#sds2	sfile-2.txt	./Example/structure/DielectricStacking	sfile-1	../../E

Calculate TRA

Structure file (transparent device-1)

MATERIAL	THICKNESS(nm)
air	X
Al	10:5:20
LiF	1.000000
B3PYMPM	50
CBP	20.000000
TAPC	20
cito	50
glass	X

scan

```
wavelength(nm) : 450:10:650.0
EML :
    Layerno                 : 5
    Position(nm)            : 10.000000
    ratio                   : 1.000000
    QY                      : 1.000000
    Fluorescence            : cbp_irppy2acac
    DOF                     : cbp_irppy2acac
```

Calculate TRA

Structure file (transparent device-2)

MATERIAL	THICKNESS(nm)
air	X
Al	10:5:20
LiF	1.000000
B3PYMPM	50
CBP	20.000000
TAPC	20
cito	50
glass	X
air	X

scan

```
wavelength(nm) : 450:10:650.0
EML :
    Layerno                 : 5
    Position(nm)            : 10.000000
    ratio                   : 1.000000
    QY                      : 1.000000
    Fluorescence            : cbp_irppy2acac
    DOF                     : cbp_irppy2acac
```

Example-1.txt | sfile-1-air.txt | structureList-TRACmd.txt

Name	readfilename	readfilepath	savefilename	
#Ts1	sfile-1.txt	./Example/structure/Transparent	sfile-1	../
#Ts2	sfile-1-air.txt	./Example/structure/Transparent	sfile-1	../

Calculate TRA

```
>>> ReadStructListPath  ./Example/structure/DielectricStacking

>>> ReadStructListName  structureList-TRACmd.txt

>>> readStructList

Now reading structure list file ./Example/structure/DielectricStacking\structureList-TRACmd.txt
  No./Name       filename       savefilename  CommandID  Check                              readfilepath
-------------------------------------------------------------------------------------------------------------------------------
     #sds1    sfile-1.txt            sfile-1       0.0      X  ./Example/structure/DielectricStacking  ../../Example/TRACmd/Dielectri
     #sds2    sfile-2.txt            sfile-1       0.0      X  ./Example/structure/DielectricStacking  ../../Example/TRACmd/Dielectri


Structure file reading...
-------------------------------------------------------------------------------------------
Now reading structure file ./Example/structure/DielectricStacking\sfile-1.txt
Now reading structure file ./Example/structure/DielectricStacking\sfile-2.txt
```

```
>>> ReadStructListPath  ./Example/structure/Transparent

>>> ReadStructListName  structureList-TRACmd.txt

>>> readStructList

Now reading structure list file ./Example/structure/Transparent\structureList-TRACmd.txt
  No./Name         filename         savefilename  CommandID  Check                      readfilepath
-------------------------------------------------------------------------------------------------------------------------------
      #Ts1      sfile-1.txt            sfile-1       0.0      X  ./Example/structure/Transparent      ../../Example/TRACmd/Tr
      #Ts2  sfile-1-air.txt            sfile-1       0.0      X  ./Example/structure/Transparent  ../../Example/TRACmd/Transp


Structure file reading...
-------------------------------------------------------------------------------------------
Now reading structure file ./Example/structure/Transparent\sfile-1.txt
Now reading structure file ./Example/structure/Transparent\sfile-1-air.txt
```

Calculate TRA

```
>>> printStructInfo

****************************************
Name: #sds1
[#]   Material              Thickness(nm)
----------------------------------------
[1]   1.0                   X
[2]   1.5                   X

wavelength(nm) : 480.00000:10.00000:600.00000

Device number : 1


****************************************
Name: #sds2
[#]   Material              Thickness(nm)
----------------------------------------
[1]   air                   X
[2]   1.5                   100.0
[3]   2.5                   60.0
[4]   1.5                   100.0
[5]   2.5                   60.0
[6]   1.5                   100.0
[7]   2.5                   60.0
[8]   air                   X

wavelength(nm) : 480.00000:10.00000:600.00000

Device number : 1
```

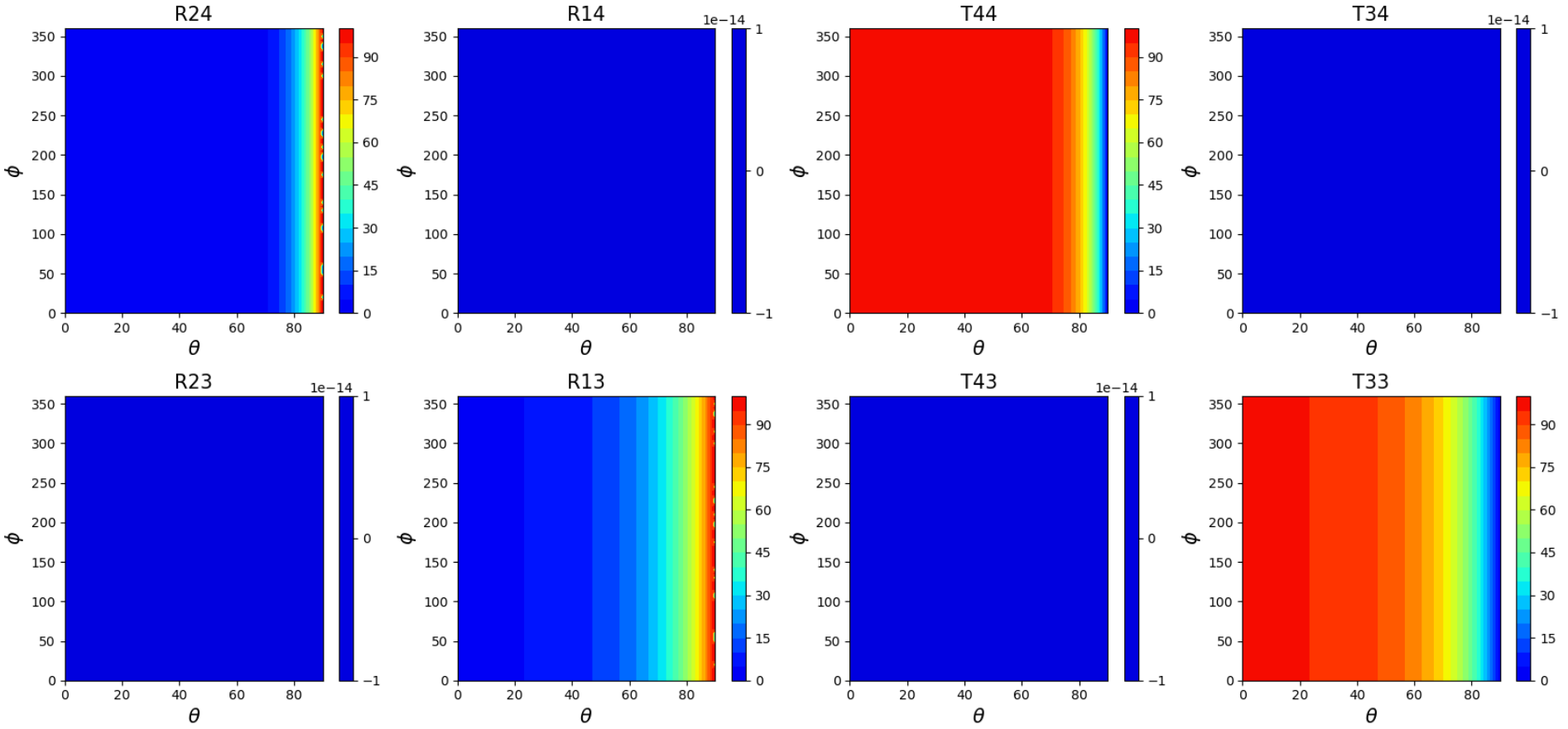
```
****************************************
Name: #Ts1
[#]   Material              Thickness(nm)
----------------------------------------
[1]   air                   X
[2]   Al                    10.00000:5.00000:20.00000
[3]   LiF                   1.0
[4]   B3PYMPM               50.0
[5]   CBP                   20.0
[6]   TAPC                  20.0
[7]   cito                  50.0
[8]   glass                 X

wavelength(nm) : 450.00000:10.00000:650.00000

EML   Fluorescence    DOF             Position(nm)    PLQY            Ratio
------------------------------------------------------------------------------------------
[5]   cbp_irppy2acac  cbp_irppy2acac  10.0            1.0             1.0
Device number : 3


****************************************
Name: #Ts2
[#]   Material              Thickness(nm)
----------------------------------------
[1]   air                   X
[2]   Al                    10.00000:5.00000:20.00000
[3]   LiF                   1.0
[4]   B3PYMPM               50.0
[5]   CBP                   20.0
[6]   TAPC                  20.0
[7]   cito                  50.0
[8]   glass                 X
[9]   air                   X

wavelength(nm) : 450.00000:10.00000:650.00000

EML   Fluorescence    DOF             Position(nm)    PLQY            Ratio
------------------------------------------------------------------------------------------
[5]   cbp_irppy2acac  cbp_irppy2acac  10.0            1.0             1.0
Device number : 3
```

Calculate TRA

```
>>> Wavelength  500:50:600

>>> Theta 0:1:90

>>> Phi 0:5:360

>>> runtime_write_matrix T

>>> runtime_plotvsWV F

>>> runtime_plotvsContour T

>>> runtime_plotvsXY F

>>> runTRA_Angle

Now running structure (#1/#4) #sds1 ...
¦Device-#1/#1¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/0min(s)/9sec(s)
Now running structure (#2/#4) #sds2 ...
¦Device-#1/#1¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/0min(s)/14sec(s)
Now running structure (#3/#4) #Ts1 ...
¦Device-#3/#3¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/0min(s)/44sec(s)
Now running structure (#4/#4) #Ts2 ...
¦Device-#3/#3¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/1min(s)/9sec(s)
>>> ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
```

Plot

MATERIAL	THICKNESS(nm)
1.0	X
1.5	X

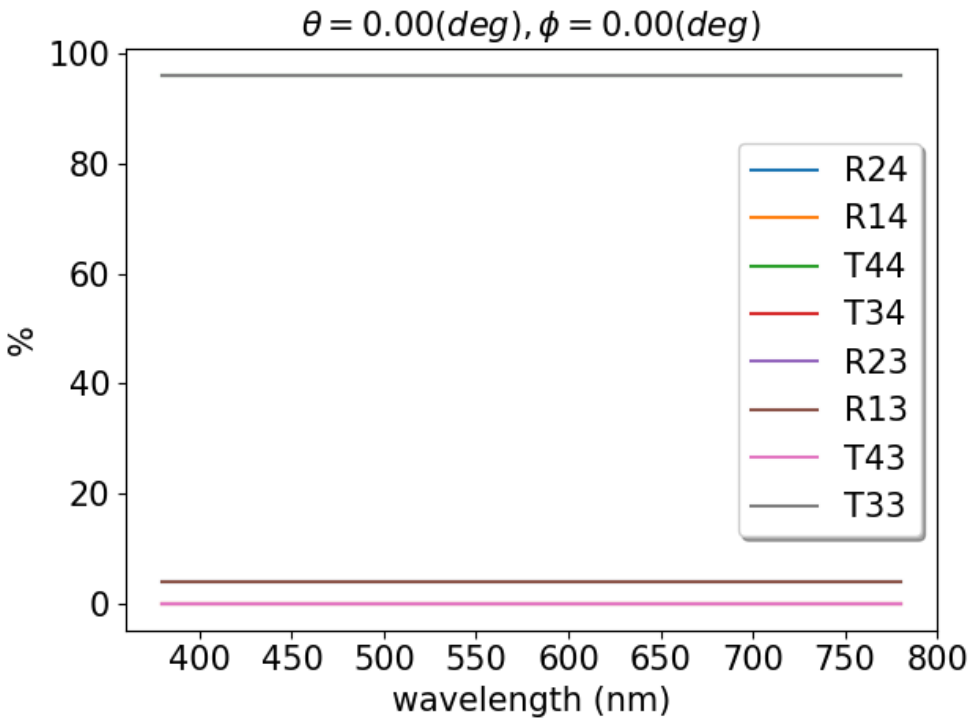


Calculate TRA

```
>>> Wavelength  380:1:780

>>> Theta (0,30,45,60)

>>> Phi 0

>>> runtime_write_matrix F

>>> runtime_plotvsWV T

>>> runtime_plotvsContour F

>>> runtime_plotvsXY F

>>> runTRA_Angle

Now running structure (#1/#4) #sds1 ...
¦Device-#1/#1¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/0min(s)/2sec(s)
Now running structure (#2/#4) #sds2 ...
¦Device-#1/#1¦(100%)>>>>>>>>>>>>>>>>>>>>¦Elapsed:0day(s)/0hr(s)/0min(s)/4sec(s)
Now running structure (#3/#4) #Ts1 ...
```

Plot

MATERIAL	THICKNESS(nm)
1.0	X
1.5	X

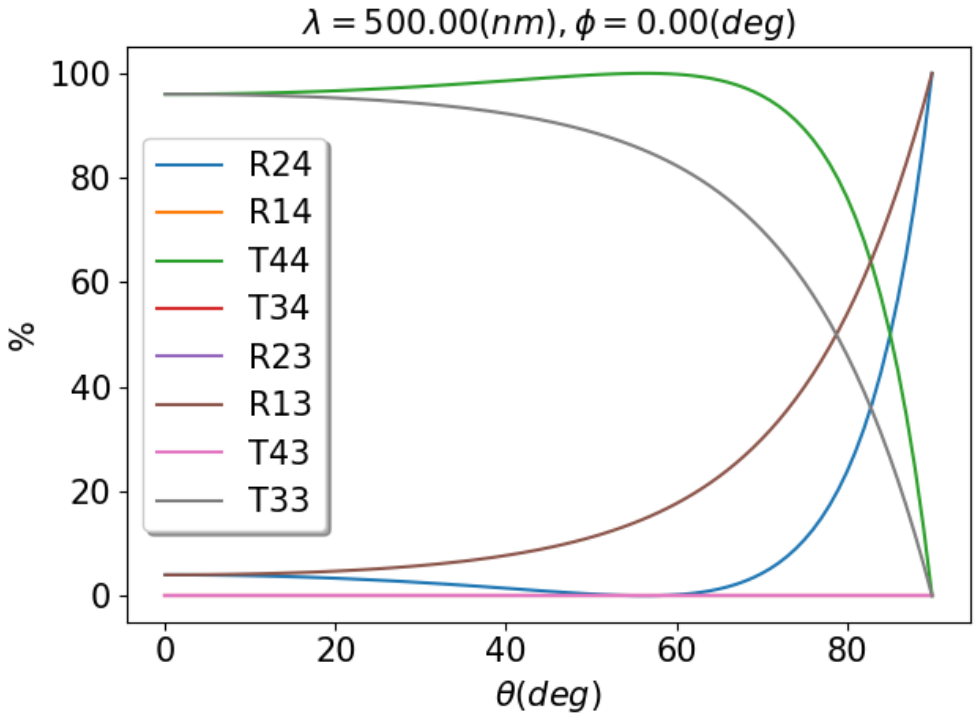


Calculate TRA

```
>>> Wavelength  500:50:600

>>> Theta 0:1:90

>>> Phi 0

>>> runtime_write_matrix T

>>> runtime_plotvsWV F

>>> runtime_plotvsContour T

>>> runtime_plotvsXY T

>>> runTRA_Angle

Now running structure (#1/#4) #sds1 ...
|Device-#1/#1|(100%)>>>>>>>>>>>>>>>>>>>>|Elapsed:0day(s)/0hr(s)/0min(s)/2sec(s)
Now running structure (#2/#4) #sds2 ...
|Device-#1/#1|(100%)>>>>>>>>>>>>>>>>>>>>|Elapsed:0day(s)/0hr(s)/0min(s)/3sec(s)
Now running structure (#3/#4) #Ts1 ...
|Device-#3/#3|(100%)>>>>>>>>>>>>>>>>>>>>|Elapsed:0day(s)/0hr(s)/0min(s)/10sec(s)
Now running structure (#4/#4) #Ts2 ...
|Device-#3/#3|(100%)>>>>>>>>>>>>>>>>>>>>|Elapsed:0day(s)/0hr(s)/0min(s)/11sec(s)
```

Plot

MATERIAL	THICKNESS(nm)
1.0	X
1.5	X



Exit the material manager system

Exit the material manager system.
*** The material manager system would be automatically saved into the user's setting directory.

```
>>> exit

------------------------------------------------------------------------------------------------------
End running GOODLAB anisotropic simulator ver1.0 Sun Apr 12 21:25:18 2020
Elapsed time : 0 day(s)/ 0 hr(s)/ 3 min(s)/ 38.60393166542053 sec(s)
------------------------------------------------------------------------------------------------------
```