Supplement EM
Multilayer Optical Thin-Film Analysis Software Program

CONTENTS

I. INTRODUCTION

Supplement EM. This supplement contains the listings of all the Matlab .m files used in determining the reflectance and transmittance characteristics of multilayer optical thin-film structures. In addition, there are files for displaying graphical results. A number of Matlab script .m files contain examples of various multilayer optical thin-film structures.

II. MAIN PROGRAM

The main program, called AEM.m, is the first program in the listing.

AEM.m

```
% MAIN PROGRAM NAME: AEM
clear; clf; clc
% Step 1: Specify Initial Quantities
Prelim; Structure
% Step 2: Compute TE and TM Incident Wavefunctions
[PsiI_TE,PsiI_TM] = PsiI(ThetaI,epP,muP);
% Step 3: Draw Thin-Film Structure
[XYZ] = DrawTFS(IndexP,IndexQ,IndexF,ThickP,ThickQ,ThickF,DS,CG);
% Step 4: Region P, Q, and F Calculations
RegionP; RegionQ; RegionF;
% Step 5: Vary the Vacuum Wavelength
for Lamb = LambMin:LambDel:LambMax
% Step 6: Compute Thin-Film Phases and Matrix Q
Phases; MatrixQ;
% Step 7: Compute the Matrices MR and MT
[MR,MT] = MatrixMRMT(Q);
% Step 8: Compute Reflectance and Transmittance
Wavefunction; Probability;
end
% Step 9: Plot Reflectance and Transmittance
[FIN] = PlotRef(RTE,RTM,LambMin,LambMax,LambDel,ThetaI,CG);
[RPB] = PlotTra(TTE,TTM,LambMin,LambMax,LambDel,CG);
```

III. MATLAB .M FUNCTION FILES

All the Matlab .m Function files are next listed in alphabetical order.

Angle.m

```
% FUNCTION: Angle
function [Theta] = Angle(ThetaI,IndexP,Index)
Theta = asind((IndexP/Index)*sind(ThetaI));
end
```

Color.m

```
% FUNCTION: Color
function [v] = Color(n,GC)
a = real(n);
if GC == 1; v = [0.7 0.7 0.7];
if a >= 0.99, v = [1 1 1]; end
if a >= 1.01, v = [1 0 0]; end
if a >= 1.25, v = [0 1 1]; end
if a >= 1.50, v = [0 1 0]; end
if a >= 1.75, v = [1 1 0]; end
if a >= 2.00, v = [0 0 1]; end
if a >= 2.25, v = [1 0 1]; end
if a >= 2.50, v = [0 0 0]; end
 else; v = [1 1 1];
if a >= 0.99, v = [1 1 1]*0.95; end
if a >= 1.01, v = [1 1 1]*0.90; end
if a >= 1.25, v = [1 1 1]*0.85; end
if a >= 1.50, v = [1 1 1]*0.80; end
if a >= 1.75, v = [1 1 1]*0.75; end
if a >= 2.00, v = [1 1 1]*0.70; end
if a >= 2.25, v = [1 1 1]*0.65; end
if a >= 2.50, v = [1 1 1]*0.60; end
end
end
```

DrawTFS.m

```
% FUNCTION: DrawTFS
function [XYZ] = DrawTFS(NP,NQ,NF,TP,TQ,TF,DS,CG)
XYZ = 'Goodbye';
figure(1); clf
if CG == 1
BC = [1.0 0.9 0.7]; else
BC = [1.0 1.0 1.0]; end
set(1,'Color',BC)
HA = axes('position',[0.05 0.10 0.35 0.80]);
H = sum(TF) + 100;
HP = plot([0 0 1 1],[0 H H 0],'-k');
set(HP,'Color',BC)
hold on
MI = 0; MA = 50;
HF = fill([0.3 0.3 0.7 0.7],[MI MA MA MI],Color(NP,CG));
HT = text(0.85,(MI+MA)/2,[sprintf('%4.3f',NP) ]);
set(HT,'FontSize',[15],'FontWeight','Bold')
if NP == 1
HT = text(0.1,(MI+MA)/2,'Air'); else
HT = text(0.1,(MI+MA)/2,'Glass'); end
set(HT,'FontSize',[15],'FontWeight','Bold')
HT = text(0.42,(MI+MA)/2,'Entrance');
set(HT,'FontSize',[15],'FontWeight','Bold')
wsize = size(TF,2);
MI = MA;
for ws = 1:wsize
MA = MI + TF(ws);
HF = fill([0.3 0.3 0.7 0.7],[MI MA MA MI],Color(NF(ws),CG));
HT = text(0.75,(MI+MA)/2,[sprintf('%4.3f',real(NF(ws)))]);
set(HT,'FontSize',[15],'FontWeight','Bold')
if imag(NF(ws)) > 0
HT = text(0.83,(MI+MA)/2,['+ ' sprintf('%4.3f',imag(NF(ws))) 'i']);
set(HT,'FontSize',[15],'FontWeight','Bold')
end
HT = text(0.2,(MI+MA)/2,[sprintf('%4.0f',TF(ws))]);
set(HT,'FontSize',[15],'FontWeight','Bold')
MI = MA;
end
MA = MI + 50;
HF = fill([0.3 0.3 0.7 0.7],[MI MA MA MI],Color(NQ,CG));
HT = text(0.85,(MI+MA)/2,[sprintf('%4.3f',NQ) ]);
set(HT,'FontSize',[15],'FontWeight','Bold')
if NQ == 1
HT = text(0.1,(MI+MA)/2,'Air'); else
HT = text(0.1,(MI+MA)/2,'Glass'); end
set(HT,'FontSize',[15],'FontWeight','Bold')
HT = text(0.47,(MI+MA)/2,'Exit');
set(HT,'FontSize',[15],'FontWeight','Bold')
set(HA,'Color',BC,'XColor',BC,'YColor',BC)
HT = title(DS);
set(HT,'FontSize',[15],'FontWeight','Bold')
HX = xlabel('Thickness (nm)              Index');
set(HX,'FontSize',[15],'FontWeight','Bold','Color',[0 0 0])
clc
end
```

MatrixA.m

```
% FUNCTION: MatrixA
function [A] = MatrixA(ax,ay,az)
A = zeros(6,6);
A(2,6) = -ax; A(3,5) = +ax; A(5,3) = -ax; A(6,2) = +ax;
A(1,6) = +ay; A(3,4) = -ay; A(4,3) = +ay; A(6,1) = -ay;
A(1,5) = -az; A(2,4) = +az; A(4,2) = -az; A(5,1) = +az;
end
```

MatrixC.m

```
% FUNCTION: MatrixC
function [C] = MatrixC(ep,mu)
C = eye(6,6); C(3,3) = ep; C(6,6) = mu;
end
```

MatrixM.m

```
% FUNCTION: MatrixM
function [M] = MatrixM(NR,NL,C)
M11 = C;      M12 = C*NL;
M21 = C*NR; M22 = C;
M = [M11 M12; M21 M22];
end
```

MatrixMRMT.m

```
% FUNCTION: MatrixMRMT
function [MR,MT] = MatrixMRMT(Q)
Q11 = Q(1:6,1:6);
Q12 = Q(1:6,7:12);
Q21 = Q(7:12,1:6);
Q22 = Q(7:12,7:12);
MR = Q21*inv(Q11); MT = inv(Q11);
end
```

MatrixN.m

```
% FUNCTION: MatrixN
function [N] = MatrixN(A,W)
N = inv(W)*A;
end
```

MatrixP.m

```
% FUNCTION: MatrixP
function [P] = MatrixP(w,n,theta,lamda)
phi = 2*pi*n*(w/lamda)*cosd(theta);
P = zeros(12,12);
P(1:6,1:6)    = eye(6,6)*exp(+i*phi);
P(7:12,7:12) = eye(6,6)*exp(-i*phi);
end
```

MatrixW.m

```
% FUNCTION: MatrixW
function [W] = MatrixW(ep,mu,n)
W = zeros(6,6);
W(1,1) = -ep/n; W(2,2) = -ep/n; W(3,3) = -ep/n;
W(4,4) = +mu/n; W(5,5) = +mu/n; W(6,6) = +mu/n;
end
```

PlotRef.m

```
% FUNCTION: PlotRef
function [FIN] = PlotRef(RTE,RTM,LMIN,LMAX,LDEL,THE,CG)
x = LMIN:LDEL:LMAX;
HA = axes('position',[0.50 0.50 0.45 0.30]);
if CG == 1
HH = plot(x,100*real(RTE),'-r',x,100*real(RTM),'-b');
else
HH = plot(x,100*real(RTE),'ok',x,100*real(RTM),'xk');
end
set(HH,'LineWidth',[5]): set(HH,'MarkerSize',[1])
Hx = xlabel('Vacuum Wavelength (nm)');
set(Hx,'FontSize',[15],'FontWeight','Bold')
Hy = ylabel('Reflectance ( % )');
set(Hy,'FontSize',[15],'FontWeight','Bold')
axis([min(x) max(x) -2 102])
set(HA,'xtick',[LMIN:50:LMAX+5])
set(HA,'ytick',[0 20 40 60 80 100])
set(HA,'FontSize',[15],'FontWeight','Bold')
set(HA,'LineWidth',[2])
if CG == 1; set(HA,'Color',[0 1 1]); else
set(HA,'Color',[1 1 1]*0.95); end
HT = text(min(x),110,'Polarization: ');
set(HT,'FontSize',[15],'FontWeight','Bold')
if CG == 1
HT = text(min(x),110,'                       TE ');
set(HT,'FontSize',[15],'FontWeight','Bold','Color',[1 0 0])
HT = text(min(x),110,'                               TM ');
set(HT,'FontSize',[15],'FontWeight','Bold','Color',[0 0 1])
else
HT = text(min(x),110,'                       TE o');
set(HT,'FontSize',[15],'FontWeight','Bold','Color',[0 0 0])
HT = text(min(x),110,'                                 TM x');
set(HT,'FontSize',[15],'FontWeight','Bold','Color',[0 0 0])
end
HT = text(min(x),130.0,['Incid =  ' sprintf('%4.2f',THE) ' Deg']);
set(HT,'FontSize',[15],'FontWeight','Bold')
HT = text(min(x),150.0,'Richard P. Bocker, Ph.D.');
set(HT,'FontSize',[15],'FontWeight','Bold')
HT = text(min(x),140.0,'Carlsbad, California, USA');
set(HT,'FontSize',[15],'FontWeight','Bold')
HT = text(min(x),160.0,'Multilayer Optical Thin-Film Analysis');
set(HT,'FontSize',[15],'FontWeight','Bold')
grid on
FIN = 'Finished';
clc
end
```

PlotTra.m

```
% FUNCTION: PlotTra
function [RPB] = PlotTra(TTE,TTM,LMIN,LMAX,LDEL,CG)
x = LMIN:LDEL:LMAX;
HA = axes('position',[0.50 0.10 0.45 0.30]);
if CG == 1
HH = plot(x,100*real(TTE),'-r',x,100*real(TTM),'-b');
else
HH = plot(x,100*real(TTE),'ok',x,100*real(TTM),'Xk');
end
set(HH,'LineWidth',[5]); set(HH,'MarkerSize',[1])
Hx = xlabel('Vacuum Wavelength (nm)');
set(Hx,'FontSize',[15],'FontWeight','Bold')
Hy = ylabel('Transmittance ( % )');
set(Hy,'FontSize',[15],'FontWeight','Bold')
axis([min(x) max(x) -2 102])
set(HA,'xtick',[LMIN:50:LMAX+5])
set(HA,'ytick',[0 20 40 60 80 100])
set(HA,'FontSize',[15],'FontWeight','Bold')
set(HA,'LineWidth',[2])
if CG == 1; set(HA,'Color',[0 1 1])
else
set(HA,'Color',[1 1 1]*0.95); end
grid on
RPB = 'Thats all Folks';
clc
end
```

PsiI.m

```
% FUNCTION: PsiI
function [PsiI_TE,PsiI_TM] = PsiI(ThetaI,epP,muP)
R = sqrt(epP/muP); S = sqrt(muP/epP);
Vec_TE = [0 1 0 +R*cosd(ThetaI) 0 -R*sind(ThetaI)]';
Vec_TM = [-S*cosd(ThetaI) 0 +S*sind(ThetaI) 0 1 0]';
PsiI_TE = Vec_TE/sqrt(Vec_TE'*Vec_TE);
PsiI_TM = Vec_TM/sqrt(Vec_TM'*Vec_TM);
end
```

IV. MATLAB .M SCRIPT FILES

Matlab .m Script files are next listed in alphabetical order.

MatrixQ.m

```
% SCRIPT: MatrixQ
Q = inv(MIR);
for n = 1:N
Q = Q*Mn(:,:,n)*inv(Pn(:,:,n))*inv(Mn(:,:,n));
end
Q = Q*MTT;
```

Phases.m

```
% SCRIPT: Phases
for n = 1:N
[Pn(:,:,n)] = MatrixP(ThickF(n),IndexF(n),ThetaF(n),Lamb);
end
```

Prelim.m

```
% SCRIPT: Prelim
disp('Matlab: Multilayer Optical Thin-Film Analysis Program')
disp('Author: Richard P. Bocker, Ph.D.'); disp(' ')
disp('Begin Calculations'); disp(' ')
CG       = input(' Type 1 for Color or 2 for Gray Plots: ');
ThetaI   = input(' Type in Angle of Incidence (deg): ');
LambMin  = input(' Type in Minimum Vacuum Wavelength (nm): ');
LambMax  = input(' Type in Maximum Vacuum Wavelength (nm): ');
LambDel  = input(' Type in Wavelength Increment (nm): ');
```

Probability.m

```
% SCRIPT: Probability
AA = PsiR_TE; BB = PsiI_TE;
CC = PsiR_TM; DD = PsiI_TM;
EE = PsiT_TE; FF = PsiT_TM;
NUM = sqrt(AA(1:3)'*AA(1:3))*sqrt(AA(4:6)'*AA(4:6));
DEN = sqrt(BB(1:3)'*BB(1:3))*sqrt(BB(4:6)'*BB(4:6));
RTE(L) = (NUM/DEN);
NUM = sqrt(CC(1:3)'*CC(1:3))*sqrt(CC(4:6)'*CC(4:6));
DEN = sqrt(DD(1:3)'*DD(1:3))*sqrt(DD(4:6)'*DD(4:6));
RTM(L) = (NUM/DEN);
NUM = sqrt(EE(1:3)'*EE(1:3))*sqrt(EE(4:6)'*EE(4:6));
DEN = sqrt(BB(1:3)'*BB(1:3))*sqrt(BB(4:6)'*BB(4:6));
TTE(L) = (NUM/DEN)*Ratio;
NUM = sqrt(FF(1:3)'*FF(1:3))*sqrt(FF(4:6)'*FF(4:6));
DEN = sqrt(DD(1:3)'*DD(1:3))*sqrt(DD(4:6)'*DD(4:6));
TTM(L) = (NUM/DEN)*Ratio;
clear AA BB CC DD EE FF
L = L + 1;
```

RegionF.m

```
% SCRIPT: RegionF
for n = 1:N
[ThetaF(n)] = Angle(ThetaI,IndexP,IndexF(n));
[CF]  = MatrixC(epF(n),muF(n));
[WF]  = MatrixW(epF(n),muF(n),IndexF(n));
[AFR] = MatrixA(cosd(90-ThetaF(n)),0,cosd(ThetaF(n)));
[AFL] = MatrixA(cosd(90-ThetaF(n)),0,cosd(180-ThetaF(n)));
[NFR] = MatrixN(AFR,WF);
[NFL] = MatrixN(AFL,WF);
[Mn(:,:,n)] = MatrixM(NFR,NFL,CF);
end
L = 1;
```

RegionP.m

```
% SCRIPT: RegionP
[CP]  = MatrixC(epP,muP);
[WP]  = MatrixW(epP,muP,IndexP);
[APR] = MatrixA(cosd(90-ThetaI),0,cosd(ThetaI));
[APL] = MatrixA(cosd(90-ThetaI),0,cosd(180-ThetaI));
[NPR] = MatrixN(APR,WP);
[NPL] = MatrixN(APL,WP);
[MIR] = MatrixM(NPR,NPL,CP);
```

RegionQ.m

```
% SCRIPT: RegionQ
[ThetaT] = Angle(ThetaI,IndexP,IndexQ);
[CQ]  = MatrixC(epQ,muQ);
[WQ]  = MatrixW(epQ,muQ,IndexQ);
[AQR] = MatrixA(cosd(90-ThetaT),0,cosd(ThetaT));
[AQL] = MatrixA(cosd(90-ThetaT),0,cosd(180-ThetaT));
[NQR] = MatrixN(AQR,WQ);
[NQL] = MatrixN(AQL,WQ);
[MTT] = MatrixM(NQR,NQL,CQ);
Ratio = cosd(ThetaT)/cosd(ThetaI);
```

Structure.m

```
% SCRIPT: Structure
disp(' Following Examples Illustrate Software Capability')
disp(' Code 01: TFS01: Layers 01: Thin Film in Vacuum')
disp(' Code 02: TFS02: Layers 01: Polarization Filter')
disp(' Code 03: TFS03: Layers 03: Antireflection Coatings')
disp(' Code 04: TFS04: Layers 03: Fabry Perot Filter')
disp(' Code 05: TFS05: Layers 09: Broad Band-Pass Filter')
disp(' Code 06: TFS06: Layers 11: High Reflectance Coatings')
disp(' Code 07: TFS07: Layers 15: Longwave Pass Filter' )
disp(' Code 08: TFS08: Layers 15: Shortwave Pass Filter')
disp(' Code 09: TFS09: Layers 21: Narrow Band-Pass Filter')
disp(' Code 10: TFS10: Layers 29: Tri-Narrow Band-Pass Filter')
C = input(' Type in Two-Digit Code Number:  ');
if C == 01, TFS01; end; if C == 02, TFS02; end
if C == 03, TFS03; end; if C == 04, TFS04; end
if C == 05, TFS05; end; if C == 06, TFS06; end
if C == 07, TFS07; end; if C == 08, TFS08; end
if C == 09, TFS09; end; if C == 10, TFS10; end
epP = IndexP^2;  muP = 1; epQ = IndexQ^2;  muQ = 1;
epF = IndexF.^2; muF = ones(size(epF));
```

Wavefunction.m

```
% SCRIPT: Wavefunction
PsiR_TE = MR*PsiI_TE;
PsiR_TM = MR*PsiI_TM;
PsiT_TE = MT*PsiI_TE;
PsiT_TM = MT*PsiI_TM;
```

V. MATLAB .M SCRIPT FILES - EXAMPLES

In addition, there are ten Matlab .m Script files depicting examples of different multilayer optical thin-film structures. One can easily add more to this list by examining the content of these files as well as the Structure.m script file.

TFS01.m

```
% SCRIPT: TFS01
DS = 'TFS01: Thin Film in Vacuum ( 1 Layer )';
N = 1;                        % Number of Thin-Film Layers
ThickP = 40;                  % Region P Gap Width (nm)
IndexP = 1.00;                % Region P Index of Refraction
ThickQ = 40;                  % Region Q Gap Width (nm)
IndexQ = 1.00;                % Region Q Index of Refraction
ThickF = [350];               % Thin-Film Thickness (nm)
IndexF = [1.80];              % Thin-Film Index of Refraction
```

TFS02.m

```
% SCRIPT: TFS02
DS = 'TFS02: Polarization Filter ( 1 Layer )';
N = 1;                        % Number of Thin-Film Layers
ThickP = 40;                  % Region P Gap Width (nm)
IndexP = 1.00;                % Region P Index of Refraction
ThickQ = 40;                  % Region Q Gap Width (nm)
IndexQ = 1.00;                % Region Q Index of Refraction
ThickF = [300];               % Thin-Film Thickness (nm)
IndexF = [3.00];              % Thin-Film Index of Refraction
ThetaI = atand(IndexF);       % Polarizing Angle
```

TFS03.m

```
% SCRIPT: TFS03
DS = 'TFS03: Antireflection Coatings ( 3 Layers )';
TFI = [1.47 2.14 1.80];
QWT = (550/4)*[1 1 1];        % Quarter Wavelength
N = 3;                        % Number of Thin-Film Layers
ThickP = 40.0;                % Region P Gap Width (nm)
IndexP = 1.00;                % Region P Index of Refraction
ThickQ = 40;                  % Region Q Gap Width (nm)
IndexQ = 1.52;                % Region Q Index of Refraction
IndexF = TFI;                 % Thin-Film Indices of Refraction
ThickF = (QWT./IndexF);       % Thin-Film Thicknesses (nm)
clear TFI QWT
```

TFS04.m

```
% SCRIPT: TFS04
DS = 'TFS04: Fabry Perot Filter ( 3 Layers )';
TFT = [25 370 25];
TFI = [0.20+i*3.44 1.90 0.20+i*3.44];
N = 3;                          % Number of Thin-Film Layers
ThickP = 40.0;                  % Region P Gap Width (nm)
IndexP = 1.00;                  % Region P Index of Refraction
ThickQ = 40;                    % Region Q Gap Width (nm)
IndexQ = 1.52;                  % Region Q Index of Refraction
ThickF = TFT;                   % Thin-Film Thicknesses (nm)
IndexF = TFI;                   % Thin-Film Indices of Refraction
clear TFT TFI
```

TFS05.m

```
% SCRIPT: TFS05
DS = 'TFS05: Broad Band-Pass Filter ( 9 Layers )';
TFT = [60 100 60 100 240 100 60 100 60];
TFI = [2.35 1.35 2.35 1.35 2.35 1.35 2.35 1.35 2.35];
N = 9;                          % Number of Thin-Film Layers
ThickP = 40.0;                  % Region P Gap Width (nm)
IndexP = 1.00;                  % Region P Index of Refraction
ThickQ = 40;                    % Region Q Gap Width (nm)
IndexQ = 1.52;                  % Region Q Index of Refraction
ThickF = TFT;                   % Thin-Film Thicknesses (nm)
IndexF = TFI;                   % Thin-Film Indices of Refraction
clear TFT TFI
```

TFS06.m

```
% SCRIPT: TFS06
DS = 'TFS06: High Reflectance Coatings ( 11 Layers )';
TFT = [60 100 60 100 60 100 60 100 60 100 60];
TFI = [2.35 1.35 2.35 1.35 2.35 1.35 2.35 1.35 2.35 1.35 2.35];
N = 11;                         % Number of Thin-Film Layers
ThickP = 40.0;                  % Region P Gap Width (nm)
IndexP = 1.00;                  % Region P Index of Refraction
ThickQ = 40;                    % Region Q Gap Width (nm)
IndexQ = 1.52;                  % Region Q Index of Refraction
ThickF = TFT;                   % Thin-Film Thicknesses (nm)
IndexF = TFI;                   % Thin-Film Indices of Refraction
clear TFT TFI
```

TFS07.m

```
% SCRIPT: TFS07
DS = 'TFS07: Longwave Pass Filter ( 15 Layers )';
H = 2.35; L = 1.35;
TFI = [H L H L H L H L H L H L H L H];
ABC = [0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 0.5]*450;
N = 15;                         % Number of Thin-Film Layers
ThickP = 40.0;                  % Region P Gap Width (nm)
IndexP = 1.00;                  % Region P Index of Refraction
ThickQ = 40;                    % Region Q Gap Width (nm)
IndexQ = 1.52;                  % Region Q Index of Refraction
IndexF = TFI;                   % Thin-Film Indices of Refraction
ThickF = (ABC/4)./IndexF;       % Thin-Film Thicknesses (nm)
clear ABC TFI H L
```

TFS08.m

```
% SCRIPT: TFS08
DS = 'TFS08: Shortwave Pass Filter ( 15 Layers )';
H = 2.35; L = 1.35;
TFI = [L H L H L H L H L H L H L H L];
ABC = [0.5 1 1 1 1 1 1 1 1 1 1 1 1 1 0.5]*750;
N = 15;                          % Number of Thin-Film Layers
ThickP = 40.0;                   % Region P Gap Width (nm)
IndexP = 1.00;                   % Region P Index of Refraction
ThickQ = 40;                     % Region Q Gap Width (nm)
IndexQ = 1.52;                   % Region Q Index of Refraction
IndexF = TFI;                    % Thin-Film Indices of Refraction
ThickF = (ABC/4)./IndexF;        % Thin-Film Thicknesses (nm)
clear ABC TFI H L
```

TFS09.m

```
% SCRIPT: TFS09
DS = 'TFS09: Narrow Band-Pass Filter ( 21 Layers )';
H = 2.35; L = 1.35;
TFI = [L H L H L H L H L H L H L H L H L H L H L];
ABC = [1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1]*558;
N = 21;                          % Number of Thin-Film Layers
ThickP = 40.0;                   % Region P Gap Width (nm)
IndexP = 1.00;                   % Region P Index of Refraction
ThickQ = 40;                     % Region Q Gap Width (nm)
IndexQ = 1.52;                   % Region Q Index of Refraction
IndexF = TFI;                    % Thin-Film Indices of Refraction
ThickF = (ABC/4)./IndexF;        % Thin-Film Thicknesses (nm)
clear ABC TFI H L
```

TFS10.m

```
% SCRIPT: TFS10
DS = 'TFS10: Tri-Narrow Band-Pass Filter ( 29 Layers )';
H = 2.30; L = 1.38;
TFI = [H L H L H L H L H L H L H L H L H L H L H L H L H L H L H];
A   = [1 1 1 1 1 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1 1 1 1];
N = 29;                          % Number of Thin-Film Layers
ThickP = 40.0;                   % Region P Gap Width (nm)
IndexP = 1.00;                   % Region P Index of Refraction
ThickQ = 40;                     % Region Q Gap Width (nm)
IndexQ = 1.00;                   % Region Q Index of Refraction
IndexF = TFI;                    % Thin-Film Indices of Refraction
ThickF = (600*A/4)./IndexF;      % Thin-Film Thicknesses (nm)
clear TFI H L A
```