프로그램 설계 종합 (예)

Long-Wave-Pass Filter

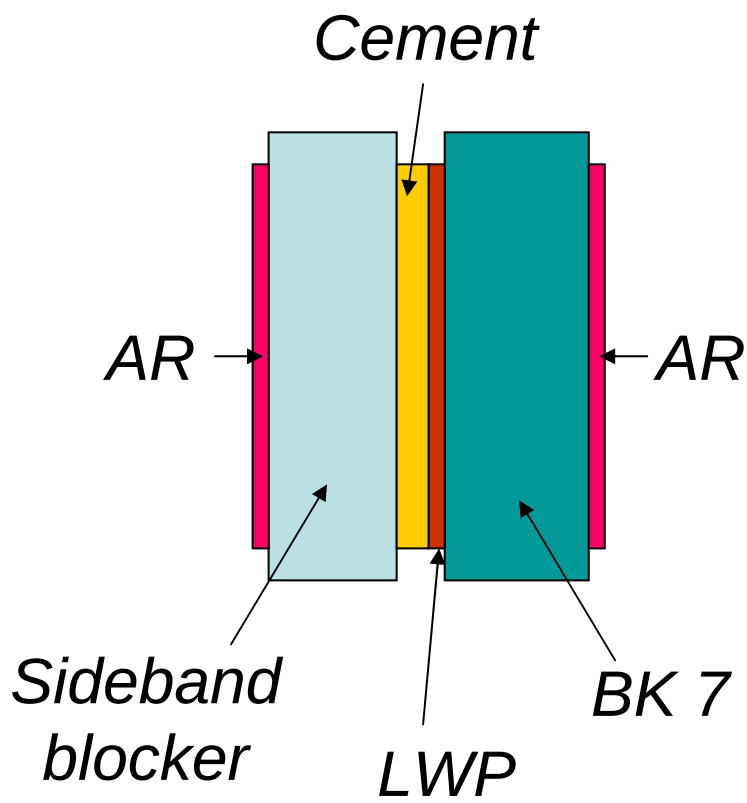
Simple Specification:

600nm - 50% transmittance

Low ripple to 850nm

No short-wave sidebands

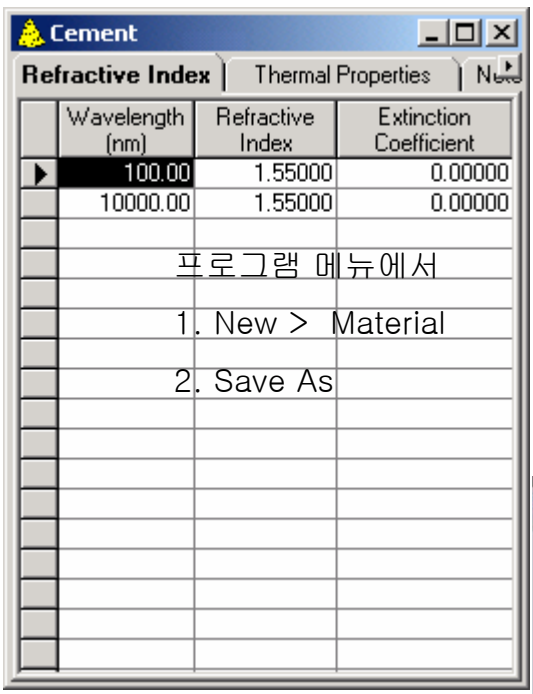
Materials Ta2O5 and SiO2

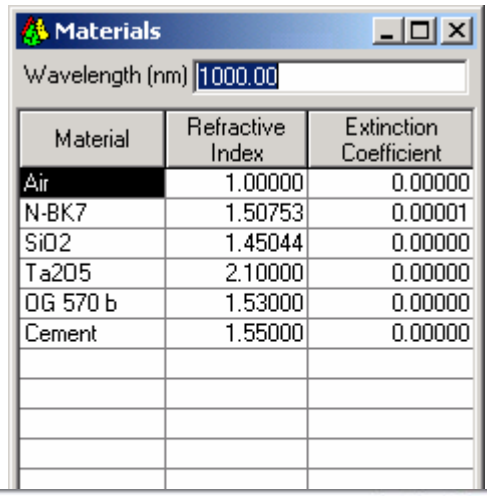


Material 준비

1. Cement : 그리 중요하지 안으므로 간단히 無 Dispersion에 index of 1.55 신규로 만듭니다.

2. N-BK7는 Material Folder중 Schott 2004 폴더, OG 570b,OG570은
Schott Filter 폴더에서 Import 기능으로 불러옵니다.



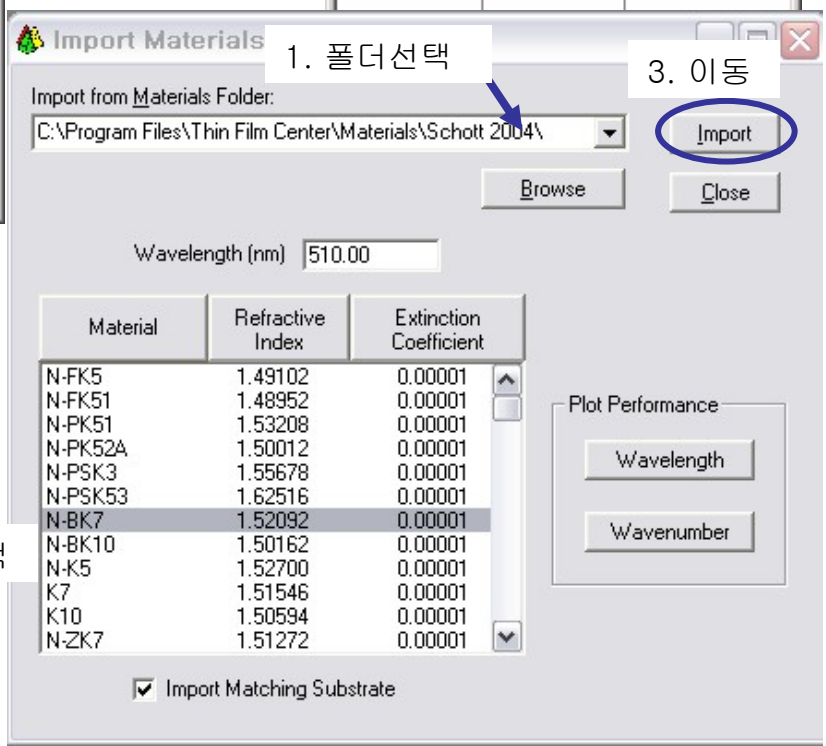


Material Import 방법.

프로그램 메뉴에서

1. Tools > Materials

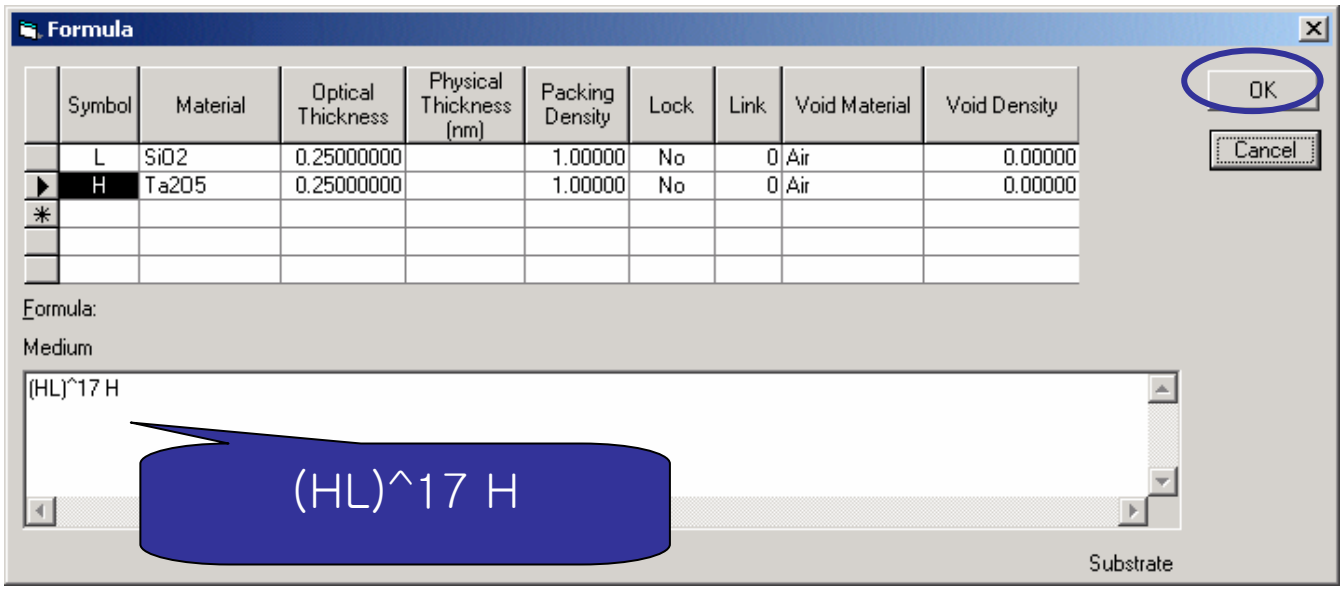
2. Edit >import



2. 물질 선택

※ Substartes도 같은
방식으로 import

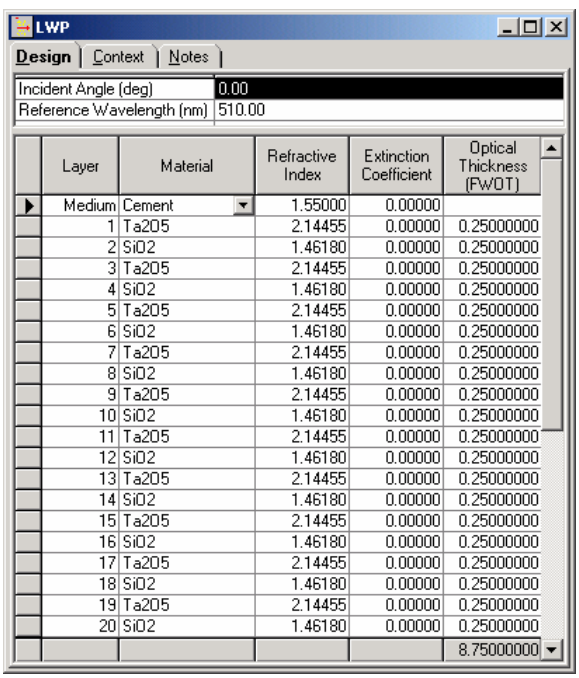
Design File 만들기

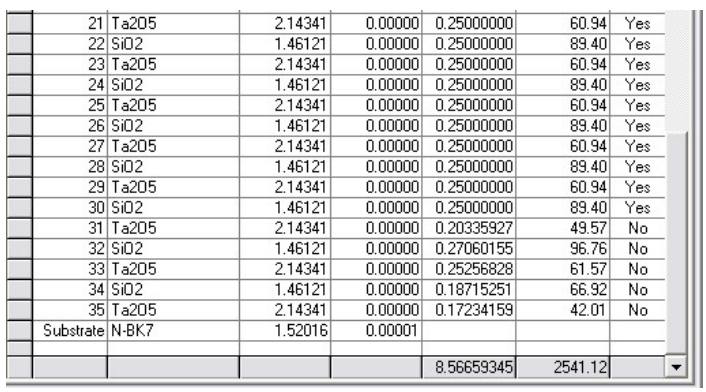


프로그램 메뉴에서, *File* > *Design.*

프로그램 메뉴에서, *Edit* > *Formula.*

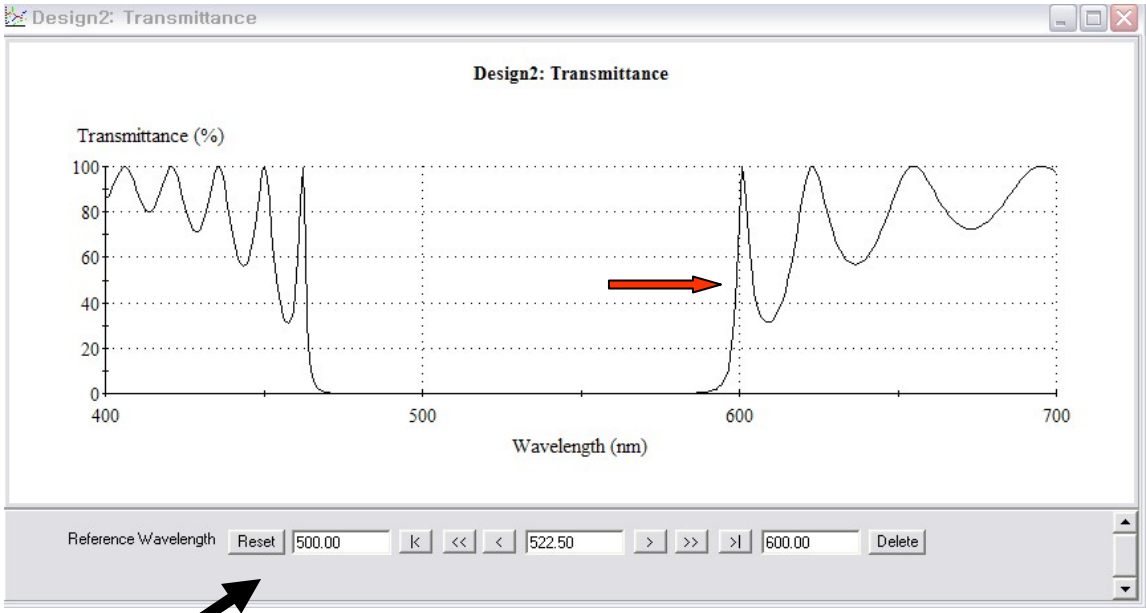
BK 7 : substrate , Cement : Incident medium.



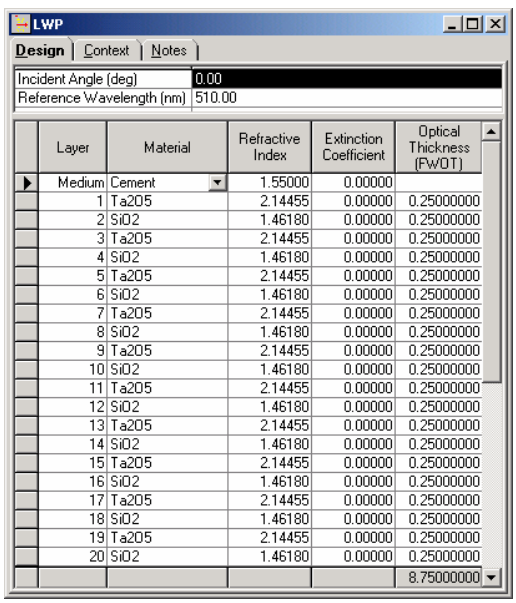


Getting the Correct Reference Wavelength

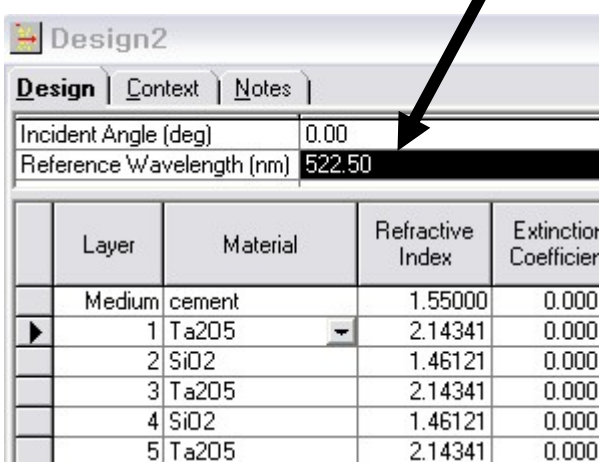
프로그램 메뉴에서, *File* > *Performance* > *Active Plot.*



프로그램 메뉴에서, *Add* > *reference wavelength,*

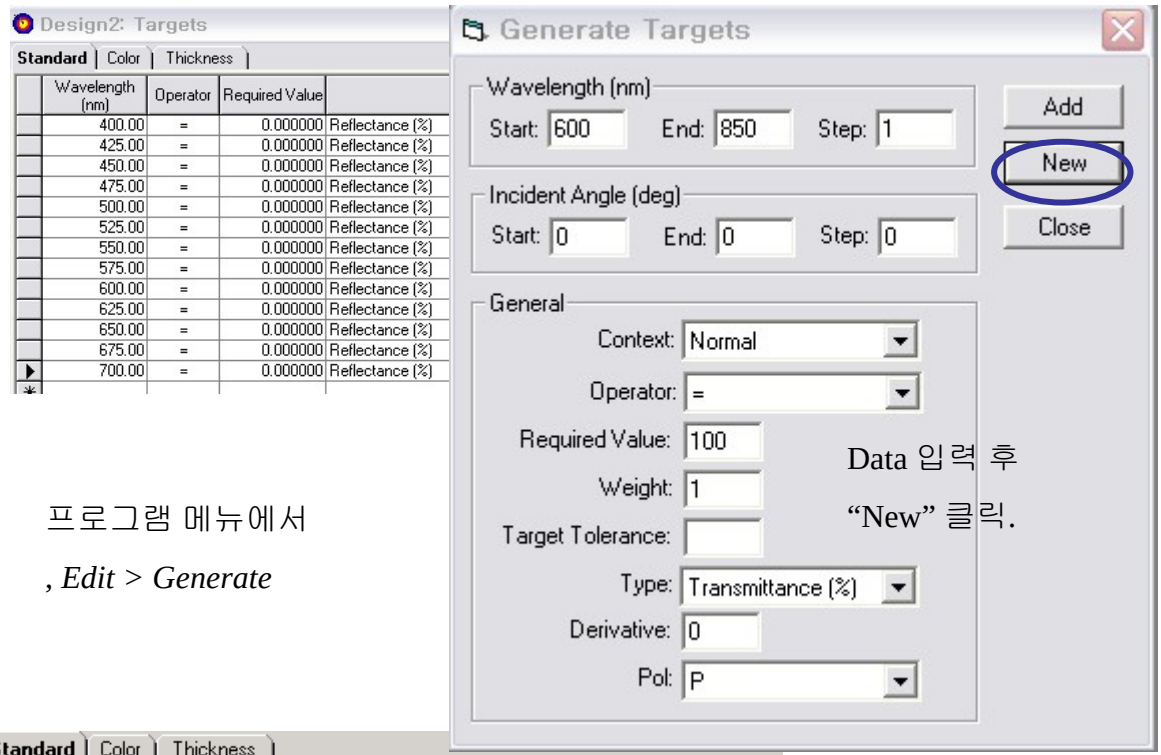


Edge가 600nm 될 때까지 reference wavelength 조정하면 약 522.50nm 됩니다.



Setting Up for Refinement

프로그램 메뉴에서, *Parameters* > *refinement* > *Targets*



프로그램 메뉴에서

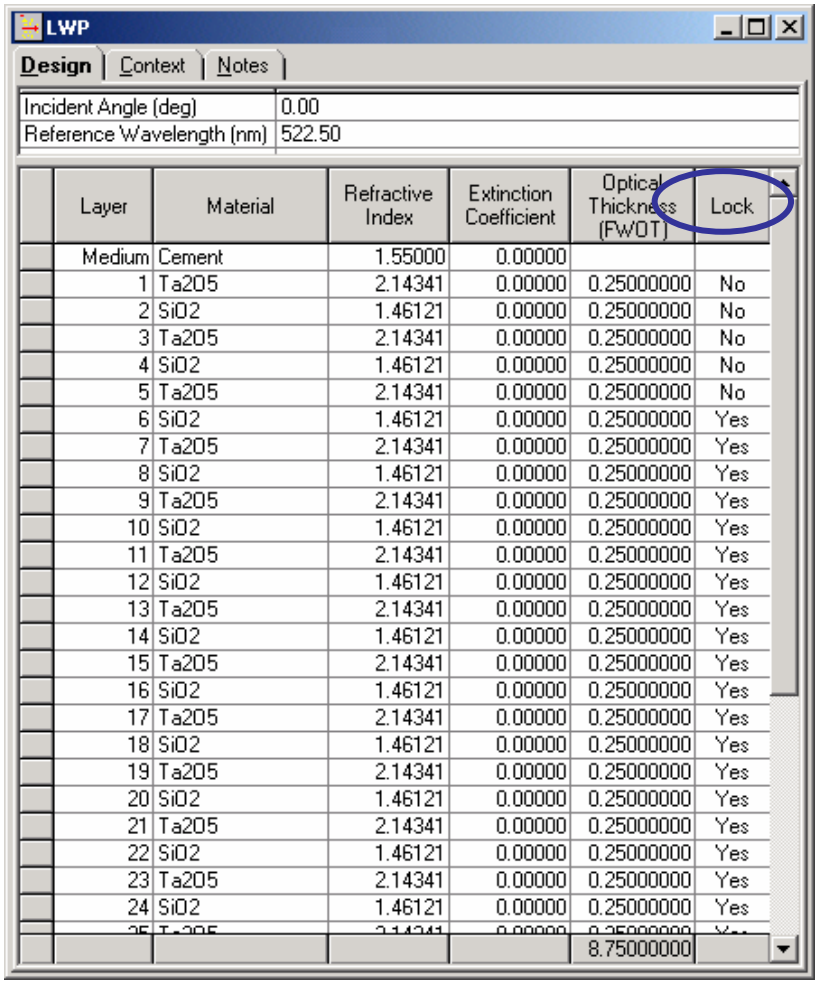
, *Edit* > *Generate*

Data 입력 후

"New" 클릭.

Standard | Color | Thickness

Wavelength (nm)	Required Value	Target Tolerance	Type
600.00	100.000000	1.000000	Transmittance (%)
601.00	100.000000	1.000000	Transmittance (%)
602.00	100.000000	1.000000	Transmittance (%)
603.00	100.000000	1.000000	Transmittance (%)
604.00	100.000000	1.000000	Transmittance (%)
605.00	100.000000	1.000000	Transmittance (%)
606.00	100.000000	1.000000	Transmittance (%)
607.00	100.000000	1.000000	Transmittance (%)
608.00	100.000000	1.000000	Transmittance (%)
609.00	100.000000	1.000000	Transmittance (%)
610.00	100.000000	1.000000	Transmittance (%)
611.00	100.000000	1.000000	Transmittance (%)
612.00	100.000000	1.000000	Transmittance (%)
613.00	100.000000	1.000000	Transmittance (%)
614.00	100.000000	1.000000	Transmittance (%)
615.00	100.000000	1.000000	Transmittance (%)
616.00	100.000000	1.000000	Transmittance (%)
617.00	100.000000	1.000000	Transmittance (%)
618.00	100.000000	1.000000	Transmittance (%)
619.00	100.000000	1.000000	Transmittance (%)
620.00	100.000000	1.000000	Transmittance (%)
621.00	100.000000	1.000000	Transmittance (%)
622.00	100.000000	1.000000	Transmittance (%)
623.00	100.000000	1.000000	Transmittance (%)



Design file이 선택된 상태에서

프로그램 메뉴에서, *lock/Link* > *Lock All*

상위 5 Layer와

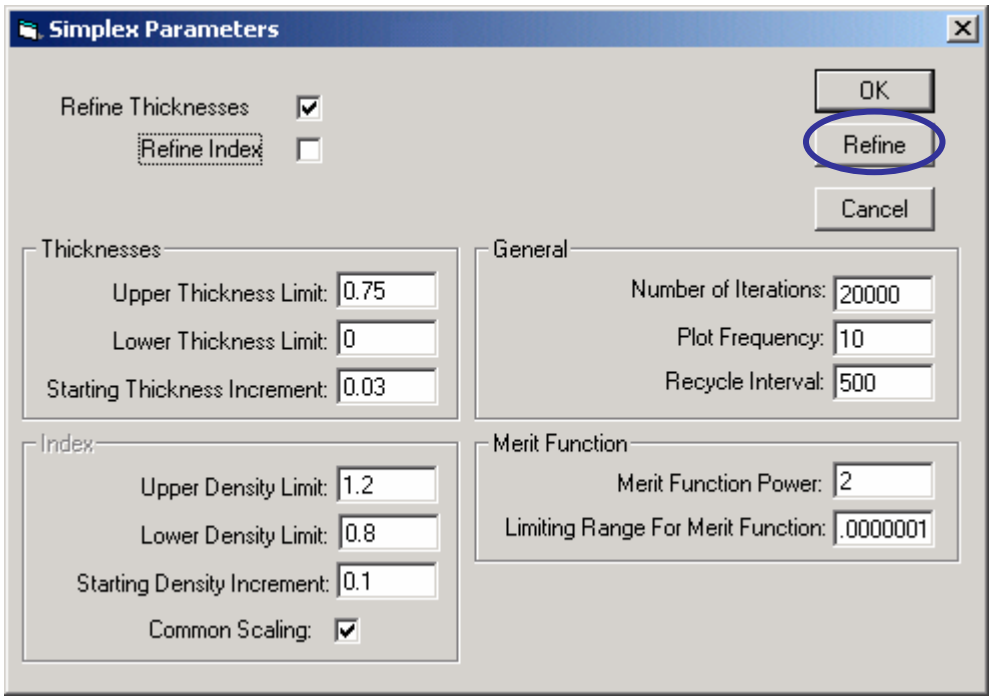
하위 5 Layer만

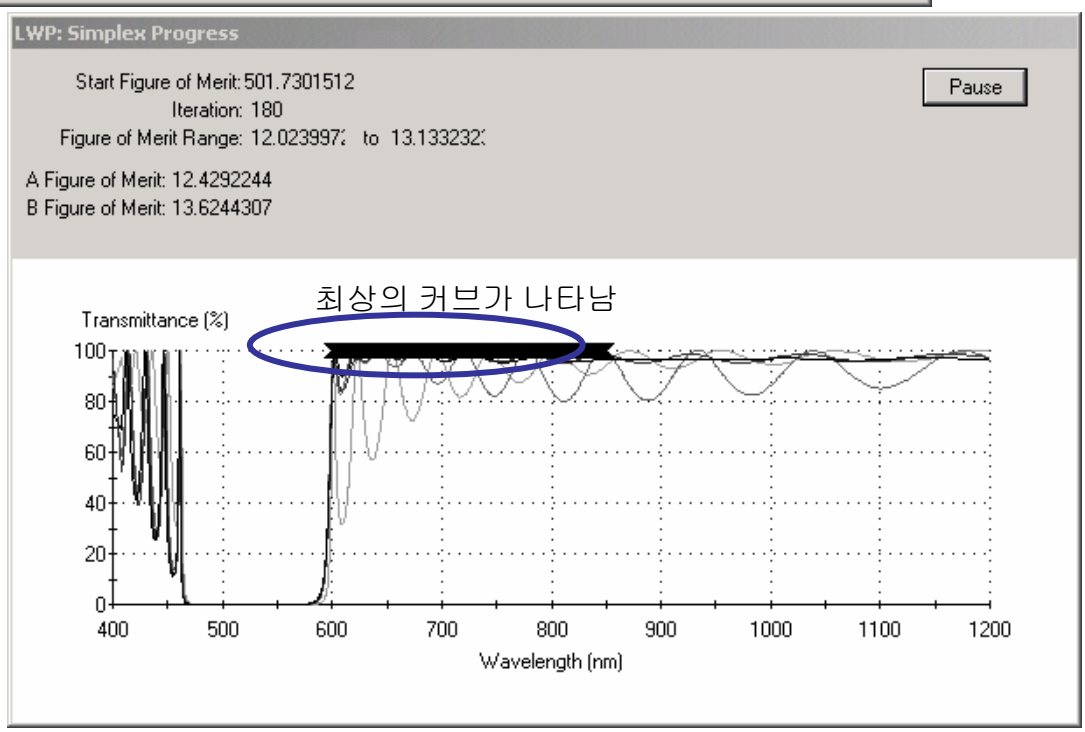
마우스로 클릭하여

“Lock No” 로 변경

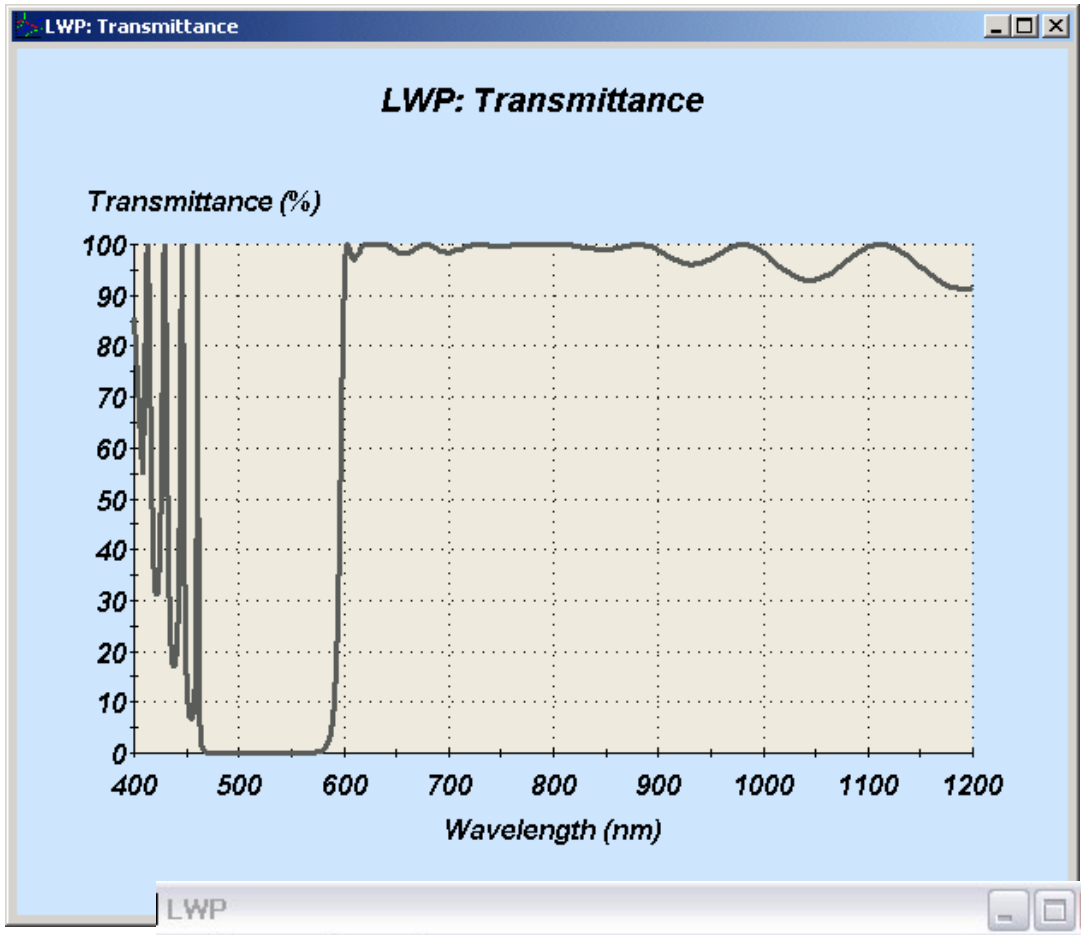
Ripple 제거를 위한 Refinement

프로그램 메뉴에서,
Parameters > Refinement > Simplex





Performance of the Long Wave Pass Filter



LWP

esign | Context | Notes

cident Angle (deg)	0.00
eference Wavelength (nm)	522.50

	Layer	Material	Refractive Index	Extinction Coefficient	Optical Thickness (FWOT)	Physical Thickness (nm)	Lock
	Medium	cement	1.55000	0.00000			
	1	Ta2O5	2.14341	0.00000	0.58343218	142.22	No
	2	SiO2	1.46121	0.00000	0.00000140	0.00	No
	3	Ta2O5	2.14341	0.00000	0.20542547	50.08	No
	4	SiO2	1.46121	0.00000	0.27111760	96.95	No
	5	Ta2O5	2.14341	0.00000	0.17059360	41.59	No
	6	SiO2	1.46121	0.00000	0.25000000	89.40	Yes

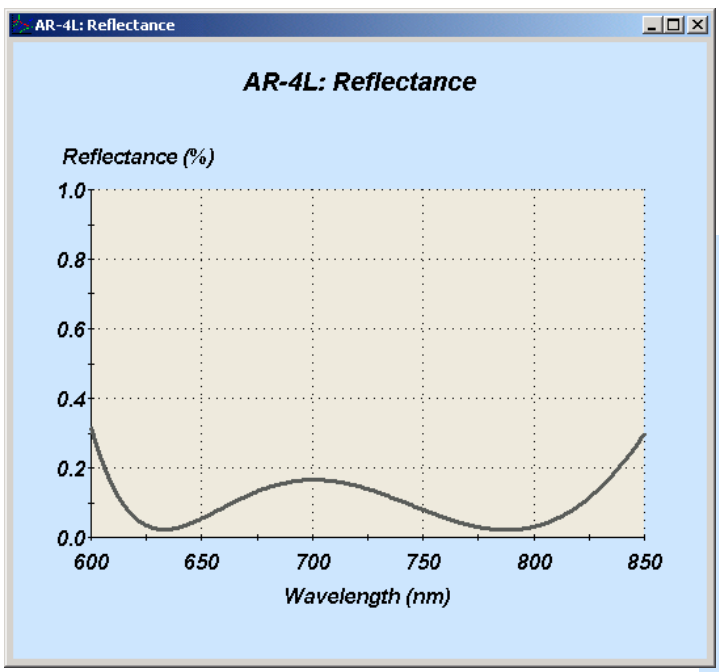
The Antireflection Coating

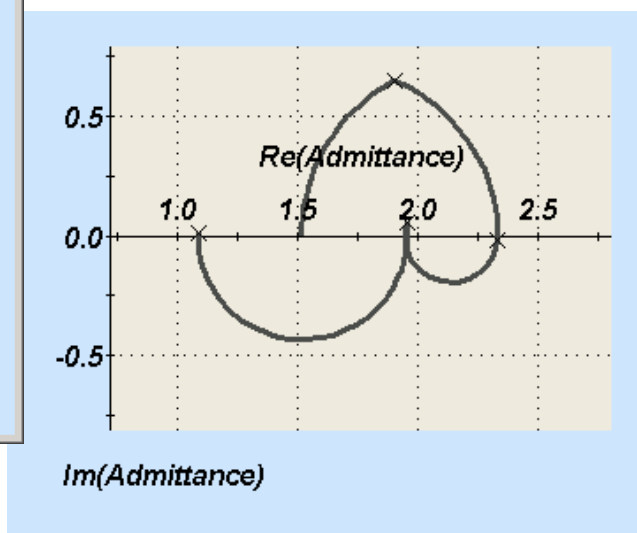
AR-4L

Design | Context | Notes

Incident Angle (deg)	0.00
Reference Wavelength (nm)	510.00

	Layer	Material	Refractive Index	Extinction Coefficient	Optical Thickness (FWOT)
▶	Medium	Air	1.00000	0.00000	
	1	SiO2	1.46180	0.00000	0.35773306
	2	Ta2O5	2.14455	0.00000	0.37169681
	3	SiO2	1.46180	0.00000	0.08681442
	4	Ta2O5	2.14455	0.00000	0.15405159
	Substrate	N-BK7	1.52092	0.00001	
					0.97029588





프로그램 메뉴에서, *Tools > Analysis > Admittance*

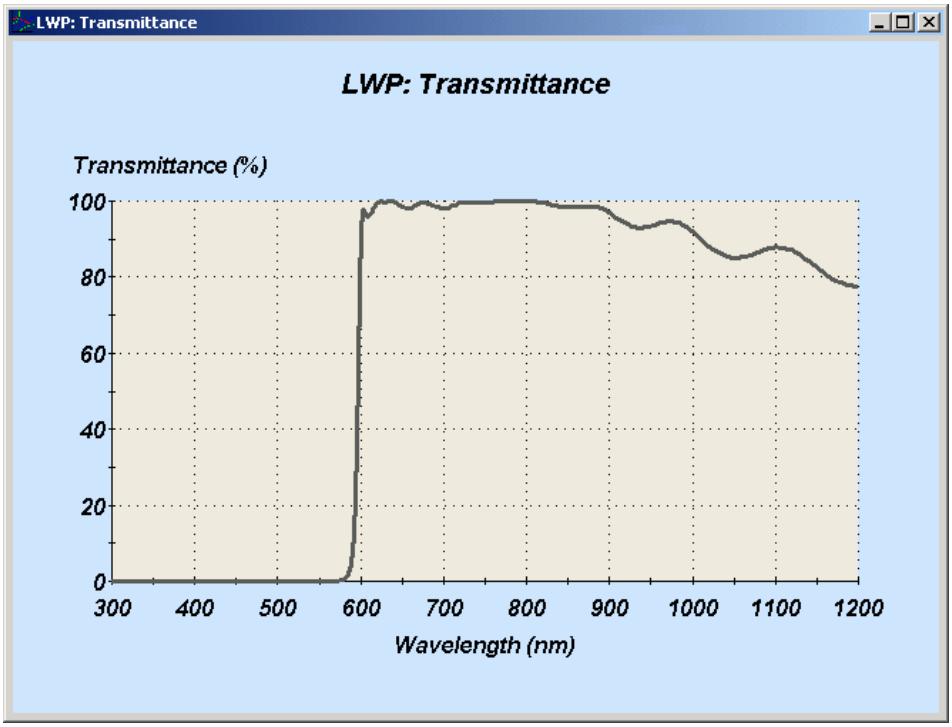
Complete Performance Modeled by Stack

프로그램 메뉴에서, *File* > *New* > *Stack*

LWP

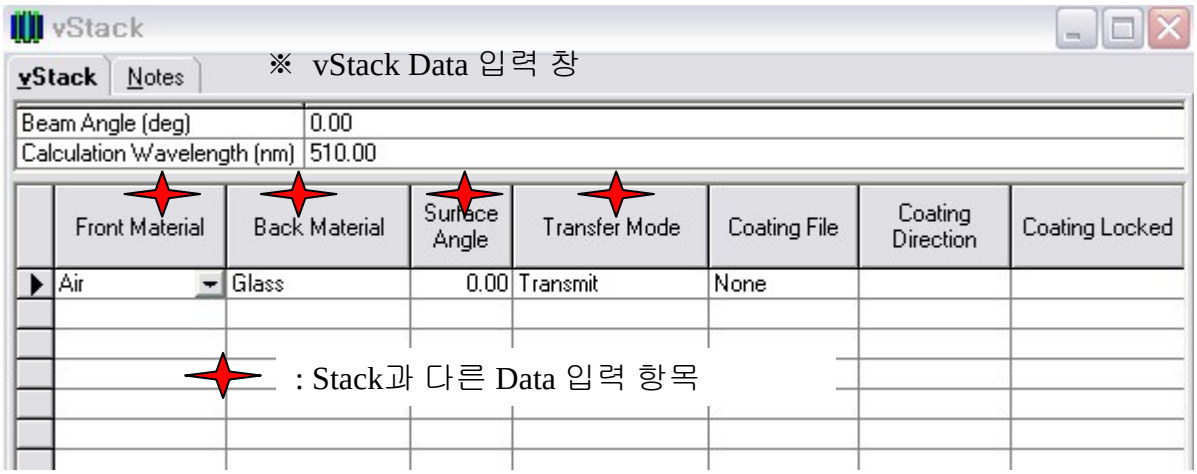
Stack | Notes

	Medium Type	Medium Material	Medium Substrate	Medium Thickness (mm)	Coating File	Coating Direction	Coating Locked
▶	Incident	Air					
	Parallel	OG 570 b	OG 570	3.000	ar-4l.dds	Forward	No
	Parallel	Cement	Lossless	1.000	None		
	Parallel	N-BK7	N-BK7 25mm	1.000	lwp.dds	Forward	No
	Emergent	Air			ar-4l.dds	Reversed	No



Stack을 이용하여
AR Coating과 조합.

※ Stack과 선택사항인 vStack 차이.



Front Material specifies the material in which the light is incident on the surface.

Back Material specifies the material on the other side of the surface from the front material.

Surface Angle specifies the angle that the surface normal makes with the reference direction

Transfer Mode specifies the component of light that is transferred from one surface to the next. This parameter has seven values:

Transmit: The transmitted portion of the beam is propagated to the next surface and the reflected beam is discarded.

Reflect: The reflected portion of the beam is propagated to the next surface and the transmitted beam is discarded.

Perfect Reflect: This special mode reflects 100% of the beam and propagates it to the next surface.

Rotate 0: This special mode rotates the beam 90 degrees about its axis and propagates it to the next surface.

Rotate 90: This special mode has no effect on the beam and propagates it to the next surface. It is included to make it easy to switch off any of the rotations listed below.

Rotate 180: This special mode rotates the beam 180degrees about its axis and propagates it to the next surface.

Rotate -90: This special mode rotates the beam 270 degrees about its axis and propagates it to the next surface.

Perfect Retro: This special mode reflects 100% of the beam back along the direction that it entered and propagates it to the next surface.

제조(생산)를 위한 고려 사항들

RunSheet 와 Simulator를 이용하여 제조(생산)에 대한 검토와 계획을 할 수 있습니다.

1. Machine Configuration

Coating machine, monitoring systems, sources, tooling factors, monitoring chips 등의 세부사항을 설정, 설계에 반영합니다.

2. RunSheet

증착 동안의 layer thickness 제어에 대한 계획을 세우기 위한 monitoring signals을 예측 합니다.

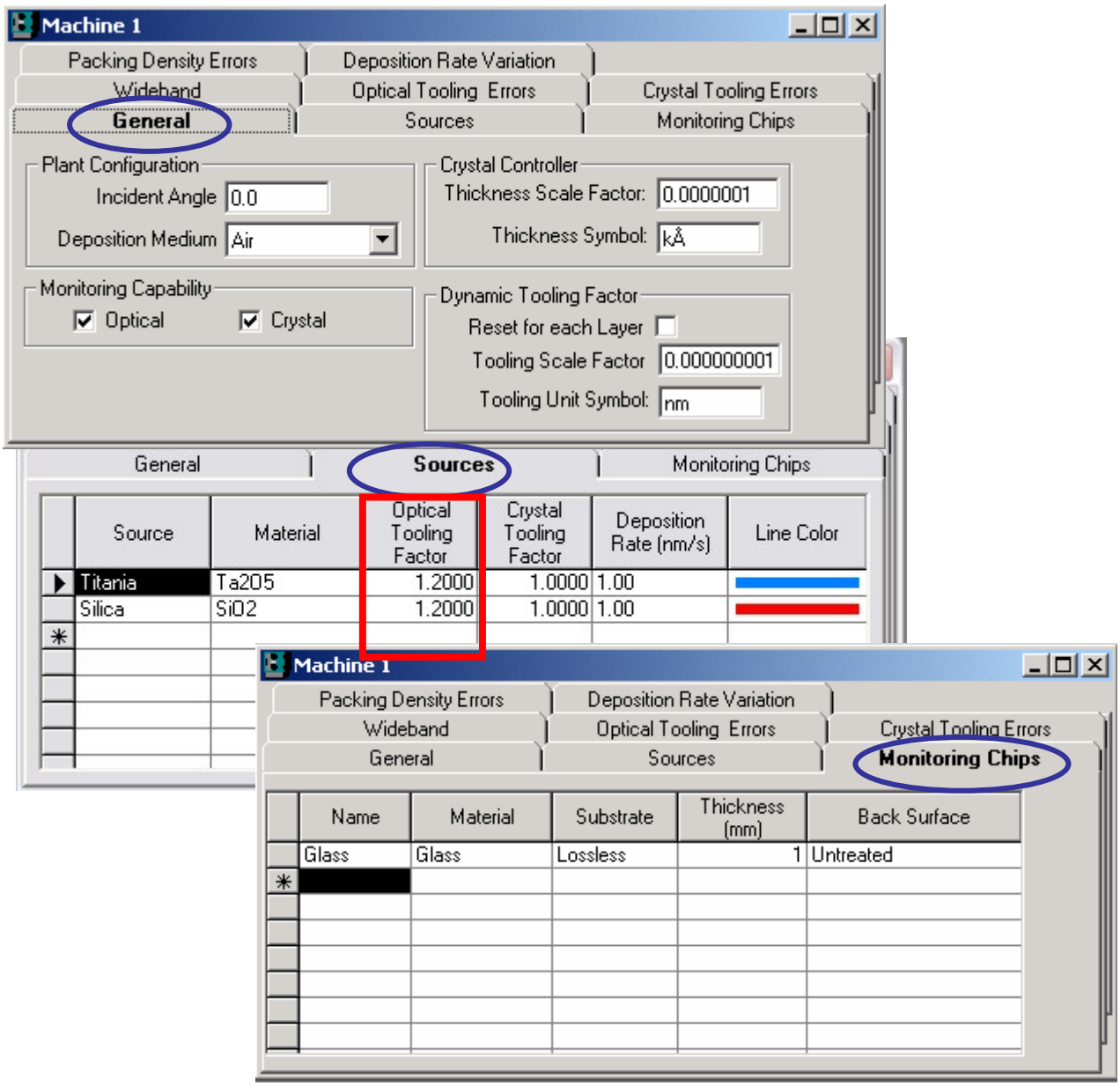
3. Simulator

완성된 RunSheet를 이용하여 errors in tooling factors, wavelength, packing density, temperature 및 signal noise가 포함된 실제 코팅 생산 예측(Simulation)을 합니다.

Machine Configuration

프로그램 메뉴에서, *File > New > Machine Configuration*

RunSheet를 이용하기 위해서는 Machine Configuration에서 General, Sources와 Monitoring Chips 정보와 , 그리고 필요시 Wideband 정보가 필요 합니다.
그 외 입력 정보들은 Simulator에 필요하며 그 값들은 지금 설계한 Edge Filter에 사용, 시험해 보겠습니다. 두께 제어를 위한 optical tooling factors 를 1.2 설정합니다.

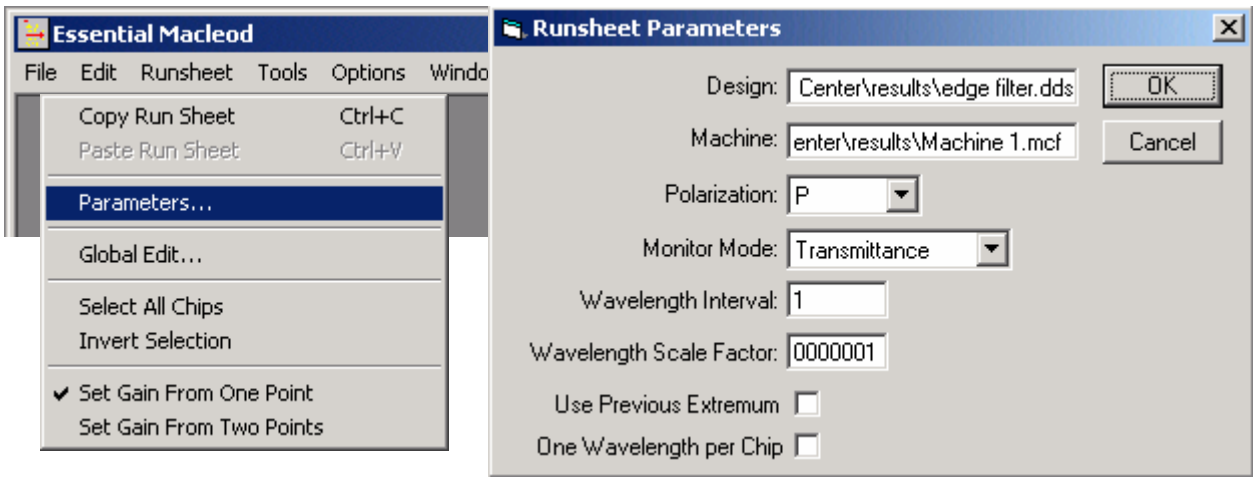


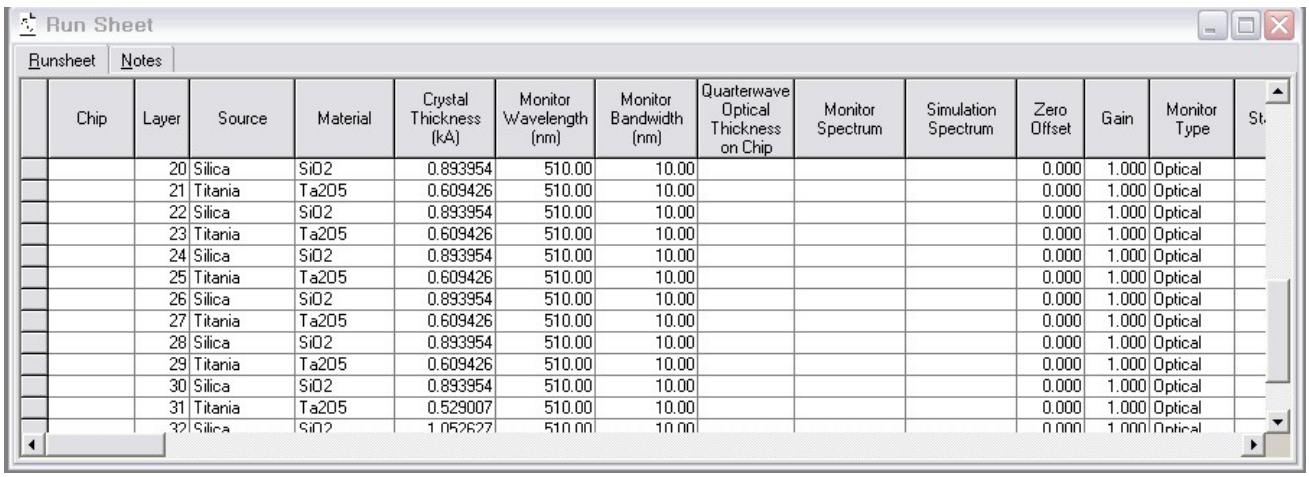
RunSheet

프로그램 메뉴에서, *File > New > RunSheet*

프로그램 메뉴에서, *Edit > Parameters*

Default values can then be changed easily by *Global Edit* or manually.





	Chip	Layer	Source	Material	Crystal Thickness (kA)	Monitor Wavelength (nm)	Monitor Bandwidth (nm)	Quarterwave Optical Thickness on Chip	Monitor Spectrum	Simulation Spectrum	Zero Offset	Gain	Monitor Type	St
		20	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		21	Titania	Ta2O5	0.609426	510.00	10.00				0.000	1.000	Optical	
		22	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		23	Titania	Ta2O5	0.609426	510.00	10.00				0.000	1.000	Optical	
		24	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		25	Titania	Ta2O5	0.609426	510.00	10.00				0.000	1.000	Optical	
		26	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		27	Titania	Ta2O5	0.609426	510.00	10.00				0.000	1.000	Optical	
		28	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		29	Titania	Ta2O5	0.609426	510.00	10.00				0.000	1.000	Optical	
		30	Silica	SiO2	0.893954	510.00	10.00				0.000	1.000	Optical	
		31	Titania	Ta2O5	0.529007	510.00	10.00				0.000	1.000	Optical	
		32	Silica	SiO2	1.052627	510.00	10.00				0.000	1.000	Optical	

프로그램 메뉴에서, *RunSheet > Calculate*

RunSheet1

	Chip	Layer	Source	Material	Crystal Thickness (kÅ)	Monitor Wavelength (nm)	Monitor Bandwidth (nm)	Quarterwave Optical Thickness on Chip	Monitor Spectrum	Simulation Spectrum	Zero Offset	Gain	Monitor Type	Start At	First Maxima	First Minima	Last Maxima	Last Minima	Finish At	Final Swing	Peaks
	1: Glass	1	Titania	TiO2	0.223289	500.00	1.00	0.505			0	1	Optical	91.7980					76.2047	16.9865	↑
		2	Silica	SiO2	0.937082	500.00	1.00	1.316			0	1	Optical	76.2047	93.8514	74.4274			93.2887	2.8965	↓↑
		3	Titania	TiO2	0.424921	500.00	1.00	0.962			0	1	Optical	93.2887		41.5628			41.5704	0.0147	↓
		4	Silica	SiO2	0.804786	500.00	1.00	1.130			0	1	Optical	41.5704	67.9001				66.0113	7.1738	↑
	2: Glass	5	Titania	TiO2	0.642370	500.00	1.00	1.454			0	1	Optical	66.0113		19.3072			32.2773	27.7707	↓
		6	Silica	SiO2	0.719674	500.00	1.00	1.010			0	1	Optical	32.2773	49.6602				39.2242	60.0361	↑
		7	Titania	TiO2	0.554994	500.00	1.00	1.256			0	1	Optical	39.2242		14.6080			24.1182	38.6339	↓
		8	Silica	SiO2	0.881331	500.00	1.00	1.237			0	1	Optical	24.1182	38.9356				24.6664	96.2999	↑
	3: Glass	9	Titania	TiO2	0.554994	500.00	1.00	1.256			0	1	Optical	24.6664		14.0321			35.3541	200.5013	↓
		10	Silica	SiO2	0.881331	500.00	1.00	1.237			0	1	Optical	35.3541	46.6087				26.7761	176.2172	↑
		11	Titania	TiO2	0.554994	500.00	1.00	1.256			0	1	Optical	26.7761		22.8730			74.3369	318.5114	↓

Monitoring chips은 항상 Titania 시작해서 두 Layer의 Silica를 갖는 경우 입니다.

해당 Chip에 마우스를 놓고 클릭하면 Chip 번호가 순서대로 나오게 됩니다.

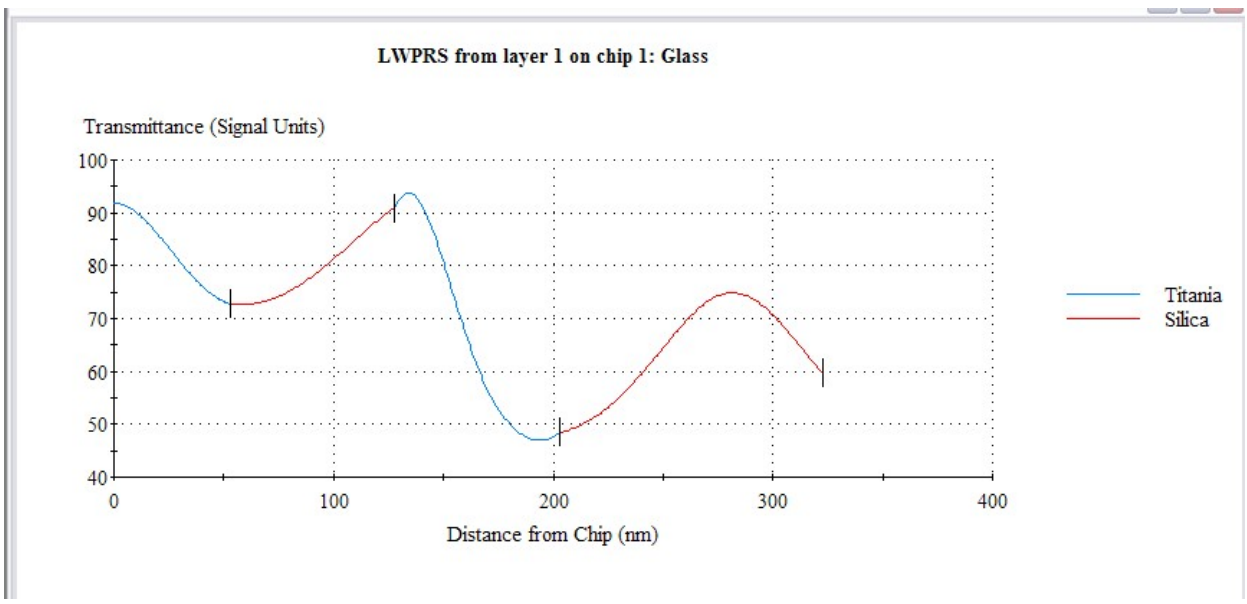
LWPRS

Runsheet | Notes

Chip, 1.Glass를 마우스로 클릭하고

	Chip	Layer	Source	Material	Crystal Thickness (kA)	Monitor Wavelength (nm)	Monitor Bandwidth (nm)	Quarterwave Optical Thickness on Chip	M Spe
▶	1: Glass	1	Titania	Ta2O5	0.444625	510.00	10.00	0.897	
		2	Silica	SiO2	0.617631	510.00	10.00	0.850	
		3	Titania	Ta2O5	0.629584	510.00	10.00	1.271	
		4	Silica	SiO2	0.996188	510.00	10.00	1.371	
	2: Glass	5	Titania	Ta2O5	0.481766	510.00	10.00	0.972	
		6	Silica	SiO2	0.893954	510.00	10.00	1.230	

프로그램 메뉴에서, *RunSheet > Plot one Chip*



LWPRS Chip, 2.Glass를 마우스로 클릭하고

Runsheet | Notes

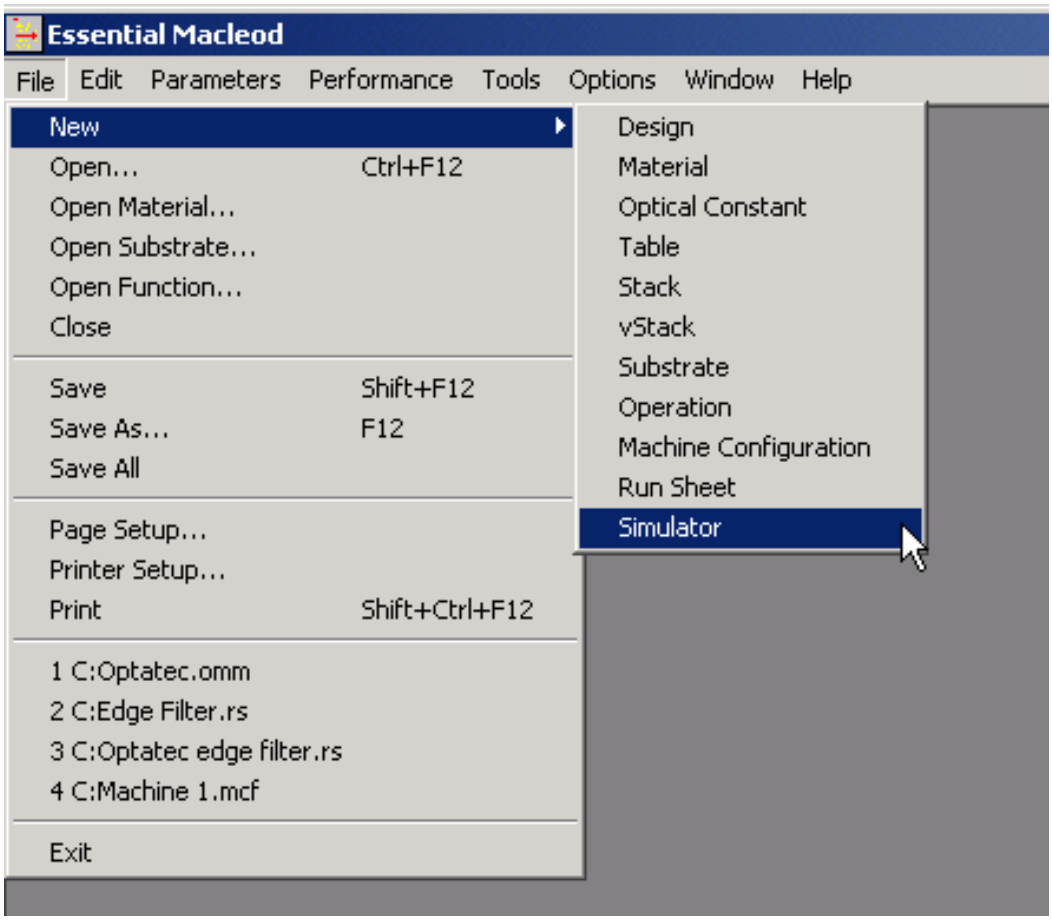
	Chip	Layer	Source	Material	Crystal Thickness (kA)	Monitor Wavelength (nm)	B
	1: Glass	1	Titania	Ta2O5	0.444625	510.00	
		2	Silica	SiO2	0.617631	510.00	
		3	Titania	Ta2O5	0.629584	510.00	
		4	Silica	SiO2	0.996188	510.00	
▶	2: Glass	5	Titania	Ta2O5	0.481766	510.00	
		6	Silica	SiO2	0.893954	510.00	
		7	Titania	Ta2O5	0.609426	510.00	
		8	Silica	SiO2	0.893954	510.00	

프로그램 메뉴에서, *RunSheet > Plot one Chip*

Run Sheet 파일은 “File” > “Export” > “CSV File “ (a comma-separated variable) 기능으로 엑셀 또는 Note 포맷 파일 등으로 변환 하여 Coating Controller 등 다른 프로그램에서 그대로 활용이 가능 합니다.

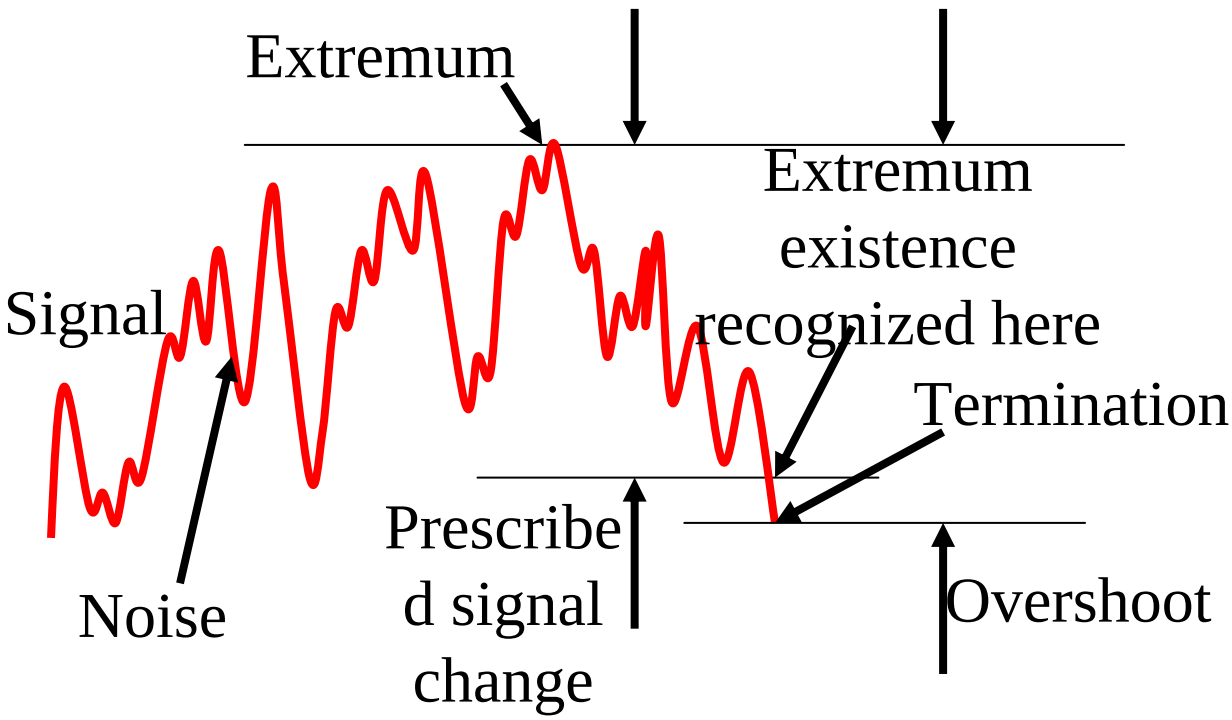
Simulator

Simulator를 이용하여 코팅 생산을 시뮬레이션 하여 모니터링 수행의 유효성 체크를 해 보겠습니다.

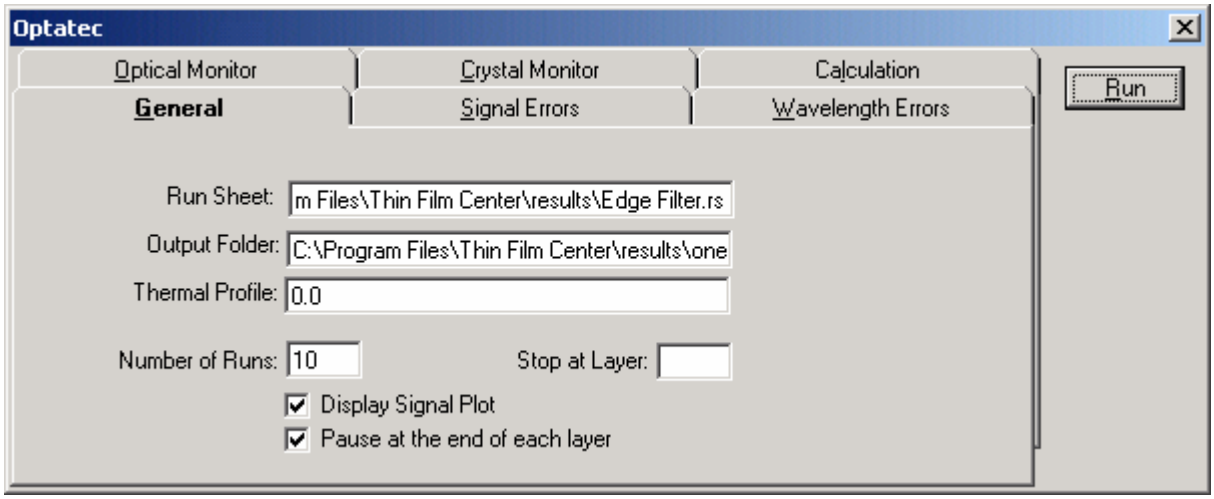


Monitoring Simulation

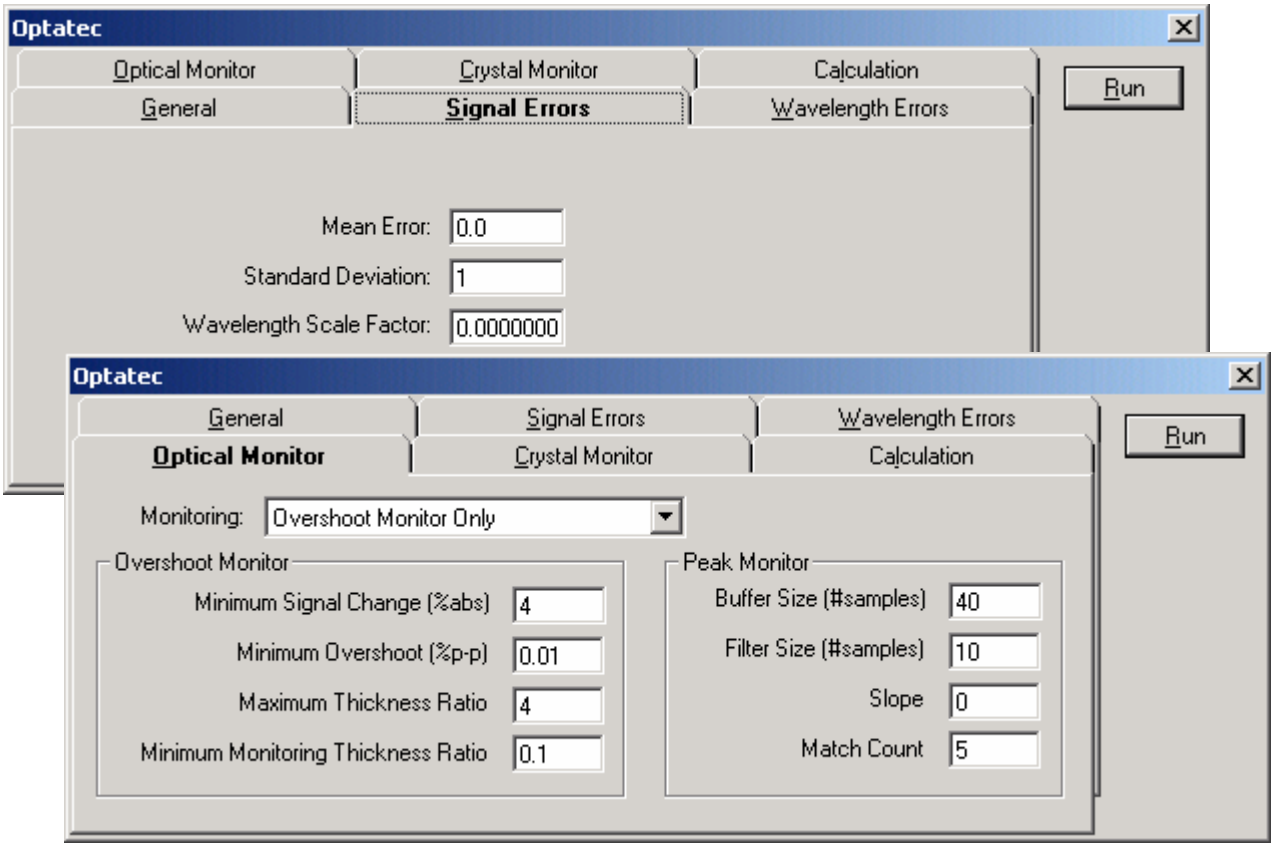
Simulato에서 극점 검파은 최대 또는 최소를 지나가는 규정된 신호 변화에 의해서 되며 부가적인 overshoot 역시 정의 할 수도 있고 , 그것이 규정된 신호변화 보다 작은 경우의 Layer는 극점에서 종결 될 수도 있습니다.



Simulator

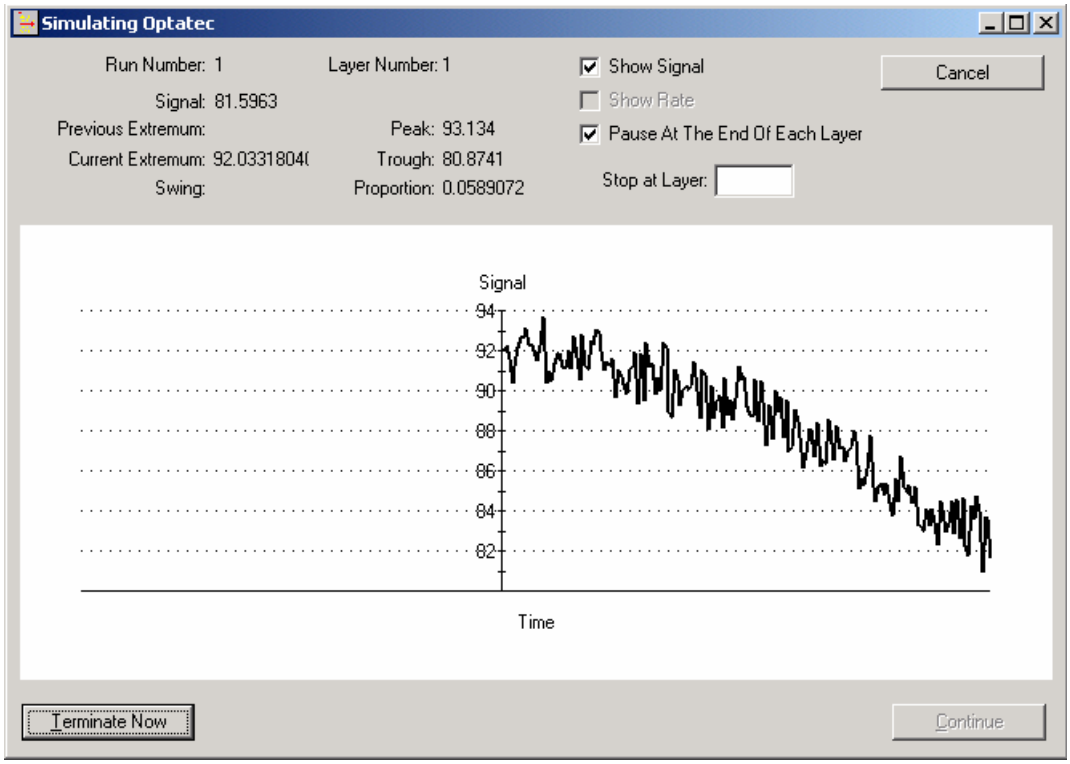


Standard deviation for optical signal noise : 1 입력.

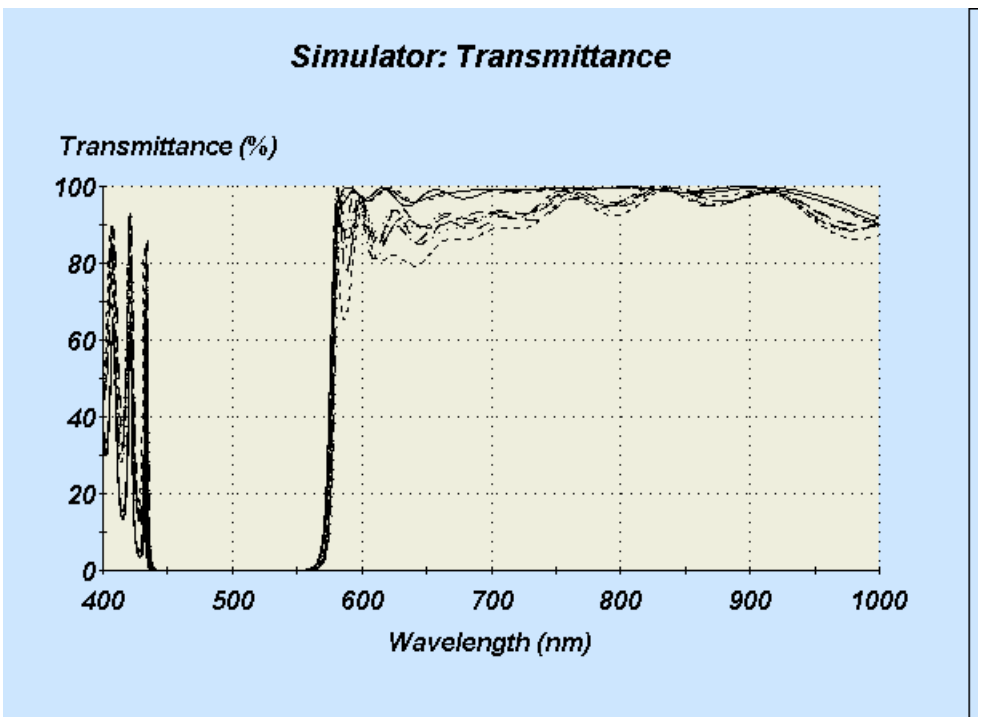


Minimum signal change 값은 signal noise의 4배와 같거나 이상.

아래그림 : The signal during the monitoring of the first layer on the first chip

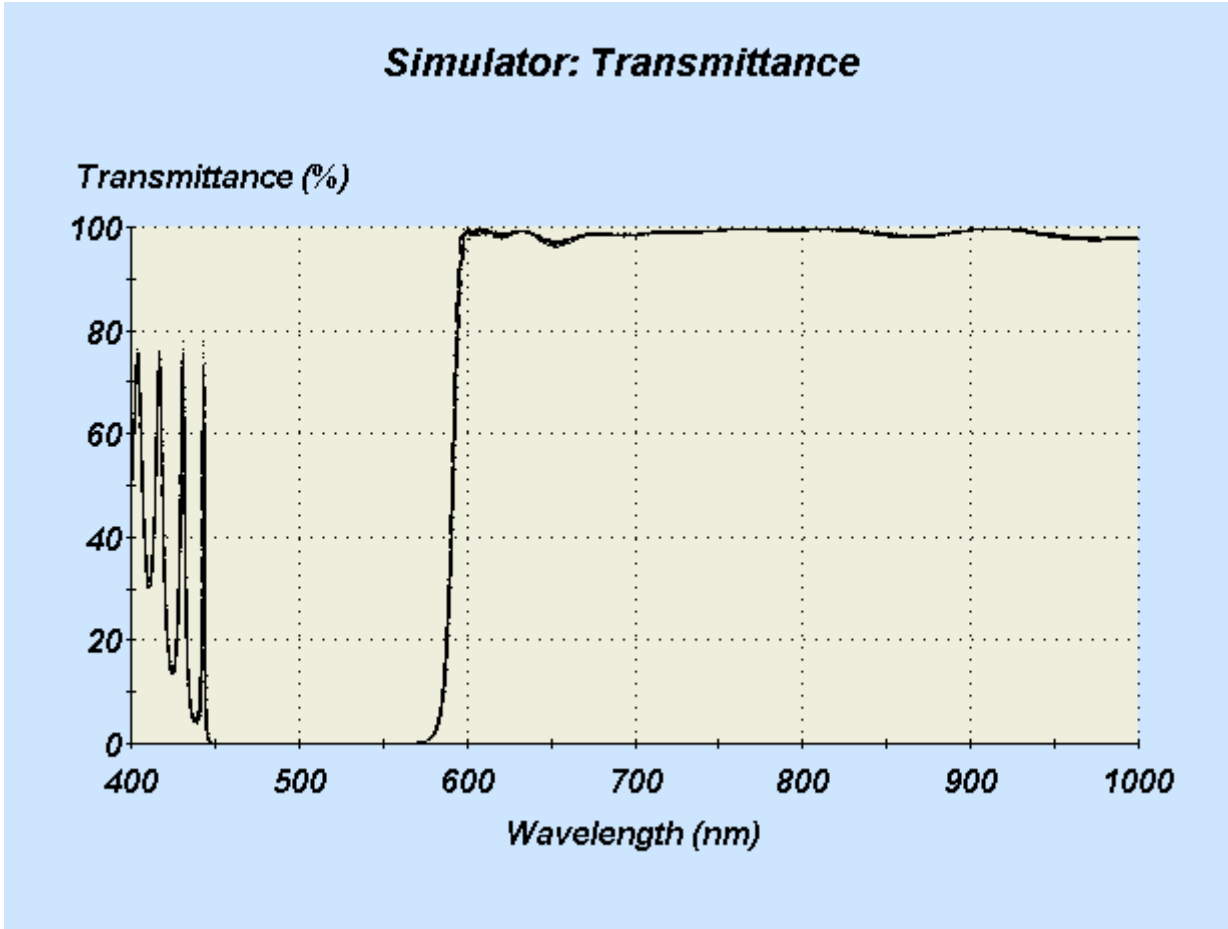


Simulator의 10회 최종결과 목표치 대비 조금 미흡 하므로



Signal Errors에서 standard deviation : 0.4%,

Optical Monitor에서 minimum signal change : 2% 수정한 후 다시 Simulation 하면



거의 완벽한 결과치를 보여주며 보다 더 완벽한 설계를 위해서는

Edge를 600nm로 가게끔 조금 수정 하거나 tooling factor errors

또는 temperature 등의 변화를 주어 다시 Simulation을 하면 됩니다.

Theoretical Performance of the Final Design