

Optical thin film design software TFV

New features from version 2.2 to version 3.0.

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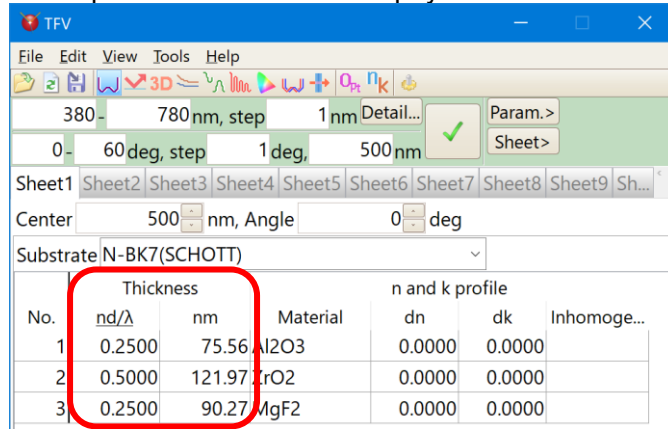
1. Summary

A description of the main functions added in the upgrade from TFV version 2.2 to version 3.0.

For details of functions, refer to the instruction manual. From the TFV main menu, [Help] - [User's Guide(pdf)]

2. Film thickness display format

Both optical film thickness and physical film thickness are now displayed.

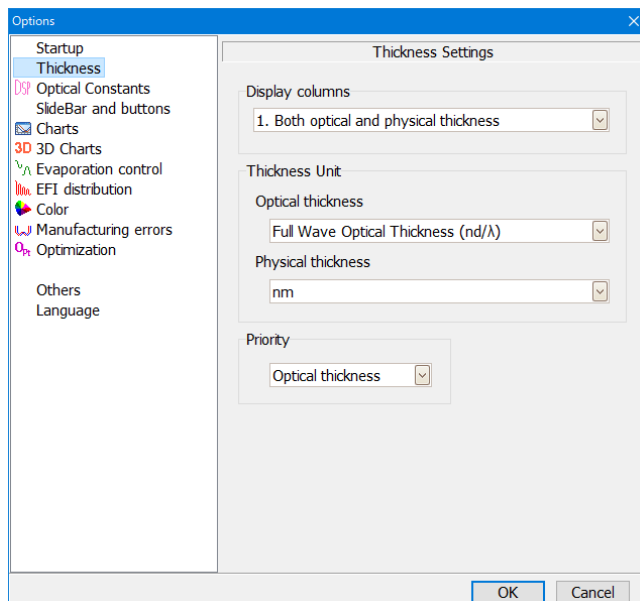


2.1. Selecting the thickness display format

You can select the thickness display format.

Display columns	(1) Both optical and physical thickness. (2) Optical thickness only (3) Physical thickness only (4) Automatic switch optical and physical thickness(Previous version style) In automatic switch mode, if less than 10 value is entered then it will be calculated as the optical thickness, if ten or more value is entered then it will be calculated as the physical thickness.
Thickness unit	Unit of physical thickness: nm or Angstrom. Unit of optical thickness: nd/Lambda or QWOT. ※ If you select the (4) automatic switch mode then the unit of physical thickness is fixed to Angstrom and the unit of optical thickness is fixed to nd/Lambda.

For change these settings, select the [Options] from the [Tools] menu or toolbar and select [Thickness].



2.2. Thickness priority

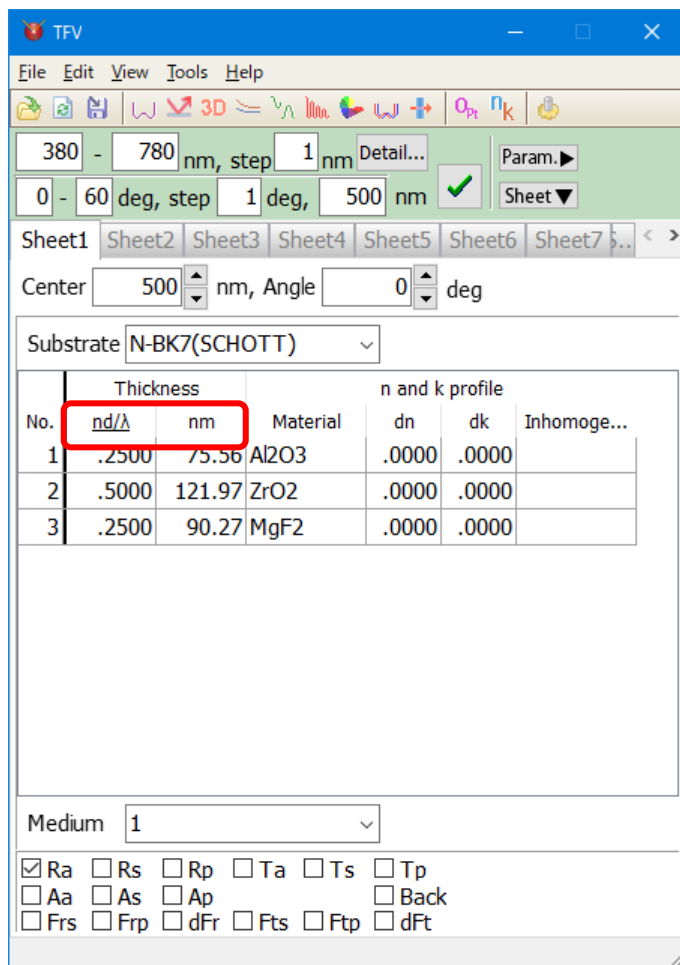
If [1. Both optical and physical thickness] is selected, it is necessary to select which of the optical thickness and the physical thickness is given priority in the [Priority] column.

[Operation in optical thickness priority]

When the center wavelength and refractive index are changed, the display value of the optical thickness is fixed and the physical thickness is changed. The optical thickness is used for calculation.

[Operation in physical thickness priority]

When the center wavelength and refractive index are changed, the display value of the physical thickness is fixed and the optical thickness is changed. The physical thickness is used for calculation.



Underline appears below the preferred thickness units.

- Note

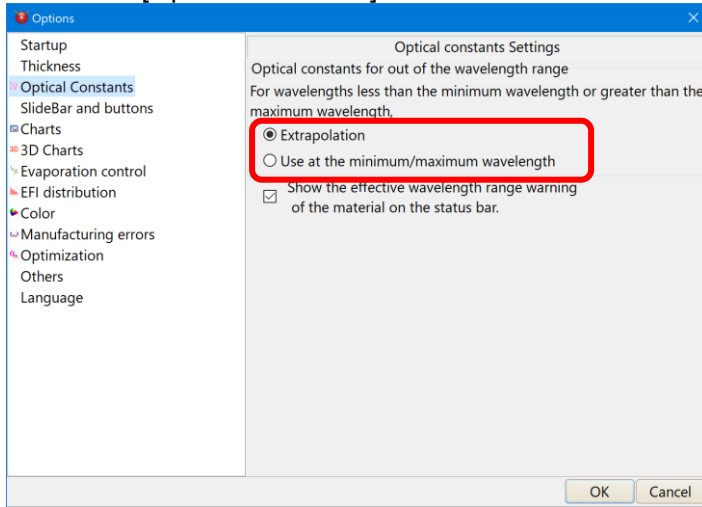
When you change the priority, there is a slight error in calculation by the floating point.

Also, when the priority is different in save the film data and read the film data, there is a slight error in calculation.

3. Setting of optical constants outside effective wavelength range

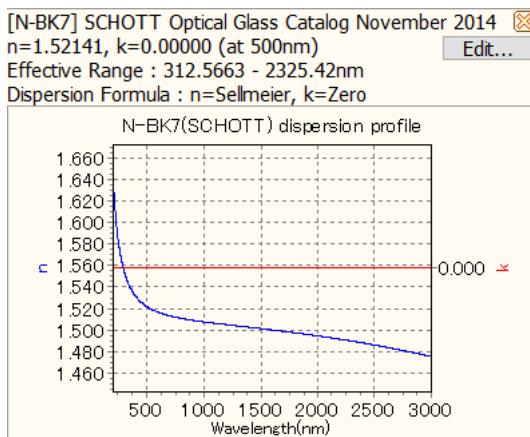
The calculation method of the optical constant can be selected when the calculation wavelength deviates from the effective wavelength range of the optical constants of the substrate and the film material. You can choose from two types: extrapolate or extend horizontally in the wavelength direction.

From the TFV main menu, select [Tool] - [Options] to open the options screen. Set in the [Optical Constants] column.

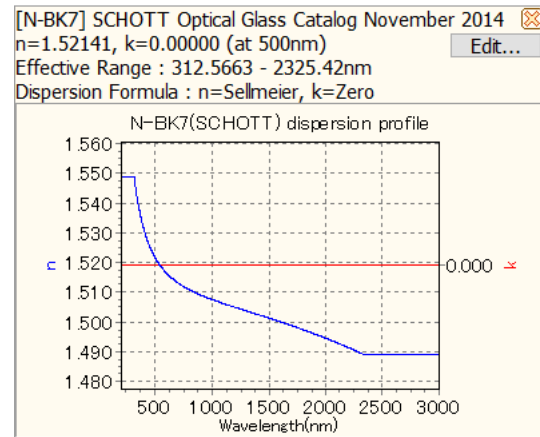


"Extrapolate" is a conventional TFV calculation method.

* Please note that the calculation result varies depending on which one you select.

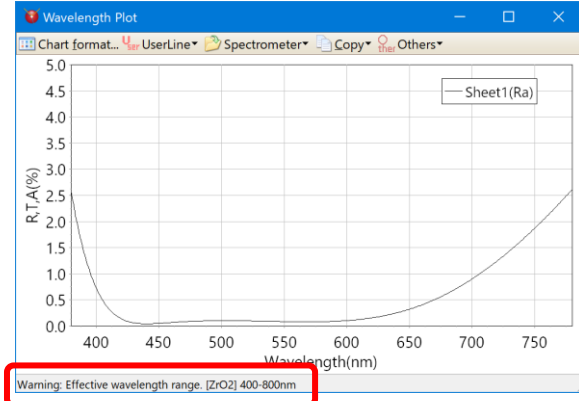


When "Extrapolate" is selected.



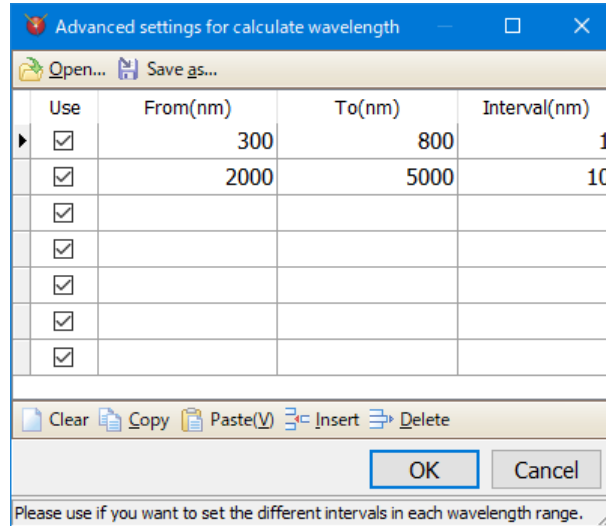
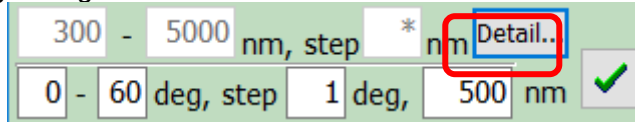
When "Use at the minimum / maximum wavelength" is selected.

If it exceeds the effective wavelength range, a message is displayed at the bottom of the graph window. If you do not want to display a message, uncheck the " Show the effective wavelength range warning ¥n of the material on the status bar."" on the above option screen.



4. Setting calculation wavelength range

It is now possible to set the calculation wavelength range intermittently or to set different wavelength intervals for each wavelength range.



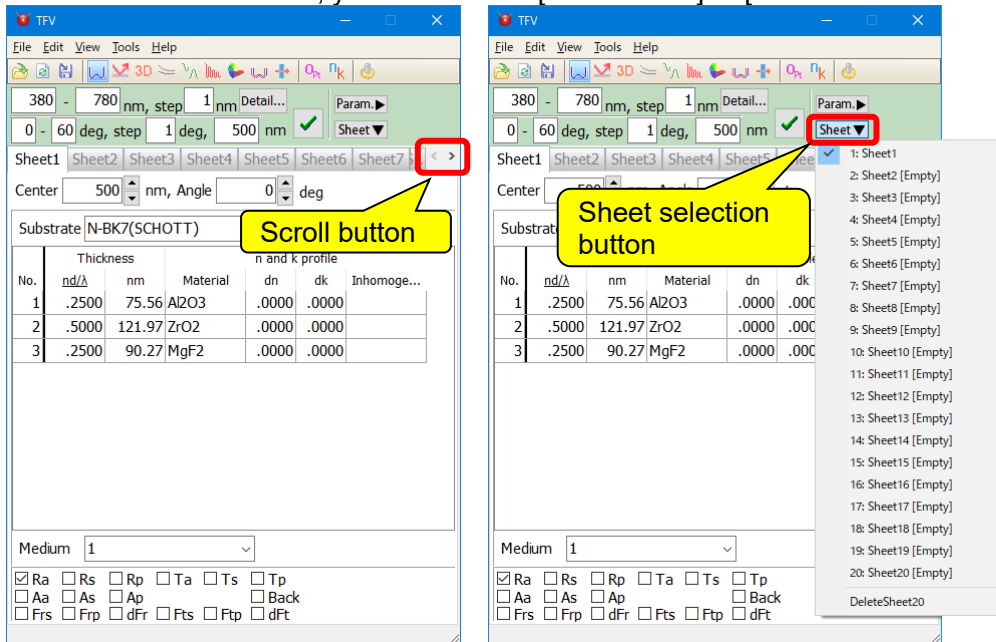
Advanced settings for calculate wavelength window.

5. Number of sheets

The number of sheets in the main window has increased to 20.

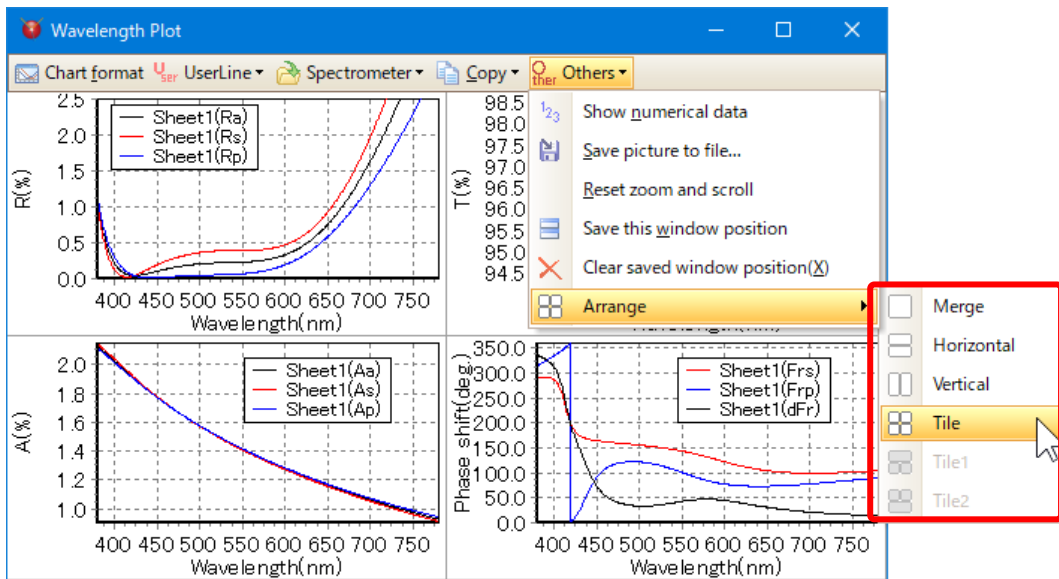
5.1. Select main window sheet

To select a hidden sheet, you can use the [scroll button] or [sheet selection button].

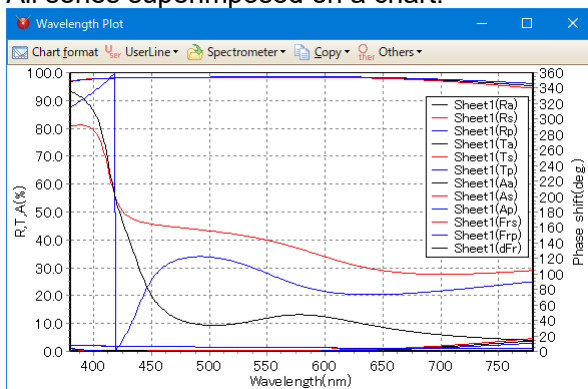


6. Wavelength chart and incident angle chart

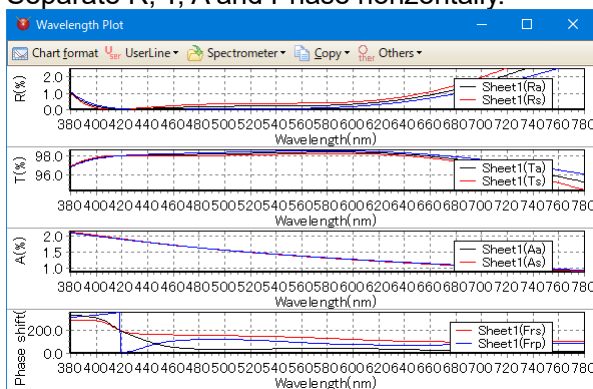
You can now choose how to display the graph. For arrange the chart view, select [Others]-[Arrange] on the toolbar or select [Arrange] on the right click popup menu.



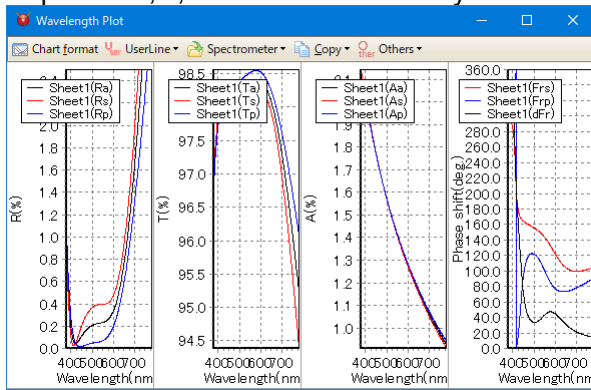
- Merge
All series superimposed on a chart.



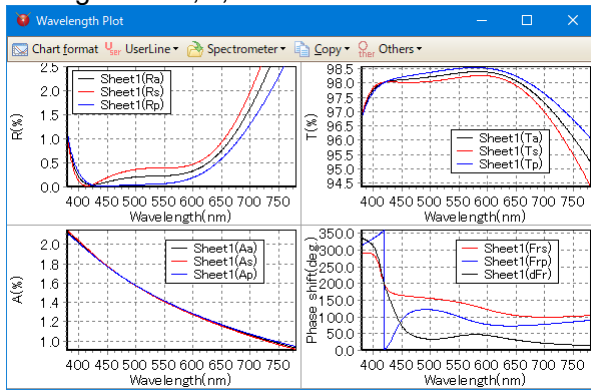
- Horizontal
Separate R, T, A and Phase horizontally.



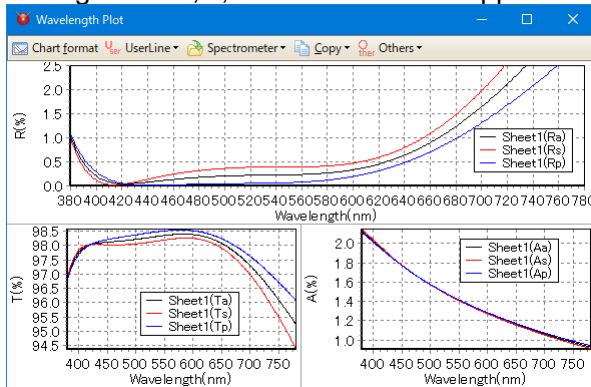
- Vertical
Separate R, T, A and Phase vertically.



- Tile
Arrange tiles R, T, A and Phase.

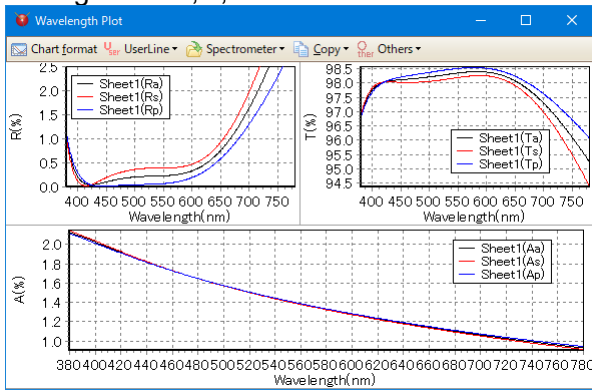


- Tile1
Arrange tiles R, T, A and Phase. The upper chart displays large.



- Tile2

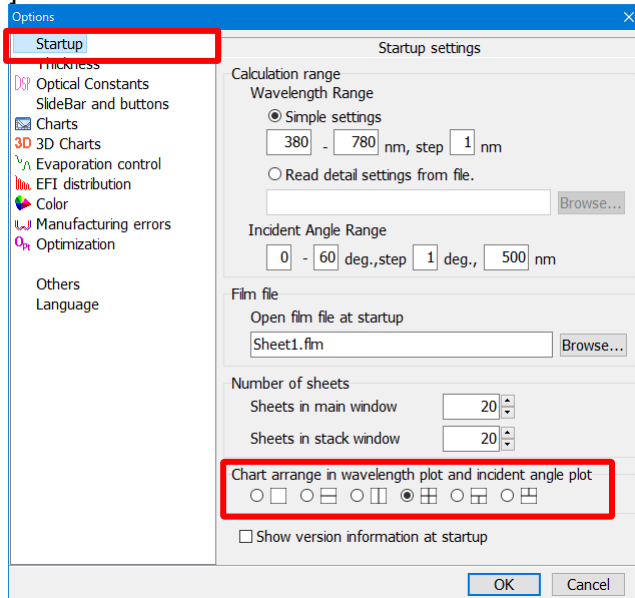
Arrange tiles R, T, A and Phase. The lower chart displays large.



- Initial settings

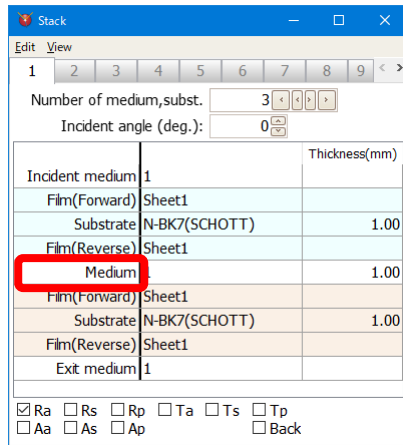
You can set the initial view.

For set the initial view, select [Options] from tool bar on the main window or select [Tools]-[Options] from main menu. Select [Startup]-[Chart arrange in wavelength plot and incident angle plot].



7. Total of multiple substrates (Stack)

It is now possible to calculate multiple substrates. “Both side window” has been renamed to “Stack window”.



With the medium to medium as one block, spectral characteristics for each block can be displayed numerically.

Block 1

Block 2

Wavelength(nm)	Sheet1(Ra)	Stack1(Ra)	Stack1-1(Ra)	Stack1-2(Ra)
380	2.583477606	9.082413118	4.502322921	5.033265045
381	2.445031814	8.619593469	4.256861276	4.770103090
382	2.312149033	8.173186890	4.021928114	4.516837313
383	2.184718008	7.743132762	3.797316755	4.273335502
384	2.062622466	7.329331276	3.582806784	4.039450912
385	1.945741726	6.931645606	3.378165570	3.815023484
386	1.833951296	6.549904187	3.183149743	3.599881051
387	1.727123440	6.183903059	2.997506639	3.393840527
388	1.625127724	5.833408278	2.820975690	3.196709066
389	1.527831531	5.498158348	2.653289764	3.008285201
390	1.435100559	5.177866674	2.494176455	2.828359943
Max.	2.615381789	9.229443306	4.582655862	5.096693940
Min.	0.043510567	0.326275819	0.155909951	0.086955945
Avg.	0.569680009	2.148990397	1.082644504	1.122963878

8. Internal transmittance of the substrate

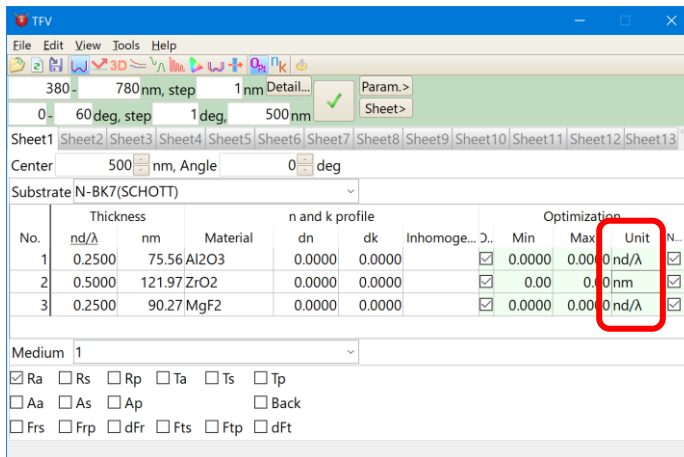
You can now register the internal transmittance of the substrate. Used in stack calculation.

WL.(nm)	Ti(%)	Thickness(mm)
290	6.3	10
300	29.2	10
310	57.4	10
320	77	10
334	90.5	10

9. Optimization

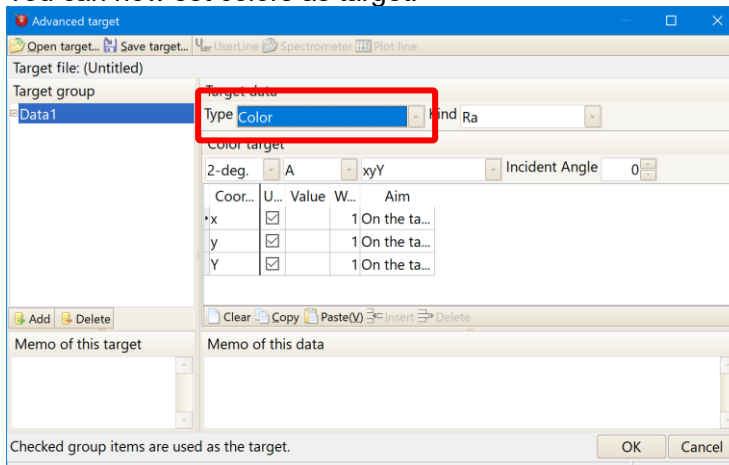
9.1. The unit of the maximum and minimum thickness

It is now possible to select whether to set the maximum and minimum thickness by optical thickness or physical thickness.



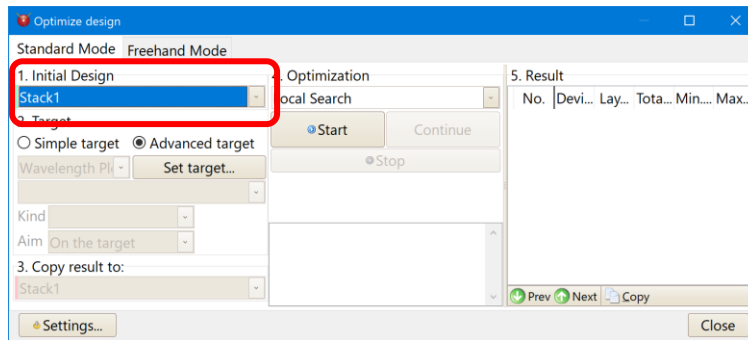
9.2. Color optimization

You can now set colors as target.



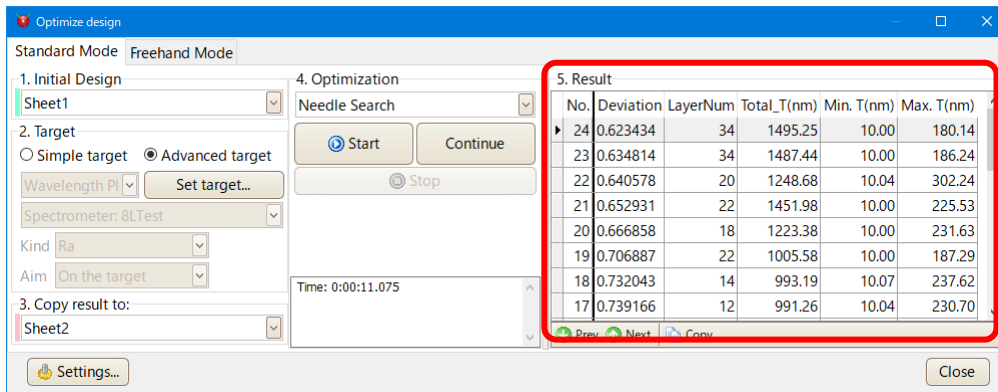
9.3. Stack optimization

It is now possible to optimize the stack.
When you display the stack window, you can select the stack for the initial design.

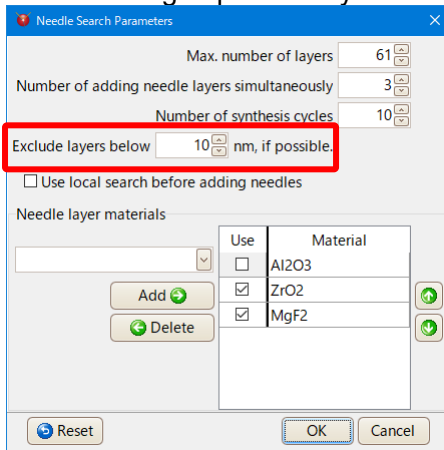


9.4. Improvement of needle search

It now displays optimization history at needle search.

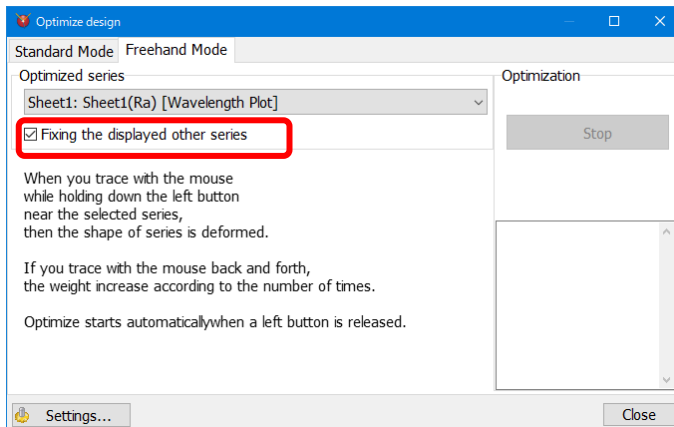


Added setting to prevent layers as thin as possible.



9.5. Free-hand mode

When multiple series are displayed for initial design, optimization can be done not to change other series as much as possible.



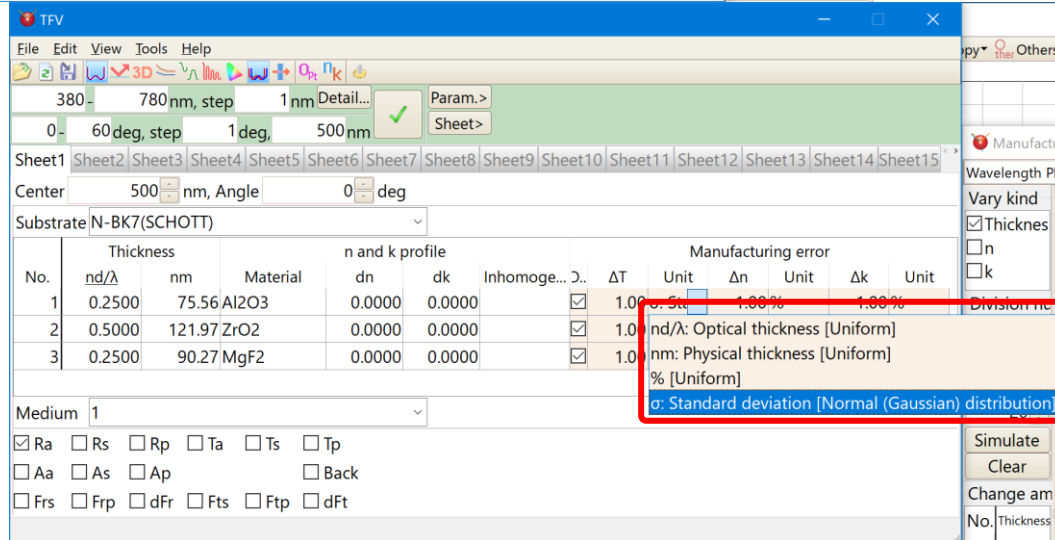
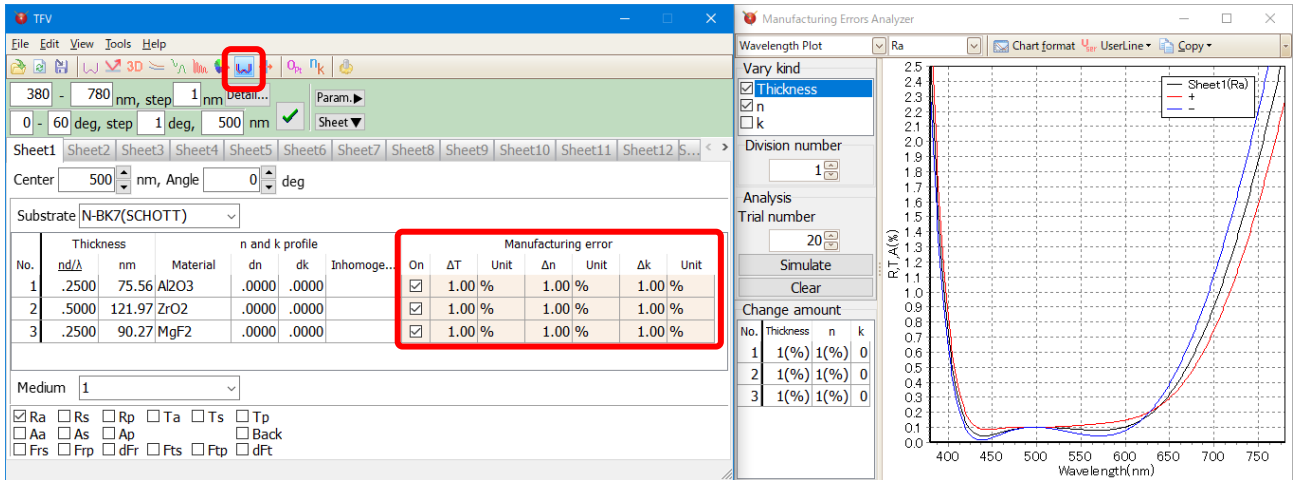
When multiple series are displayed for initial design, if you check "Fixing the displayed other series" then all displayed series for initial design are used as the target.

For example, if it has been displayed Ra, Ra(back) and Ta in Sheet1 on the chart and you select the [Sheet1(Ra)] at "Optimized series" and you check the "Fixing the displayed other series", then the optimization is performed to target the three series of deformed Ra, Ra(back) and Ta. If you uncheck the "Fixing the displayed other series", then the optimization is performed to target only series of deformed Ra.

10. Manufacturing error

You can now set the amount of change for each layer.

Also, it is now possible to calculate when changing randomly with normal (Gaussian) distribution.



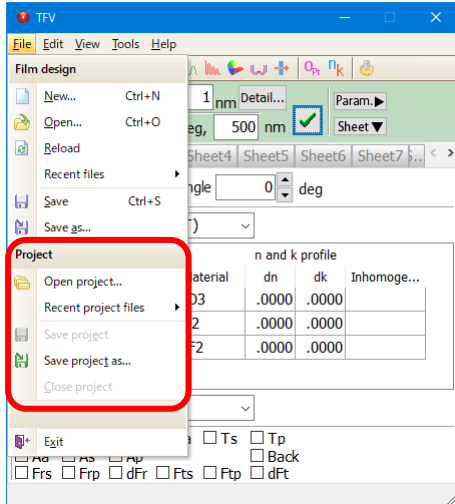
In the display of numerical data, it is now possible to display not only the conventional numerical display but also the numerical value of film thickness, $n \cdot k$ of each Trial.

Wavelength(nm)	Sheet1 (Ra)	+	-	Trial1	Trial2
380	2.583477606	2.882646393	2.328185732	2.855738419	3.348346275
381	2.445031814	2.730102770	2.201887753	2.709443480	3.188003370
382	2.312149033	2.583653665	2.080675991	2.568536523	3.033172582
383	2.184718008	2.443187972	1.964442835	2.432931938	2.883782037
384	2.062622466	2.308587780	1.853076969	2.302538436	2.739753227
385	1.945741726	2.179729096	1.746463890	2.177259608	2.601001587
386	1.833951296	2.056482556	1.644486399	2.056994470	2.467437054
387	1.727123440	1.938714105	1.547025065	1.941637992	2.338964612
388	1.625127724	1.826285660	1.453958675	1.831081605	2.215484827
Max.	2.615381789	2.882646393	2.990836841	2.855738419	3.348346275
Min.	0.043510567	0.085545715	0.015934834	0.009031237	0.012872915
Avg.	0.569680009	0.534080767	0.629079835	0.603518643	0.604882560

Sheet1 (Ra)	ΔThickness	Δn	Δk	ΔThickness	Δn
Sheet1 (Ra)	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000
+	0.002500000	0.016543418	0.000000000	0.005000000	0.020497548
-	-0.002500000	-0.016543418	0.000000000	-0.005000000	-0.020497548
Trial1	-0.001226400	-0.013446561	0.000000000	0.002430125	-0.005540062
Trial2	-0.002218083	-0.007820675	0.000000000	0.004758610	0.011376260
Trial3	0.001796213	0.005520938	0.000000000	-0.003630322	0.019297266
Max. of Trial	0.002449205	0.014912312	0.000000000	0.004758610	0.019577079
Min. of Trial	-0.002366708	-0.015859772	0.000000000	-0.004929031	-0.018515266
Avg. of Trial	0.000127192	-0.002174906	0.000000000	-0.000438239	0.003547896
SD(σ) of Trial	0.001623233	0.009453832	0.000000000	0.003044229	0.012689185

11. Save and read the project

You can save the design data displayed on each sheet of the main window, the structure of the stack window, the arrangement of the window being displayed, the format of the graph, the user line, etc. as a "project" in the file.



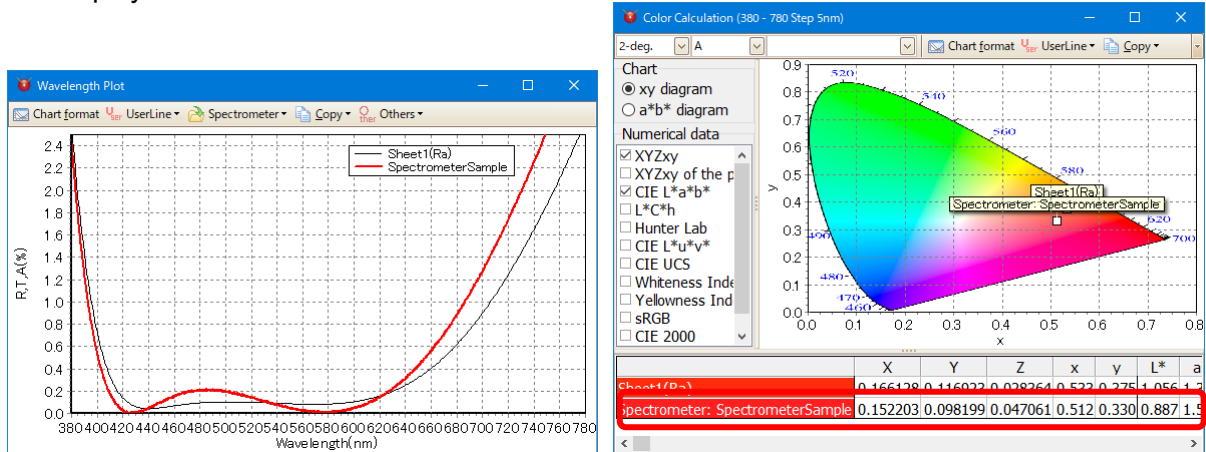
- Stored contents

The following contents are saved.

Items	Stored contents
Film data	Film data file name of each sheets on main window.
Calculation settings	Start wavelength, end wavelength, wavelength interval, start incident angle, end incident angle, incident angle interval and calculation wavelength of the incident angle characteristic.
Kind of the plot	Selection state of kind of the plot (Ra, Rs, Rp, Ta...dFt, Back) on each sheets.
Number of sheet	Number of visible sheet on main window.
Main window	Display position, size and selected sheet.
User line	File name of visible user line, line color, line style and line width. Except unsaved user line.
Photometer line	File name of visible user line, line color, line style and line width. If converted absolute value, reference substrate name also will be saved.
Chart format	Chart format of each chart.
EFI distribution	Selection state of kind of the plot (Ave.(s,p), s...).
Color calculation	Selection state of visual field, illuminant, base of the color difference, diagram kind and numerical data.
Manufacturing errors chart	Selection state of kind of chart (wavelength, incident angle or color), kind of plot(Ra, Rs...), vary kind.
Stack window	Number of visible sheet on stack window. Incident angle, incident medium, film, medium, substrate, exit medium, thickness, kind of plot(Ra, Rs...) and window position.

12. Color calculation of spectrophotometer data, user line data

The color calculation result of spectrophotometer data and user line data displayed in the wavelength chart is displayed on the color window.



The linear interpolation value of the 380 – 780nm 5nm intervals are used. Even when the wavelength range is less or data points is enough, then calculate by extrapolation-interpolation. Always using 5nm intervals for calculation, even if original data is 1nm intervals.

13. Copy/Paste for cell in the design sheet

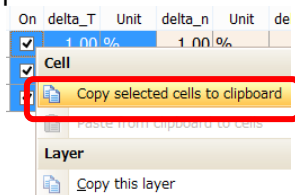
You can copy-pasting of design data by selecting the cells.

The cell that you want to copy and then selected with the mouse or [Shift + Arrow] key as shown in the figure below.

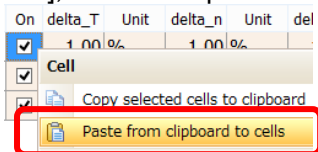
Manufacturing error				
On	delta_T	Unit	delta_n	Unit
<input checked="" type="checkbox"/>	1.00	%	1.00	%
<input checked="" type="checkbox"/>	1.00	%	1.00	%
<input checked="" type="checkbox"/>	1.00	%	1.00	%

It is not possible to be selected with the mouse to the check box cell first. In this case, please select from lower right cell first by mouse or use [Shift + Arrow] key.

If select [Edit] – [Copy selected cells to clipboard] from the main menu or [Copy selected cells to clipboard] from the right-click menu, then the contents of the selected range is copied to the clipboard.



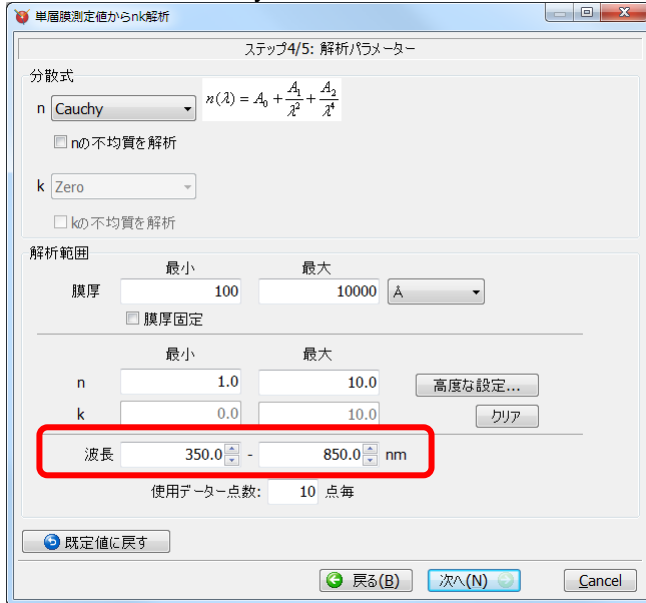
If right-click a cell in the upper left corner that you want to paste, and press [Paste from clipboard to cells], then the clipboard contents will be copied.



You can also copy from Excel.

14. n and k analysis from mono layer measurement data

Analysis wavelength range can now be set.
Please use it when the wavelength range is too wide or exclude wavelengths with poor measurement accuracy.

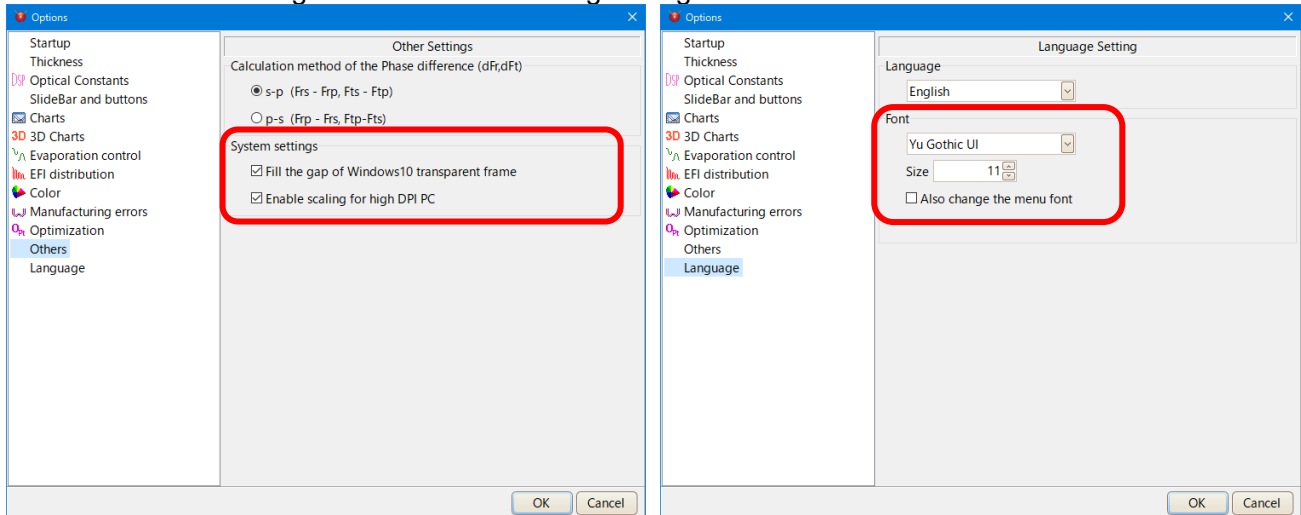


Also, there were cases where analysis could not be done in the previous version, but we improved it so that it can be analyzed as much as possible.

15. Improve display

15.1. High resolution display compatible

Even characters with high resolution display are now displayed without blurring. Characters are scaled according to the Windows scaling setting. You can also set font and font size.



15.2. Language selection

You can now switch languages without restarting.

16. Addition of material data

Add the material of the Kyoto Thin-Film Materials Institute.

Al₂O₃(KTM), HfO₂(KTM), LaF₃(KTM), Ti₃O₅(KTM), ZrO₂(KTM), ZRT2(KTM)

17. Update of substrate data

We updated the glass data of SCHOTT, HOYA, OHARA, SUMITA, HIKARI, CDGM to the latest version as of 2014.

Since internal transmittance is also registered, stack calculations may have different results from previous versions if the glass is thick.

Also, some glasses have their refractive index changed.

Infrared substrates were added. Al₂O₃(Subst), ALON(Subst), GaAs(Subst), Ge(Subst), Si(Subst), ZnSe(Subst).

18. Spectrophotometer file

Supported reading of Shimadzu spectrophotometer SPC file, JASCO JWS file, Olympus-USPM Ver2.0 file.

19. Periodic layer

It is now possible to expand the periodic layer.

From the menu, select [Edit] - [Expand periodic layers]

20. Numerical data

Previously, only one numerical data window could be displayed, but it became possible to display multiple numeric data window at the same time.

21. Bug fixes

Fixed an error in calculation when color calculation L*a*b*, when XYZ value is 0.008856 or less.

22. Specification change

22.1. Display of back side characteristics

The back side of the transmittance and the back side of the transmission phase are not displayed since they are the same value as the front side.

22.2. Change help file format

The Windows help file has been abolished and changed to display the pdf.

23. Film data file compatibility with old version

If you save the film data file of the new version in the old version, then the items that do not exist in the old version will be deleted.

Items that are saved will be as follows for each version.

		TFV3.0	TFV2.2
Thickness	Optical thickness	○	If you read the files of TFV3.0 in TFV2.2, the thickness that is set to priority in TFV3.0 (where the underline is displayed in the title) will be loaded.
	Physical thickness	○	
n and k profile	Material	○	○
	dn	○	○
	dk	○	○
	Inhomogeneity	○	○
Evaporation control	Tooling	○	○
	dn	○	○
	dk	○	○
	Filter(nm)	○	○
	Start	○	○
	MG	○	○
Optimization	On	○	○
	Min	○	○
	Max	○	○
	Unit	○	×The unit is always nm.
	Needle	○	○
Manufacturing error	On	○	×
	delta_T	○	×
	Unit of delta_T	○	×
	delta_n	○	×
	Unit of delta_n	○	×
	delta_k	○	×
	Unit of delta_k	○	×
Period layer	Period	○	○
	Magnification	○	○
Others	Center wavelength of design	○	○
	Incident angle	○	○
	Substrate	○	○
	Incident medium	○	○
	Monitor glass	○	○
	Comment	○	○

○: Saved item, ×: Unsaved item