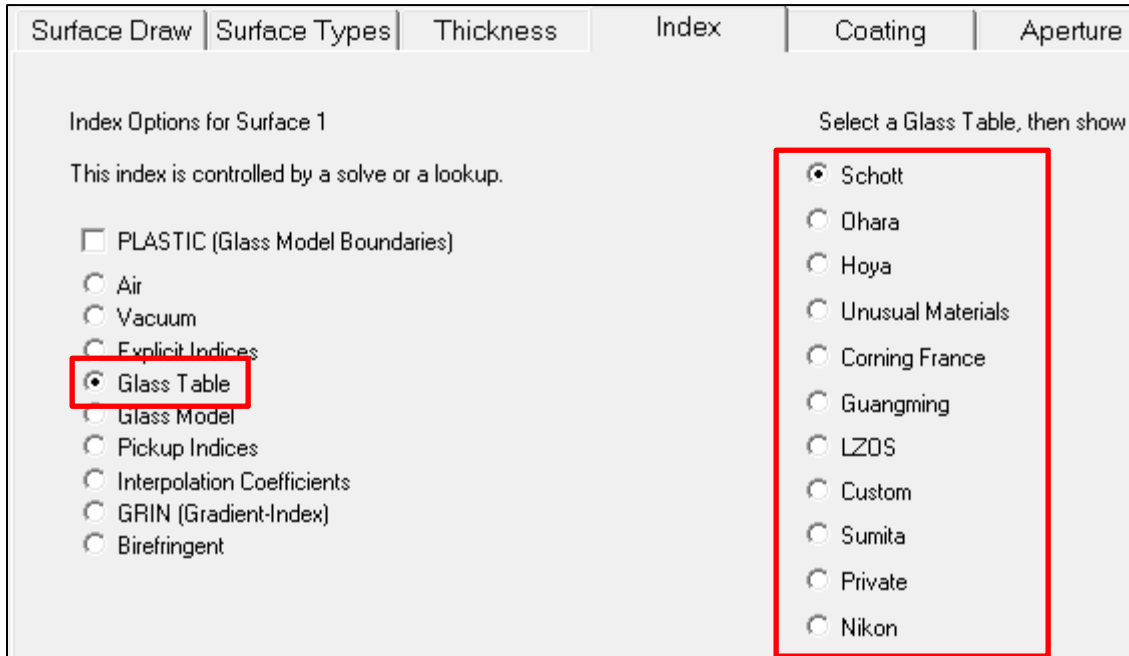# SYNOPSYS™ Glass Catalog Overview and Adding Custom Glasses

Table of Content

Available Glass Catalogs in SYNOPSYS™ :

There are 11 Glass Catalogs in SYNOPSYS™ and can be easily accessed via the Index Editor in the SpreadSheet:

The glasses in the different catalog use different interpolation function to calculate the indices at different wavelengths. This Table summarizes the default glass equations used by the different catalogs:

	Glass Formula	
Schott	SellMeier	Index=SQRT[1 +A1*w^2/(w^2-A4) +A2*w^2/(w^2-A5) +A3*w^2/(w^2-A6)]
Ohara		
Hoya	old Schott	Index=SQRT[A1+A2*w^2 +A3/w^2 +A4/w^4 +A5/w^6 +A6/w^8)]
Unusual (Note 1)		
French Corning		
Guangming		
LZOS (Russian)		
Sumita		
Nikon	Power Series- Nine Parameters	Index=SQRT[A1+A2*w^2+A3*w^4+A4/w^2 +A5/w^4 +A6/w^6+A7/w^8 +A8/w^9 +A9/w^10)]
Custom (Note 2)	old Schott	Index=SQRT[A1+A2*w^2 +A3/w^2 +A4/w^4 +A5/w^6 +A6/w^8)]
Private (Note 3)		

Note 1. The Unusual Catalog hosts the IR (Infrared) glasses and plastic materials available in SYNOPSYS™. Because it includes a large selection of materials over a wide wavelengths that cover both the visible and infrared range, it uses several glass equations to describe the indices. The old Schott formula is used for the plastic material. Other polynomials of power series as well as the Herzberger formula are used for the other materials. For more details, see the section 'Glass Formulas in SYNOPSYS™' in this document.

Note 2. The Custom Catalog is intended for customers to store their own custom glasses or materials not included in the standard glass catalogs. The indices of the glasses in this catalog is always described by the old Schott

Available Glass Catalogs in SYNOPSYS™ :

formula. For more details, see the section 'Adding Custom Glasses to the Custom Catalog' in this document or User Manual 5.20.

Note 3. The Private Catalog is intended for users who have chosen a favorite set of existing glasses and want to see only those glasses in the glass map display or use them in GSEARCH, IRG, VNUM, etc. For more details, see the section 'Private Catalog' in this document or User Manual 5.20.

A brief Discussion on the Private Catalog

SYNOPSYS can create a private glass catalog. This is intended for users who have chosen a favorite set of glass types and want to see only those glasses in the glass map display and make them available to programs such as GSEARCH, IRG, VNUM, etc.

- Private Catalog doesn't host any glasses that are not already in the other standard catalogs. There is no new information in the Private Catalog, and the only reason you would ever use it is so you can avoid seeing all the glasses in the standard table when you want to use just a selected group of them.
- Private Catalog is convenient when use GSEARCH. When common materials are placed in private library, GSEARCH can search for the corresponding materials by specifying **P**, thus avoiding the need to list all the alternative materials in each GSEARCH.

To create a private glass table, use the following syntax (for more details, see User Manual 5.20 Custom Glass Table) :

PCAT INIT

PCAT ADD
[S / O / H / F / G / R / M] glassname
[S / O / H / F / G / R / M] glassname
[S / O / H / F / G / R / M] glassname
...

END

Where the letter S/O/… in the command lines above represent the following Glass Catalogs:

	Catalog Name
S	Schott
O	Ohara
H	Hoya
F	Corning France
G	Guangming
R	LZOS (Russian)
M	Sumita

The Private Catalog is created in the current selected working directory and is only available to users while in that directory. Note that the Unusual material catalog (U) and custom catalog (C) are not permitted in this list.

To use the Private Catalog, specify the letter "P" in your lens data file.

For example, to create a Private Catalog containing three glass types, we enter

PCAT INIT !if you already have a Private Catalog, you don't need to INITiate it again. This action will wipe out the catalog.
PCAT ADD
S N-LAK10 !glass N-LAK10 from the Schott Catalog
O S-NBH5 !glass S-NBH5 from the Ohara Catalog
S N-SK16 !glass N-SK16 from the Schott Catalog
END

Now we can apply these glasses to our lens with input such as

CHG
3 GTB P !use the Private (P) Catalog in the Glass Table (GTB)
S-NBH5 !use the glass S-NBH5 that was added to the Private Catalog
END

Adding Custom Glasses

There are two ways to add custom glasses:

1. Using the AGLASS command to add customer glasses to the Custom Catalog. Glasses added by this method can only use the old Schott formula to describe the index-wavelength relation. This method is easier but with some limitations.

2. Edit the Glass Library files to add customer glasses to the standard glass catalogs in SYNOPSYS (for example, Guangming, Schott…). In this method, users can select from the nine available glass formula in SYNOPSYS to describe the index-wavelength relation.

Adding Custom Glasses to the Custom Catalog

- The Custom Catalog can store at most 50 custom glasses
- The data is stored in the binary file Cglass.dat located in the selected working directory (for example, C:\SYNOPSYS\USER)
- Glasses in the Custom Catalog cannot be used in GSEARCH
- The glass formula for this catalog is limited to the old Schott formula that takes six coefficients

Step 1. Defining the material:
Index data for materials not in the standard glass catalogs may be input to SYNOPSYS using the command GLASS or GDF commands (see User Manual 3.3.4 Index Options and 5.6 GLASS for more details), if the user has access to the old Schott coefficients for the material. If the Schott coefficients are not known, the user can use the GFIT command to calculate the values of the six coefficients from the published index data. Then use the GLASS or GDF commands to define the material index.

Step 2. Adding the new material to the Custom Catalog:
To do so, the glass must currently be present in a lens, and must be assigned a desired name with the GID format. Then it is put into the glass table with the command
      AGLASS <u>SN</u>   (Add GLASS, see User Manual 5.20 Custom Glass Table)
where SN is the surface number assigned with the desired glass.
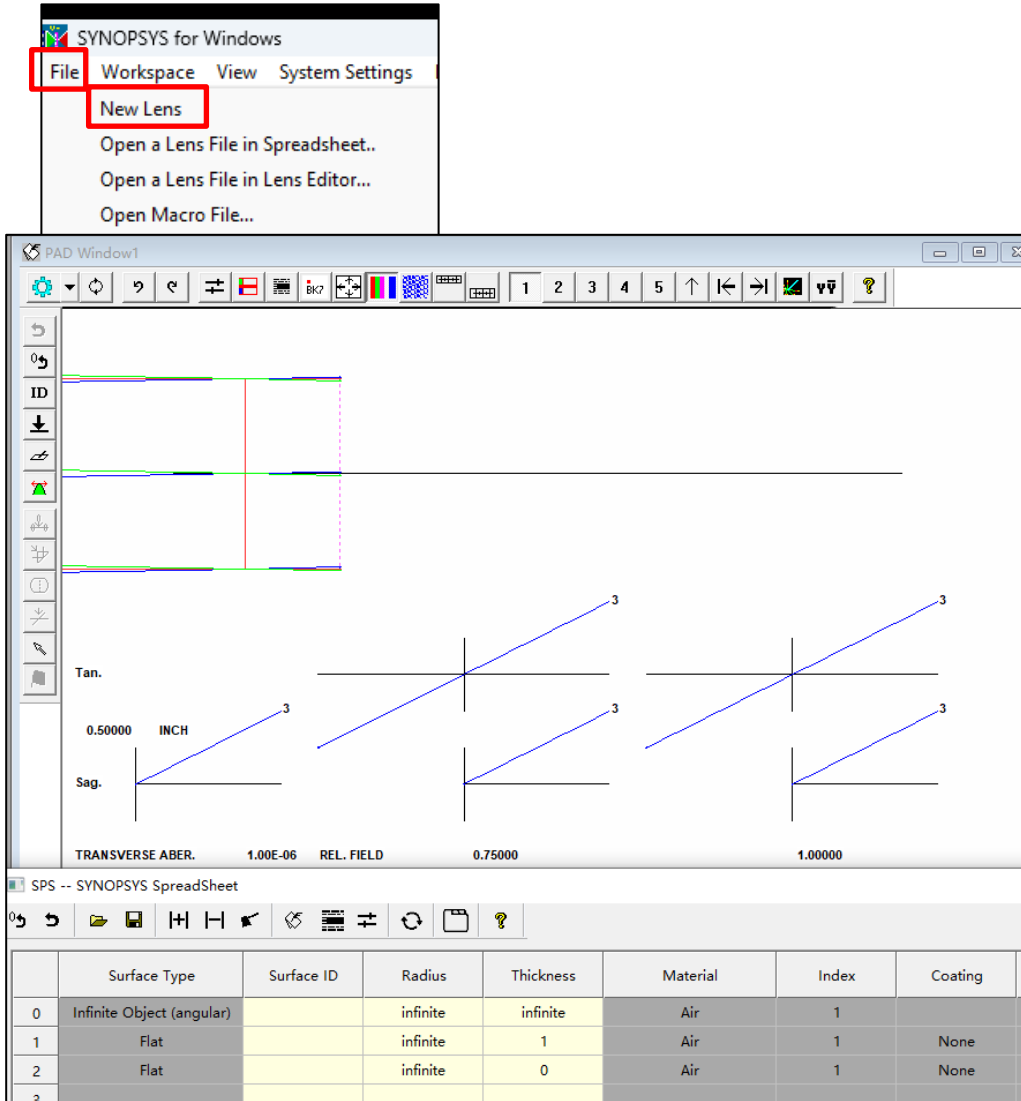
- Once the glass is added to the Custom Catalog, it may be accessed via the Custom Catalog (C in the Glass Table).
- If the material has been assigned thermal-index properties (DNDT) or a thermal expansion coefficient (CTE), those data are saved in the catalog as well.
- The contents of the custom glass table may be printed with the command PCGLASS.
- To delete a glass in the catalog, first enter the command DGLASS to invoke the action. Then enter the glass name in the next command input line.

An example is presented in the next few pages.

EXAMPLE, Adding Custom Glasses to the Custom Catalog

For this example, our focus is on showing the mechanisms to create and add the custom glasses to the Custom Catalog. So we will just use a simple dummy system that consists of two flat surfaces as a demonstration:

1. Click the File menu and then select the 'New Lens' option to launch a new lens with 2 flat dummy surfaces.

	Surface Type	Surface ID	Radius	Thickness	Material	Index	Coating
0	Infinite Object (angular)		infinite	infinite	Air	1	
1	Flat		infinite	1	Air	1	None
2	Flat		infinite	0	Air	1	None
3							

EXAMPLE, Adding Custom Glasses to the Custom Catalog

2. Run the macro shown here. The macro can be divided into two major blocks: 'Adding first glass' and 'Adding second glass'. For demonstration purpose, we use the long form of the GLASS command for the first and the GDF command for the second glass. The details of each block are given below.

```
!Adding first glass                                Block 1
GLASS
1
3.0862859 -0.01542532 0.02910141
0.00126438 -0.00007089 5.42510179E-06
END

CHG
1 DNDT 3.35E-6 3.8E-6 5.2E-6 0.47999 0.435835 0.365015
1 cte 1e-6
1 GID 'Custom13'
END

AGLASS 1
```
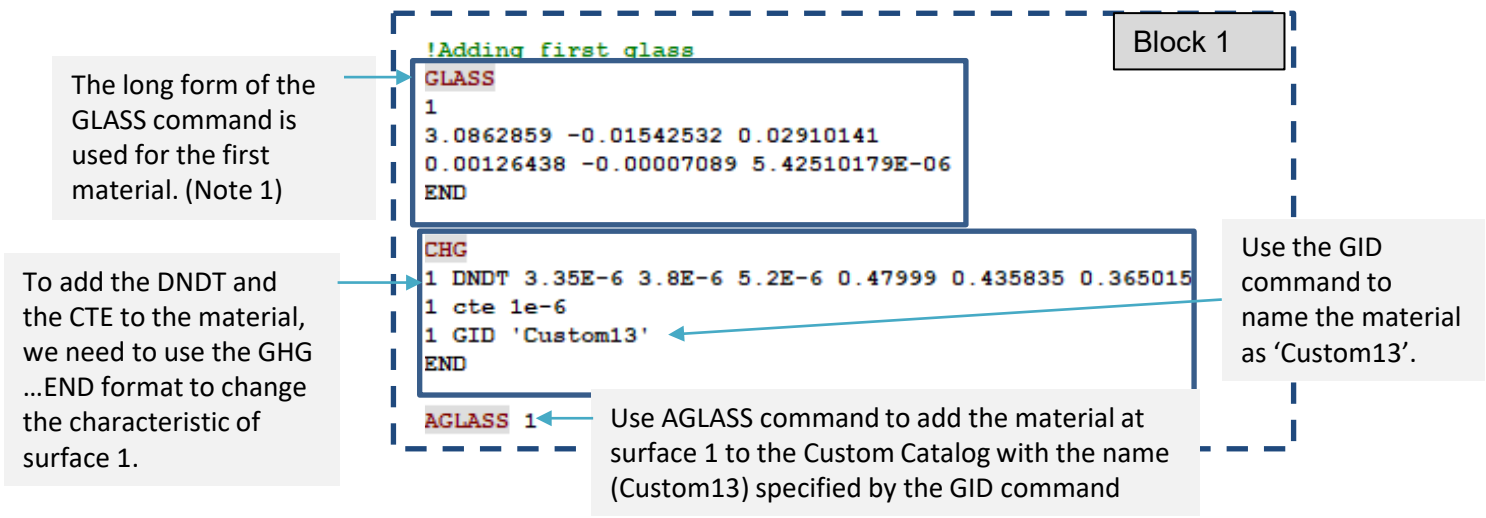
```
!Adding second glass                               Block 2
CHG
1 GDF
3.0262859 -0.01842532 0.02910141
0.00126438 -0.00007089 5.42510179E-06

1 DNDT 3.35E-6 3.8E-6 5.2E-6 0.47999 0.435835 0.365015
1 CTE 1e-6

1 GID 'Custom14'
END

AGLASS 1
```

The long form of the GLASS command is used for the first material. (Note 1)

```
!Adding first glass                                Block 1
GLASS
1
3.0862859 -0.01542532 0.02910141
0.00126438 -0.00007089 5.42510179E-06
END
```

To add the DNDT and the CTE to the material, we need to use the GHG …END format to change the characteristic of surface 1.

```
CHG
1 DNDT 3.35E-6 3.8E-6 5.2E-6 0.47999 0.435835 0.365015
1 cte 1e-6
1 GID 'Custom13'
END

AGLASS 1
```

Use the GID command to name the material as 'Custom13'.

Use AGLASS command to add the material at surface 1 to the Custom Catalog with the name (Custom13) specified by the GID command

EXAMPLE, Adding Custom Glasses to the Custom Catalog

Block 2

We use the GDF command to change the material assigned for surface 1. Because GDF belongs to the subgroup of the lens data file commands (RLE), we put it in the CHG…END (Change File).

```
!Adding second glass
CHG
1 GDF
3.0262859 -0.01842532 0.02910141
0.00126438 -0.00007089 5.42510179E-06

1 DNDT 3.35E-6 3.8E-6 5.2E-6 0.47999 0.435835 0.365015
1 CTE 1e-6

1 GID 'Custom14'
END

AGLASS 1
```

Similarly, add the DNDT and the CTE to the material. Note that these commands are in the GHG …END block as the GDF command.

Use the GID command to name the material as 'Custom14'

Use AGLASS command to add the material at surface 1 to the Custom Catalog with the name (Custom14) specified by the GID command

If you have more than two custom materials, you can keep adding similar blocks to the macro and run it to add all materials all at once.
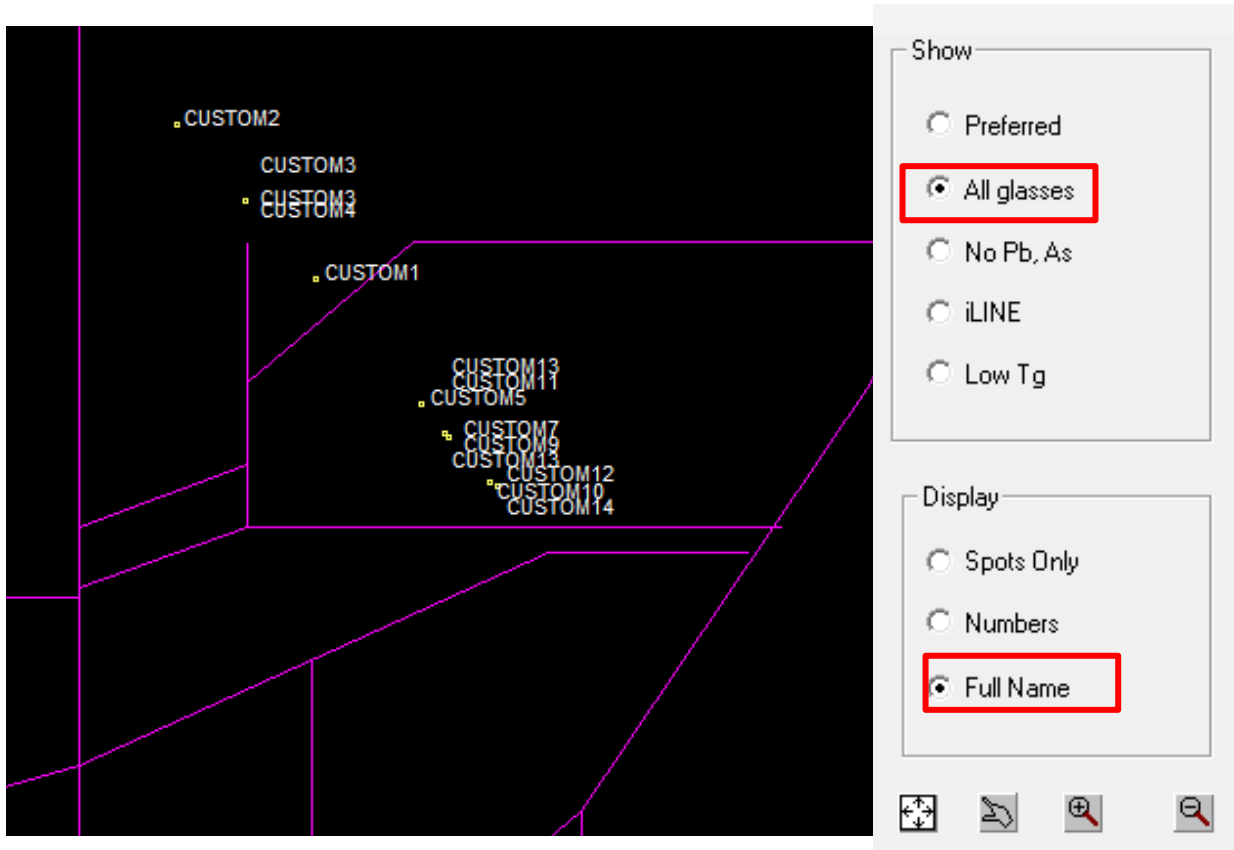
Adding Custom Glasses to the Custom Catalog

After adding the materials into the Custom Catalog, we can use them similar to any other glasses in the standard catalogs.

First, let's view the new glasses on the Glass Map. To do so, click the 'Glass Table' button in the PAD toolbar. Then select Custom and click OK.
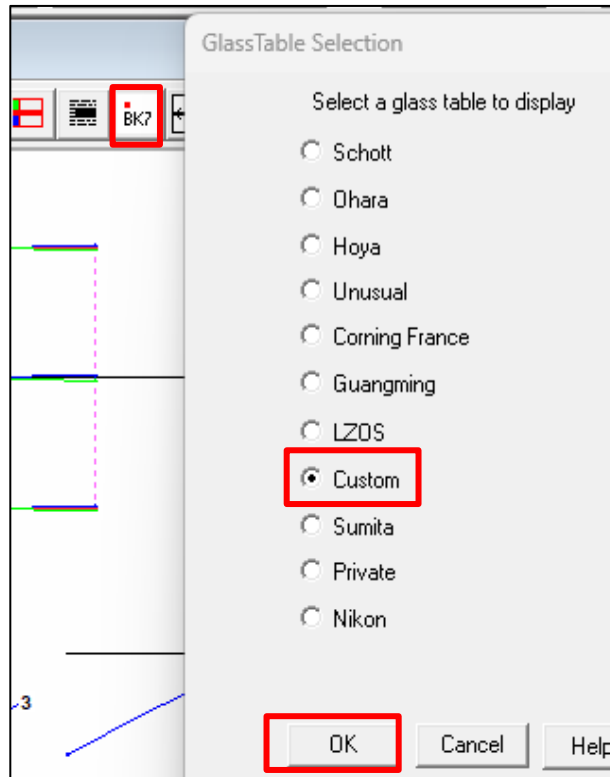
The members of the Custom Catalog can be seen in the Glass Map. If you don't see any glasses when the Map is first launched, make sure you click 'All glasses' to show them. Click 'Full Name' to show glass names.

Adding Custom Glasses to the Custom Catalog

You can also click the 'Show List' button at the lower right corner of the Glass Table Display window to see all the custom glasses defined:

```
      Use "S" buttons to sort.

       S          S       S     S      S

      Name        Nd      Vd  Bubble  Humidity
CUSTOM1        1.836894  42.96   0.0      0
CUSTOM2        1.890550  47.05   0.0      0
CUSTOM3        1.863915  45.00   0.0      0
CUSTOM3        1.863915  45.00   0.0      0
CUSTOM4        1.863915  45.00   0.0      0
CUSTOM5        1.792813  39.73   0.0      0
CUSTOM7        1.781623  38.92   0.0      0
CUSTOM9        1.781623  38.92   0.0      0
CUSTOM10       1.764704  37.72   0.0      0
CUSTOM11       1.781720  39.04   0.0      0
CUSTOM12       1.764508  37.50   0.0      0
CUSTOM13       1.781720  39.04   0.0      0
CUSTOM14       1.764508  37.50   0.0      0
CUSTOM13       1.781720  39.04   0.0      0
```

Glass	Surface
	0

- \ Apply /
- Apply + Adjust
- Properties
- Select Table
- Locate
- Graph
- Boundaries
- Transm. Range
- **Show List**
- To Graphics
- Close

You can enter the command **PCGLASS** at the command window input line to view a list of the Schott coefficients of the glasses in the custom glass table.

```
SYNOPSYS AI>PCGLASS


*******  CONTENTS OF CUSTOM GLASS TABLE *******

 CUSTOM13
0.3086286E+010.1542532E-010.2910141E-010.1264380E-020.7089000E-040.5425102E-05
 CUSTOM14
0.3026286E+010.1842532E-010.2910141E-010.1264380E-020.7089000E-040.5425102E-05
 SYNOPSYS AI>
```

To delete a glass, you can first enter the command DGLASS, then enter the name of the glass to delete at the prompt:
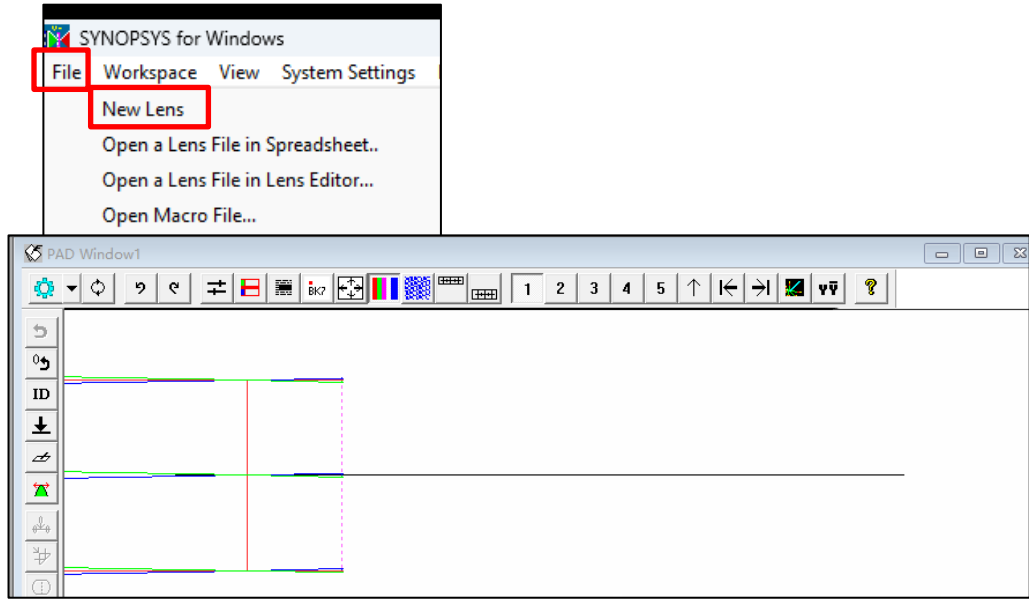
```
SYNOPSYS AI>DGLASS

GLASS TYPE>CUSTOM1

CUSTOM1
CUSTOM GLASS NUMBER   1 CUSTOM1          DELETED FROM GLASS TABLE.
SYNOPSYS AI>
```
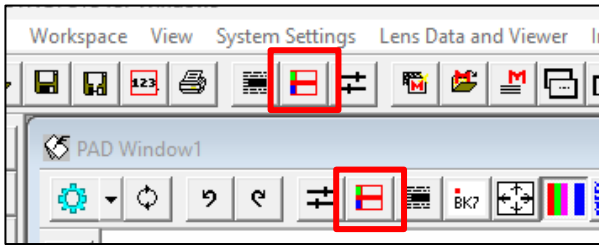
Adding Custom Glasses to the Custom Catalog

Here is a simple example showing how to use custom glasses in your lens with the SpreadSheet:
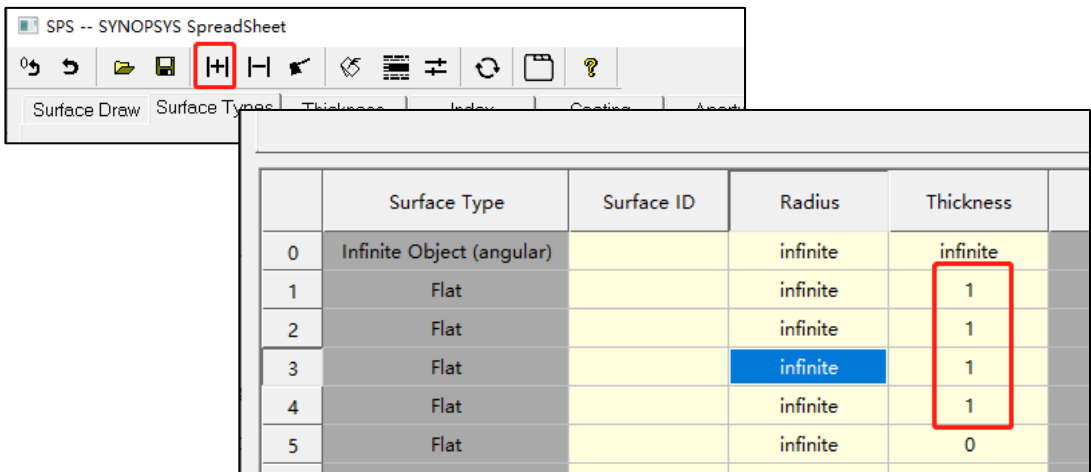
1. Click File>'New lens' to launch a new lens with 2 flat dummy surfaces.

2. Click the SpreadSheet button in the Top Toolbar of the SketchPad Toolbar to Open the SpreadSheet.

3. Click the 'Insert' button at the SpreadSheet Toolbar to add a few more surfaces as shown in the figure below. Change the thickness for surfaces 1-4 to 1 for easy viewing in the SketchPAD.

Adding Custom Glasses to the Custom Catalog

4. Click the 'Material' cell at surface 1, Then select the Glass Table in the Index Editor at the top. Select 'Custom' and then click Show Catlog. It will show all the available glasses in the catalog. Select the material we need (for example, CUSTOM13) and click OK. Finally click Set at the Index Editor to confirm the choice.

5. This way the custom glass is assigned to lens surface 1. We will do the same to assign another custom material (CUSTOM14) to surface 3.

	Surface Type	Surface ID	Radius	Thickness	Material	Index
0	Infinite Object (angular)		infinite	infinite	Air	1
1	Flat		infinite	1	CUSTOM13	1.78172
2	Flat		infinite	1	Air	1
3	Flat		infinite	1	CUSTOM14	1.76451
4	Flat		infinite	1	Air	1
5	Flat		infinite	0	Air	1

6. The system is updated in the SketchPad.
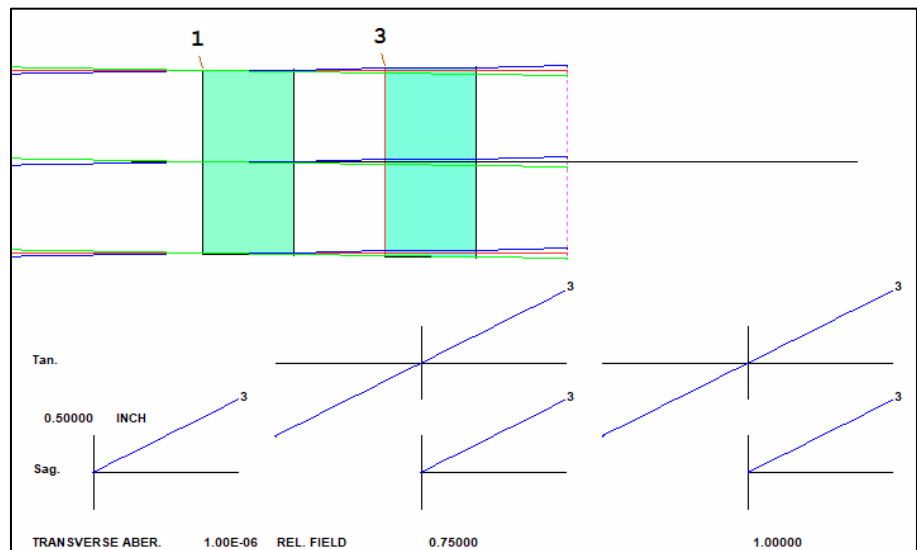
Finding the old Schott Coefficients with GFIT

In the last example, we illustrated how to define a custom material when the Schott coefficients of the glass are given. However, sometimes, we only have the measured or published index table of the material, but not the Schott coefficients. In that case, we can use the command GFIT to find the Schott coefficients that give the best fit index-wavelength curve.
For the details on the GFIT syntax, see User Manual 3.3.4 Index Options.
Once the six Schott coefficients is known, we can use the method shown in the last example to define the new material and add it to the Custom Catalog.
An example is given here to demonstrate how to use GFIT.

Shown here is the Schott Formula for calculating the indices at different wavelength:

$$N**2 = A0 + A1\ \lambda**2 + A2\ \lambda**-2 + A3\ \lambda**-4 + A4\ \lambda**-6 + A5\ \lambda**-8$$

N: glass index
λ: wavelength in μm
A0 – A5: the six Schott coefficients

Assume that you want to use an IR material that's not included in the SYNOPSYS™ Glass Catalogs. The material Indices at different wavelengths are shown in the table to the right. We will demonstrate how to use the GFIT command to find the best fit Schott Coefficients from the index Table.

Because GFIT is a command to use with lens surfaces, we will first launch a simple dummy system by selecting 'New lens' in the File menu:

WL (um)	Index
3	2.8013
4	2.7943
5	2.7906
6	2.7878
7	2.7853
8	2.783
9	2.7803
10	2.7775
11	2.7747
12	2.7719

Finding the old Schott Coefficients with GFIT

Enter the commands shown here to the Macro Editor and then hit 'Run'. The best fit Schott Coefficients is then printed in the Command Window with the fitting errors for each index.

Note: no blank line is allowed in this block

Index data
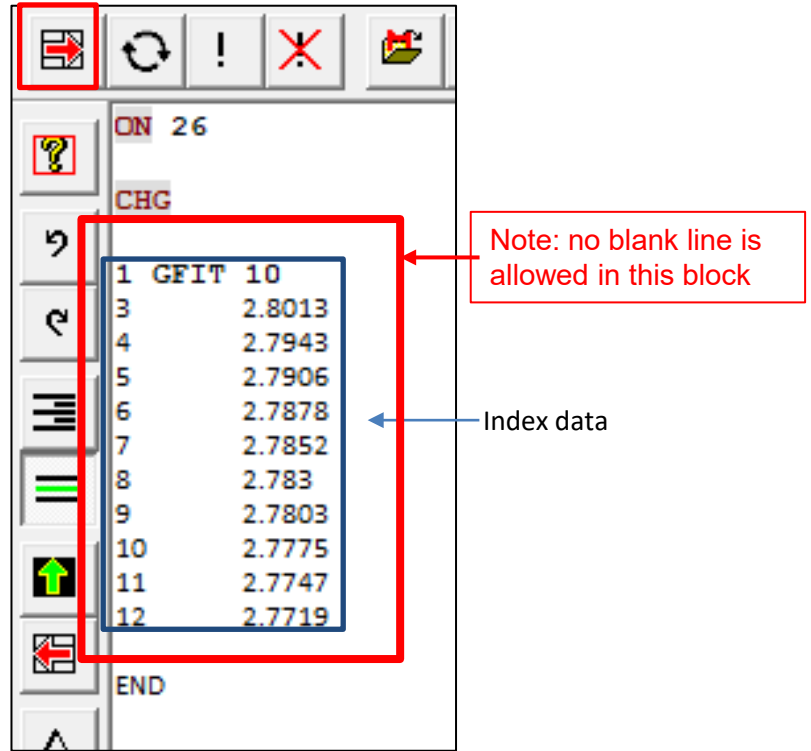
- The first line, **ON 26,** is optional to turn on the control switch 26. When it is ON, the program will also print a table giving the input data, the reconstructed index values given by the polynomial, and the error. This is useful to check the accuracy of the curve fit. If the wavelength range is too wide for the material in question, the fit may not be sufficiently precise, and it may be necessary to break up the spectral range into smaller regions over which the fit will be better.
- The keywords CHG and END signify the beginning and the ending of the change file -- a construct in SYNOPSYS™ to enter one or several commands to change the surface data of the existing system.
- In this example, we use the command, **1 GFIT 10,** to change the index of surface 1. We will redefine the index at surface 1 using the Schott formula. The Schott coefficients are obtained by fitting to the 10 index data entered after the GFIT command.

The best fit Schott Coefficients is then printed in the Command Window, together with the fitting errors for each index when switch 26 is turned on. The fit error is quite small, so this is a good fit.

```
INDEX COEFFICIENTS
0.7777124E+1-0.6907162E-3 0.7402170E+0-0.1758259E+1 0.1125514E+2 0.2411450E+1
```

NO.	WAVELENGTH	DATA	FIT	ERROR
1	3.0000000	2.8013000	2.8012950	-0.0000050
2	4.0000000	2.7943000	2.7943250	0.0000250
3	5.0000000	2.7906000	2.7905874	-0.0000126
4	6.0000000	2.7878000	2.7877779	-0.0000221
5	7.0000000	2.7852000	2.7852736	0.0000736
6	8.0000000	2.7830000	2.7828219	-0.0001781
7	9.0000000	2.7803000	2.7802999	-0.0000001
8	10.0000000	2.7775000	2.7776410	0.0001410
9	11.0000000	2.7747000	2.7748065	0.0001065
10	12.0000000	2.7719000	2.7717720	-0.0001280

Finding the old Schott Coefficients with GFIT

The Index definition at surface 1 is updated to GDF (or shown as Interpolation Coefficients in the SpreadSheet Index Editor) with the six best fit Schott Coefficients calculated by the GFIT command:

```
1 N1 2.77177199 N2 2.78527357 N3 2.80129495
1 GDF
        7.77712372  -6.90716156E-04   7.40217042E-01
       -1.75825912      11.25513883       2.41144985
1 GID  'GLASS             '
2 CV       0.0000000000000    TH       0.00000000 AIR
```

Surface Draw	Surface Types	Thickness	Index	Coating	Aperture	Tilt/Decenter

Index Options for Surface 1

This index is controlled by interpolation coefficients.

Enter desired values

- ☐ PLASTIC (Glass Model Boundaries)
- ○ Air
- ○ Vacuum
- ○ Explicit Indices
- ○ Glass Table
- ○ Glass Model
- ○ Pickup Indices
- ● Interpolation Coefficients
- ○ GRIN (Gradient-Index)
- ○ Birefringent

Value	Label
7.77712	Coefficient 1
-0.000690716	Coefficient 2
0.740217	Coefficient 3
-1.75826	Coefficient 4
11.2551	Coefficient 5
2.41145	Coefficient 6

Set   ?

	Surface Type	Surface ID	Radius	Thickness	Material	Index
0	Infinite Object (angular)		infinite	infinite	Air	1
1	Flat		infinite	1	Interpolation	2.78527

You can then add this glass into the Custom Catalog with the AGLASS command as described in the previous example:

1. Assign a glass name by changing the default glass name 'GLASS' in the GID command to your desired glass name.
2. Enter the command, AGLASS 1, to add the new glass at surface 1 to the Custom Catalog.

You can also add this glass to a different catalog by using the method of 'editing the glass catalog library file' as described in the next section.

Adding Custom Glasses by Editing the Glass Libraries

We have introduced how to add custom glass to the Custom Catalog in SYNOPSYS™. But the custom glass table does not contain certain information such as a table of transmission. To create the data required to store all of these glass properties, you must prepare a text file formatted as described in this section.

To illustrate the concept, we first take as an example the listing of the material CAFL in the Unusual catalog, which you can access via the Unusual.lib in your C:\SYNOPSYS folder and open it in Notepad for editing.
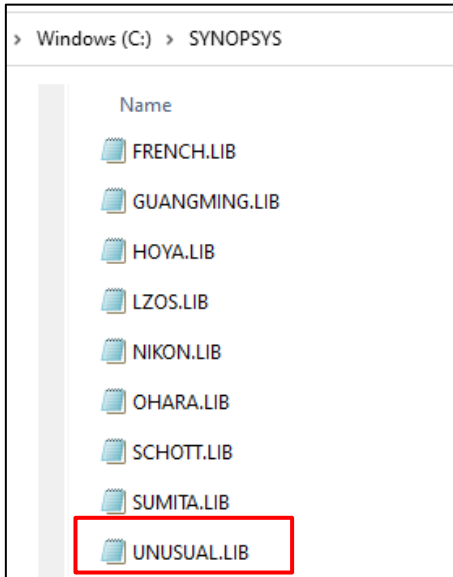
Once you open the Unusual.lib in Notepad, do a search for CAFL and you will find its data as shown below.
- The first six lines include information such as the glass name, the index interpolation formula specification and its coefficient, dN/dT, CTE… The format of the data entry for each line is explained in the next page.
- You can enter the transmission data in line 7 and beyond. The maximum allowable number of transmission data points is 50.

Line 1	CAFL S20.0 B 3.18Z
Line 2	.1495 9.429
Line 3	0.124 10.000 10 0.253
Line 4	.5675888E00 .4710914E00 3.8484723E00 .00252643E00 .01007833E00 .1200556E04
Line 5	-7.626E-6 -7.626E-6 -7.626E-6 .19 4.5 10. 18.85E-6
Line 6	13

```
.124 .15
.2 .89
.3 .95
.4 .96
.5 .97
.6 .98
4. .99
5. 1.
6. .995
7. .99
8. .97
9. .49
10. .19
```

This is the Transmission Table for the material. The 1st column is the wavelength (WL) and the 2nd is the fractional transmission (T). Maximum allowable data points is 50. In this example, there are 13 measurements.

More detailed descriptions of the format of each line can be found in the next few pages.

Adding Custom Glasses by Editing the Glass Libraries

Line 1:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1																																							

Columns 1-16: Material name; this must begin with an alphabetic character.

Column 17: Character describing the interpolation format for this material, selected from

S	6 Sellmeier coefficients
BLANK	Old Schott power-series formula
N	Nikon 9 terms power-series
W	Schott IRG, which uses 8 terms Schott IRG;
V	15 terms polynomial
X	12-term custom polynomial, broadband IR material for the Unusual Catalog
G	12 terms measured at 27 degrees C; for GE in the Unusual Catalog
Y	30-terms, for Germanium only (GE-NIR) (Germanium special) the Unusual Catalog

Column 18-22: price of the glass. The price data (if exists) in the glass catalog was collected a long time ago and haven't been updated. Thus, it doesn't represent the current pricing. Can be left blank.

Column 23: This digit is to signify the thermal properties of the material.

Blank	None
A	6 dN/dT coefficients (per Schott and Ohara catalogs), and CTE
B	3 dN/dT coefficients, 3 wavelengths at which they apply, and CTE
C	CTE only

Column 25: A number denoting the placement of the material name on the glass map relative to the location of the material symbol. Assigning a suitable number prevents the names from overlapping on the screen with the names of other materials. The positions are as given in the picture to the right. This control is obsolete.

Column 26: The number 1 if the material is a type of plastic; blank if not.

Columns 28-30: The temperature at which the index coefficients are measured, in Celsius, default 20 if no value is entered. See Note 1 below for a discussion of entering the temperatures correctly.

Column 31: humidity sensitivity; same as Climate Resistance Rating discussed in the Schott Technical Document, TIE-30 Chemical Properties of Optical Glass. A zero value would signify that the material rating is not available.

Columns 35-38: The specific gravity of the material

Column 39: The letter "Z" if the material includes a table of transmission, otherwise this must be blank.

Note 1. Entering temperature

Due to the special Fortran format (F3.1) used for the input data, the entered temperature must be a number between 1 and 99 and comply with the F3.1 format rules. If the temperature is an integer, always enter it with an explicit decimal point.

Here are some illustrative examples :

Example 1: For a temperature 20 Celsius, the following entry, with an explicit decimal point, will be parsed correctly as the desired 20 degrees.

Example 2: These two entries, without an explicit decimal point, will be parsed as 2 degrees.

Example 3: If the temperature is not an integer, for example, 22.5 Celsius, you will enter it as 225 in the slots from 28-30 as shown here. The Fortran compiler will automatically add a decimal point before the last digit entered. That is, the entered value '225' is parsed as '22.5', the desired temperature.

Example 4: Similarly, if you enter '200' in slots 28-30, it will be parsed as 20.0 Celsius.

Adding Custom Glasses by Editing the Glass Libraries

For example, this is how the glass data would look like for the glass KIRO-CGI:

Line 1:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	K	I	R	O	-	C	G	1															B					2	0	.					4	.	6	3	Z

Columns 1-16: The material name KIRO-CG1 is entered and occupied slots 1-8.

Column 17: The slot is left blank; meaning that the old Schott formula is used for index interpolation and the six coefficients will be entered in Line 4.

Schott formula:

index = A0 + A1*WA**2 + A2/WA**2 + A3 /WA**4 + A4 /WA**6 + A5 /WA**8

Column 23: The letter 'B' is entered; meaning that the following data will be expected in Line 5:

3 dN/dT coefficients, 3 wavelengths at which they apply, and CTE

Column 26: The slot is left blank; meaning that the material is not plastic.

Column 28-30: The number 20. is entered; meaning that the index coefficients are measured at 20 Celsius, which is the default.

Column 35-38: The specific gravity of the material is entered as 4.63.

Column 39: The letter "Z" is entered; meaning that the material includes a table of transmission, which will be entered in lines 7 and beyond.

Line 2:

Two numbers giving the wavelength range for the interpolation coefficients, format 2F6.3.

For example, this is how the glass data format would look like in line 2 for the glass KIRO-CGI with a wavelength range from 3µm to 12µm:

2	3.0 12.0

Line 3:

Three numbers giving the transmission range plus the thickness at which the transmission is measured, format 2F6.3, 1x, F6.2.

For example, this is how the glass data format would look like in line 3 for the glass KIRO-CGI, specifying the transmission data is measured between the wavelengths of 3µm and 15µm, with a sample thickness of 2 system unit:

3	3.0 15.0 2.0

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Line 4:

Six interpolation coefficients, format 6E13.7. This is followed by additional lines in the same format for materials required more than 6 coefficients per column 17. If you are not familiar with the Fortran format 6E13.7, see Appendix- Fortran data input format.

For example, this is how the glass data format would look like in line 4 for the glass KIRO-CGI:

4	0.6867926E+1-0.9021760E-3 0.3644910E+0 0.1533808E+1-0.5834375E+1-0.8124381E+0

$$index = A0 + A1 \cdot WA^{**}2 + A2/WA^{**}2 + A3 /WA^{**}4 + A4 /WA^{**}6 + A5 /WA^{**}8$$

A0	0.6867926E+1
A1	-0.9021760E-3
A2	0.3644910E+0
A3	0.1533808E+1
A4	-0.5834375E+1
A5	-0.8124381E+0

Line 5:

- Six dN/dT polynomial coefficients + CTE (for selection A in column 17 of line 1); entries are space delimited
- Three dN/dT values and three wavelengths + CTE (for B); entries are space delimited
- A single number for CTE (for C)

For example, this is how the glass data format would look like in line 5 for the glass KIRO-CGI.

5	.661E-4 .661E-4 .661E-4 3.0 8.0 15.0 0.142E-4

Because we specify selection B in slot 23 of Line 1, we need to supply the following data in this line:
Three dN/dT values: .661E-4 .661E-4 .661E-4
Three wavelengths: 3.0 8.0 15.0
CTE (Coefficient of Thermal Expansion): 0.142E-4

Adding Custom Glasses by Editing the Glass Libraries

Line 6 and beyond:

A single number, N, giving the number of transmission values that will follow (if Z). This is followed by N lines, each giving a wavelength and a transmission, space delimited, where N is the number of data pairs. Since the program will interpolate these data with a piecewise cubic formula, you must provide at least four values, each giving the *internal* transmission of the material at the thickness in line 3. If your data give the *external* transmission (which includes Fresnel reflection loss at the two surfaces) you must divide those data by that loss at each wavelength.

The data range of this table must match the range given in line 3, and all transmission values must be nonzero.

For example, for the glass KIRO-CGI, we entered in line 6 the number '30' to indicate there are 30 data points for the Transmission Table that follows:

6	30	
7	1.340	0.978
8	1.500	0.978
9	2.000	0.982
10	2.500	0.982
11	3.000	0.971
12	3.500	0.984
13	4.000	0.984
14	4.500	0.984
15	5.000	0.984
16	5.500	0.984
17	6.000	0.984
18	6.500	0.984
19	7.000	0.984
20	7.500	0.984
21	8.000	0.984
22	8.500	0.981
23	9.000	0.969
24	9.500	0.980
25	10.000	0.976
26	10.500	0.973
27	11.000	0.978
28	11.500	0.979
29	12.000	0.975
30	12.500	0.959
31	13.000	0.928
32	13.500	0.879
33	14.000	0.814
34	14.500	0.669
35	15.000	0.467
36	15.500	0.445

Adding Custom Glasses by Editing the Glass Libraries

To confirm that this glass is added successful, open the glass table by clicking at the Glass Table button at the SketchPad Toolbar and select the Unusual catalog to display the glasses in the Glass Table Display window.
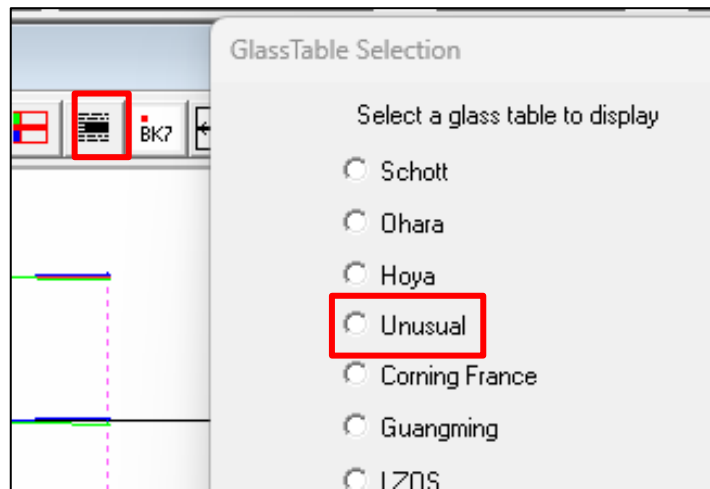

Enter the name KIRO-CG1 in the Glass entry field and then click the 'Properties' button to open the Glass Data window for this glass:
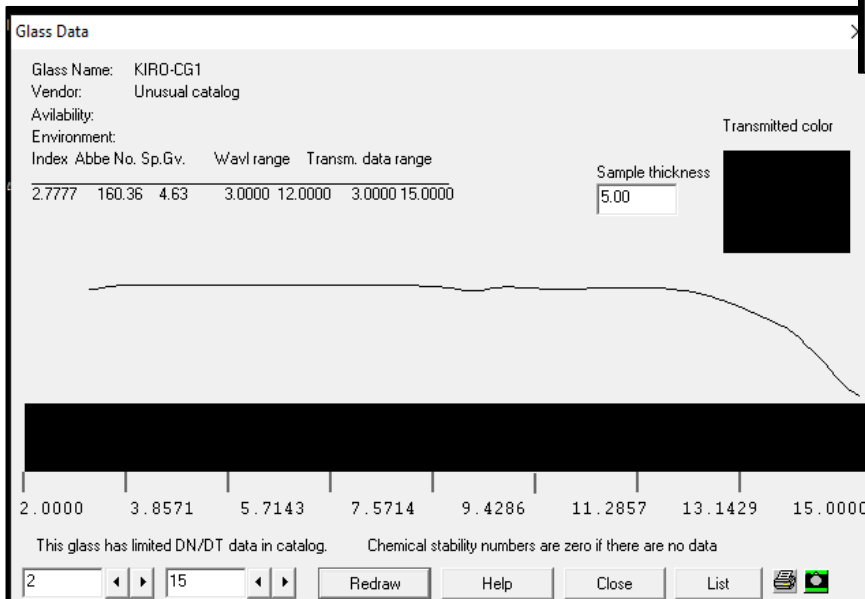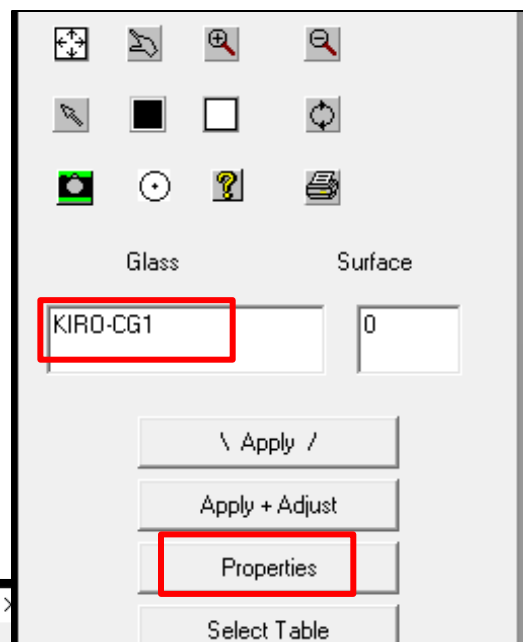
If all looks good, do the same for the other materials you want to add.

Adding Custom Glasses by Editing the Glass Libraries

When creating a glass data file of this type, it is easy to make mistake when editing. If this happens, you will probably crash the program and get a run time error similar to the one that shown below. You can fix that problem by checking your formatting carefully, especially the Fortran data format for the interpolation coefficients in line 3.
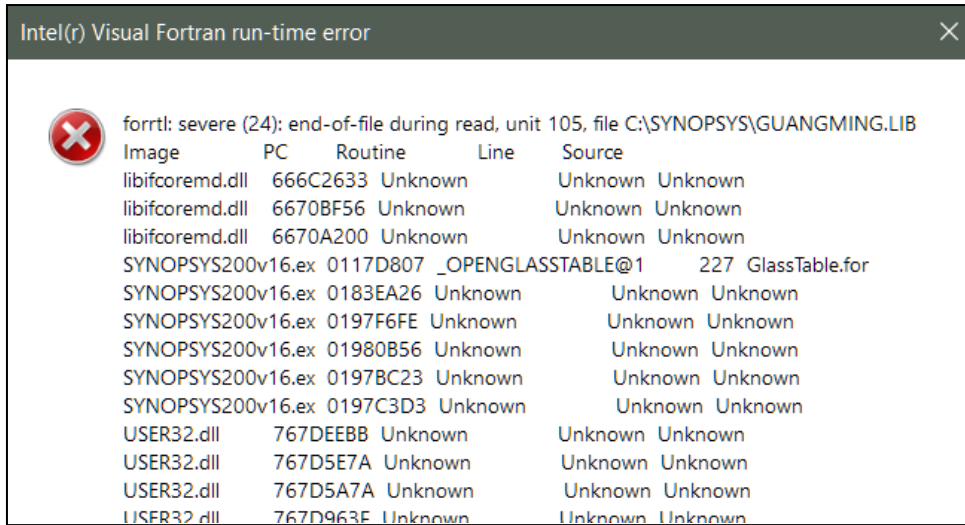
Glass Formulas in SYNOPSYS™

In total, there are eight interpolation formulas in SYNOPSYS™ for the index calculation. The Table below summarizes how their default usage in the different glass catalog.   The first column shows the name of the glass catalog. The second column is the default temperature at which the index is measured. The third column displays the name of the glass formula. The fourth column is the formula code in 17th digit of the line 1 of the glass table (see discussion in the section, Adding Custom Glasses by Editing the Glass Libraries).

For example, the first two rows of the Table tells us that the Sellmeier is the default interpolation formula for the Schott and Ohara glass catalogs. The indices of the Schott Catalog are calculated for a default temperature of 22°C, while the Ohara 25°C.
Also, the last few rows of the Table shows the different formulas used for the IR materials in the Unusual Catalog, while the plastic indices in the same catalog are calculated using the old Schott Formula.

Note that even though each catalog (except for the Unusual Catalog) has its default interpolation formula. However, as described in the section, Adding Custom Glasses by Editing the Glass Libraries, you can mix all the different formulas into one catalog by using the specific formula code in the 17th digit of line 1 when you edit the glass library.

The mathematical expressions of the Formulas can be found in the next page.

Glass Catalog	Temp	Glass Formula	Code
Schott	20	Sellmeier	S
Ohara	25		
Hoya	20	Old Schott, six term power series	Blank
Unusual, Plastic	20		
French Corning	20		
Guangming	20		
LZOS (Russian)	20		
Sumita	20		
Custom (GFIT, GLASS and GDF)	20		
Nikon	22.5	Power Series- Nine terms	N
Unusual, Schott IRG	20	Power Series- 8 terms, Schott IRG	W
Unusual, Schott IRG		Power Series- 15 terms	V
Unusual, broadband material	20	Power Series- 12 terms	X
Unusual, GE	27	Power Series- 12 terms	G
Unusual, GE-NIR	20	Power Series- 30 terms	Y
Private			

Glass Formulas in SYNOPSYS™

The formulas are as follows:

1. Old Schott Formula (blank):

$$N^{**}2 = A0 + A1\, \lambda^{**}2 + A2\, \lambda^{**}{-2} + A3\, \lambda^{**}{-4} + A4\, \lambda^{**}{-6} + A5\, \lambda^{**}{-8}$$

2. Herzberger (H) :

$$N = A0 + A1 /(\lambda^{**}2 - 0.028D0) + A2/(\lambda^{**}2 - 0.028D0)^2 + A3\, \lambda^{**}2 + A4\, \lambda^{**}4 + A5\, \lambda^{**}6$$

3. Nikon 9 terms polynomial:

$$N^{**}2 = A0 + A1^{*}\lambda^{**}2 + A2^{*}\lambda^{**}4 + A3^{*}\lambda^{**}{-2} + A4^{*}\lambda^{**}{-4} + A5^{*}\lambda^{**}{-6} + A6^{*}\lambda^{**}{-8} + A7^{*}\lambda^{**}{-9} + A8^{*}\lambda^{**}{-10}$$

4. Sellmeier (S)

$$N^{**}2 = 1 + (A1\lambda^{**}2) / (\lambda^{**}2 - A4) + (A2\, \lambda^{**}2) / (\lambda^{**}2 - A5) + (A3\, \lambda^{**}2) / (\lambda^{**}2 - A6)$$

5. Fifteen-term-polynomial (V, Schott IRG):

T = lens temperature in Kevin
C1 = A0 - A1*EXP(A2*T)
C2 = A3 + A4*EXP(A5*T)
C3 = A6 + A7*EXP(A8*T)
C4 = A9 + A10*EXP(A11*T)
C5 = A12 + A13*EXP(A14*T)

$$N^{**}2 = 1 + C1 + (C2^{*}\lambda^{**}2)/(\lambda^{**}2 - C4^{**}2) + (C3^{*}\lambda^{**}2)/(\lambda^{**}2 - C5^{**}2)$$

6. Eight-term-polynomial (W, Schott IRG):

T = lens temperature in Celsius
C1 = A0 – A1*T
C2 = A2 + A3*T
C3 = A4 + A5*T
C4 = A6
C5 = A7

$$N^{**}2 = C1 + (C2^{*}\lambda^{**}2)/(\lambda^{**}2 - C4) + (C3^{*}\lambda^{**}2)/(\lambda^{**}2 - C5)$$

7. 12-term-polynomial, wide-band IR materials (G, X):

$$N^{**}2 = A0 + A1\, \lambda^{**}2 + A2\, \lambda^{**}{-2} + A3\, \lambda^{**}{-4} + A4\, \lambda^{**}{-6} + A5\, \lambda^{**}{-8}$$
$$+ A6\lambda^{**}4 + A7\lambda^{**}6 + A8\lambda^{**}8 + A9\lambda^{**}10 + A10\lambda^{**}12 + A11\lambda^{**}3.$$

Glass Formulas in SYNOPSYS™

8. 30 term polynomial (Y):

T = lens temperature in Kevin

$S1 = A0 + A6*T + A12*T**2 + A18*T**3 + A24\ T**4$
$S2 = A1 + A7*T + A13*T**2 + A19*T**3 + A25*T**4$
$S3 = A2 + A8*T + A14*T**2 + A20*T**3 + A26*T**4$
$RL1 = A3 + A9*T + A15*T**2 + A21*T**3 + A27*T**4$
$RL2 = A4 + A10*T + A16*T**2 + A22*T**3 + A28*T**4$
$RL3 = A5 + A11*T + A17*T**2 + A23*T**3 + A29*T**4$

$$N**2 = 1+ S1*\lambda**2\ /(\lambda**2 - RL1**2) + S2*\lambda**2\ /(\lambda**2 - RL2**2) + S3*\lambda**2\ /(\lambda**2 - RL3**2)$$

Appendix – Fortran data input format

A Fortran format specification is a list of *format elements* describing the variable format (real number in either decimal or exponential form), the width (number of characters) of each variable, and (optionally) the number of decimal places.

Three variable formats are supported: E, F, and G. The most common variable format is the F format for real numbers in decimal form. The syntax for this format is:

Fw.d
where w is the width of the variable and d is the number of decimal places to the right of the (implied) decimal point. For example, F4.0 would read a four digit number with no implied decimal places. (When there are no implied decimal places, as in the case of F4.0, the format description can be simplified to F4 alone.) If, however, the data are written with an implied decimal, the user can specify a decimal point to the left of the last d digits. Thus F4.2 would read `6743' as `67.43' while F4.1 would read `6743' as `674.3'. Any decimal actually coded in the data overrides the format specification.

The E format allows the user to enter data stored in scientific notation. The syntax of the E format is the same as the F format:

Ew.d
Here W is the total width of the variable, including exponent, while D indicates the number of implied decimal places in the mantissa. The data field should contain the mantissa and the letter E followed by an integer indicating the power of ten to which the mantissa is to be raised. For example, E6.0 would read `1234E2' as `123400' (1234.0 x 10^2), while E6.1 would read `1234E2' as `12340' (123.4 x 10^2). As before, any decimal actually coded overrides the format specification, so that both E6.0 and E6.1 would read `123.4E2' as `12340'.

For horizontal spacing, the nX code is often used. This means n horizontal spaces. If n is omitted, n=1 is assumed.

Ref:
https://eml.berkeley.edu/sst/fmttop.html#:~:text=A%20Fortran%20format%20specification%20is,the%20number%20of%20decimal%20places.