

# 1. CREATING A LAMINATE IN OPTICS FOR NFRC

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## 1.1. Overview

Optics5 can be used for the limited purpose of constructing laminates for NFRC certified simulations using the following criteria:

- Laminates *cannot* have embedded coatings, where embedded coatings are defined as a coating on a substrate that touches an interlayer
- Only NFRC glass layers with the NFRC approval indicator “#” can be used in these constructed laminates
- The glass layers can be tinted or coated as long as the coatings do not face the interlayer
- The interlayers in Optics5 do not have a “#” on them and therefore, only interlayers from the LBNL/NFRC “Approved Interlayer” list can be used (this list may be updated in the future), which means the data for those interlayers was submitted to the IGDB using the criteria specified in Section 1.2 of this document.

For NFRC verification of the laminate construction submitted by simulators:

- Laminates constructed by simulators in Optics5 will not have a # next to them. (Future versions of the WINDOW software could determine if the laminate was constructed from NFRC approved # layers, and report/display this information).
- The simulator shall provide base properties for the complete laminate assembly, including solar transmittance (solar, T), visible transmittance (photopic, T), solar reflectance front (solar, Rf), solar reflectance back (solar, Rb), visible reflectance front (photopic, Rf), visible reflectance back (photopic, Rb), Emissivity front (EmitF), Emissivity back (EmitB). These values are reported on the Optics screen when the laminate is calculated, and also in the WINDOW5 Detailed Report from the Glazing System Library. This requirement is satisfied by submitting a WINDOW “mdb” database file which includes this laminate.
- An IA (or anyone else wanting to check the results) can recreate the laminate from the specified layers and verify the calculated values
- NFRC simulators shall assign numbers to the laminates starting with 30,000. The numbers do not have to be unique between simulation laboratories or even between projects in the same laboratory. These laminates are not stored in a central NFRC database.

- The naming convention for the laminate should describe the layers used to construct the laminate, using the IGDB Layer ID for glass layers and the interlayer name (from the Optics program) for the interlayer. If a glass layer is flipped, add the "F" designator to the end of the layer number. The total number of characters (not including extension, but including "/" separators in the name) cannot exceed 45.

<glass layer ID><F if layer is flipped>/<interlayer name from Optics5>/<glass layer ID><F if layer is flipped>

For example:

102/030keepsafe/2026F

## 1.2. Laminate Interlayer Data

Optics can accurately calculate the optical properties of laminates as long as the component layers with the following characteristics (and only interlayers submitted with these characteristics will be included in the “Approved Interlayer List” for NFRC certification):

- Interlayers are measured with transparent glass with a solar transmittance  $T_{sol} > 0.820$  and  $T_{vis} > 0.890$ . This ensures that a “constructed” laminate in Optics5 will always have a similar or lower transmittance than the reference laminate which determines the interlayer properties
- No glass layers have coatings next to interlayers (embedded coatings).
- Substrate layers (the base glass to which the interlayers are applied) are measured separately from the interlayers. This is the responsibility of the manufacturer submitting data to the IGDB, as discussed below.

As discussed in the LBNL document which contains guidelines for submitting data to the IGDB (*International Glazing Database: Data File Format, Version 1.4, April 2003*), “an interlayer is an adhesive layer used to join components in a laminate. The optical properties of laminate layers cannot be measured directly. Instead they are calculated from the spectral properties of a ‘reference laminate’ which consists of the interlayer laminated between two glass layers of known optical properties. To submit data for an interlayer, both the spectral optical properties of the reference laminate, and the glass layers used in the reference laminate should be submitted.”

This means that in order for an interlayer to be added to the Optics5 “Interlayer” type, and therefore used in making laminate constructions in Optics5, the spectral data for a “reference” laminate which contains that interlayer is submitted to the IGDB as follows:

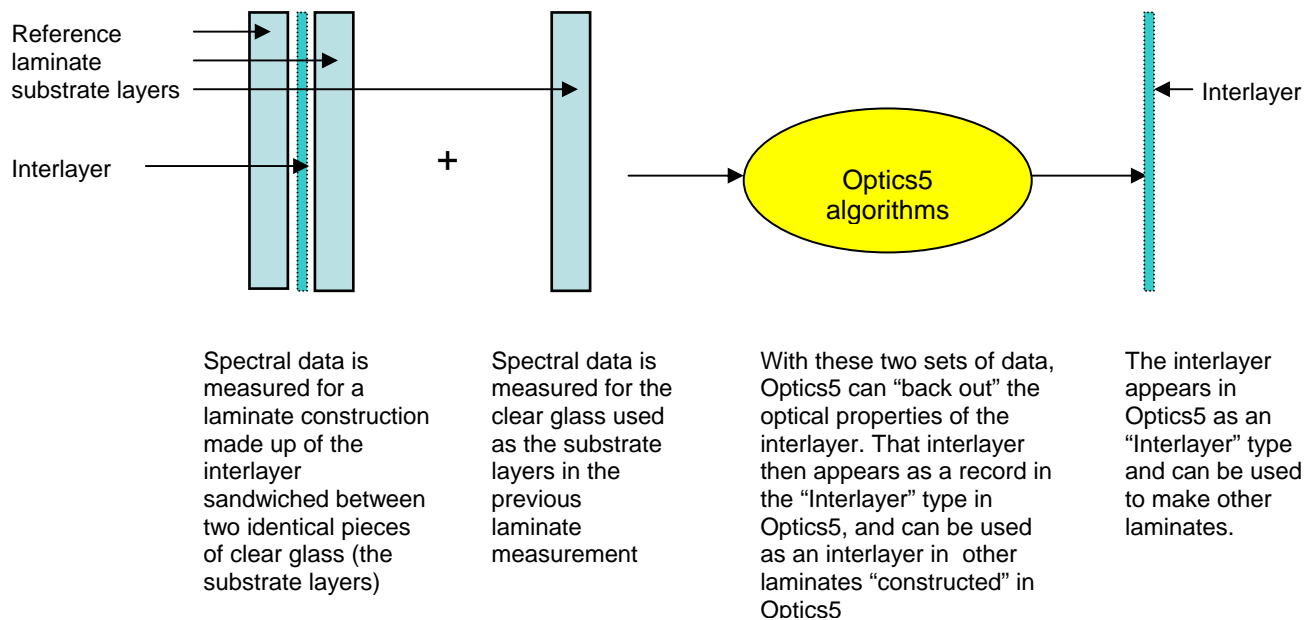


Figure 1-1. How Optics “deconstructs” measured data to obtain interlayer information.

Optics5 can do an accurate calculation for the interlayer properties from the reference laminate as long as the substrate glass layers have a high solar and visible transmittance, hence the requirement of  $T_{sol} > 0.820$  and  $T_{vis} > 0.890$ . This ensures that laminates that are later created in Optics5 with this interlayer will almost always have a lower solar and visible transmittance than the reference laminate.

## 1.3. Constructing a Laminate in Optics5

### 1.3.1. Building a New Laminate

When Optics5 starts, you can start building a laminate immediately by switching to the 'Laminate' tab and adding layers (see "1.3.3. Add Layers to a Laminate").



Figure 1-2. Click on the Laminate tab to start constructing a laminate.

If you have created a laminate already, but want to start over with an empty laminate:

- Make sure the 'Laminate' tab is selected
- Choose menu option **File|New Laminate**
- You will be prompted to save the current laminate if one already exists

**Note:** if you created new layers and did not save the layers or did not save the laminate (which would save any new layers), the new layers will be lost when you start a new laminate

### 1.3.2. Wavelength Sets

Use the NFRC default wavelength set, which is called "Optics5". This setting is shown on startup of the program, and also can be viewed (and changed if necessary) from the menu option **Tools|Select Wavelength Set**.

### 1.3.3. Add Layers to a Laminate

You can add monolithic, coated, and interlayer type layers to a laminate. There are a number of 'rules' for building laminates:

1. The first and last layer in a laminate must be a non-interlayer type (e.g. monolithic or coated)
2. You can place as many interlayers as you like adjacent to each other, but you must separate rigid non-interlayers with at least one interlayer.
3. For NFRC certified simulations, you can NOT place a coating next to an interlayer.

If you break rule 1 or 2, the operation will be cancelled.

Use the 'Add Interlayer' tab above the database to add interlayers. To add other layers, use the 'Add Glazing' tab. Only those database records with enough data to be loaded into a laminate will be shown in these views – if you want to see all records in the database, including those which cannot be used in laminates, use the 'View All' tab. If you try to load an invalid layer into a laminate from the 'View All' view of the database, an error message will be displayed.

### 1.3.4. Add Glazings to a Laminate

You can add monolithic, coated, and interlayer type layers to a laminate as long as you follow the laminate-building 'rules' (see "1.3.3. Add Layers to a Laminate" above).

To add layers from the current database to a laminate:

- Select the first available (unoccupied) layer in the laminate by clicking on its layer button – if you select an occupied layer, it will be replaced (see "1.3.8. Replace a Layer in a Laminate")

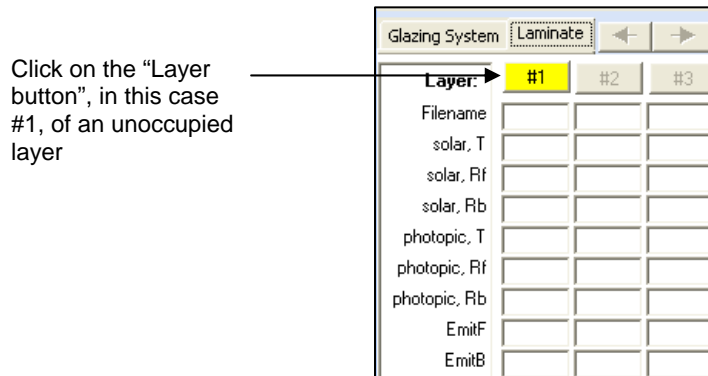


Figure 1-3. Click on the #1 layer button to add the first glass layer.

- Select the 'Add glazing' tab in the database

Type ^	FileName	ProductName	Nominal (m...)	Nominal (in)	Thickness	Manufacturer	NFRC_ID	Acceptance
Monolithic	CLEAR_3.DAT	Generic Clear Gl...	3 mm	double - 1/8 "	3.048	Generic	102	#
Monolithic	BRONZE_6.DAT	Generic Bronze ...	6 mm	1/4 "	5.7404	Generic	101	#
Monolithic	CLEAR_6.DAT	Generic Clear Gl...	6 mm	1/4 "	5.715	Generic	103	#
Monolithic	GRAY_3.DAT	Generic Grey Gl...	3 mm	double - 1/8 "	3.1242	Generic	104	#
Monolithic	BRONZE_3.DAT	Generic Bronze ...	3 mm	double - 1/8 "	3.1242	Generic	100	#

Figure 1-4. Select the glass layer from the Add Glazing tab.

- Double-click on the layer in the database  
or
- Using the mouse, drag the layer from the database over the layer button where you want to add the layer and release the mouse button  
or
- Select the layer in the database, then choose the menu option **Database|Add/Replace Layer**  
or
- Select the layer in the database, then right-click to display the pop-up menu then choose **Add/Replace Layer**

If you are replacing a layer, a dialog box will appear to confirm that you want to replace the existing layer.

**Note:** Select a layer in the database by clicking on it with the mouse, or by browsing to it by pressing the up and down arrow.

### 1.3.5. Add Interlayers

To add an interlayer to a laminate:

- Select the first available (unoccupied) layer by clicking on a layer button
- Select the 'Add Interlayer' tab

Select the Layer Button for the Interlayer

Click on the Add Interlayer tab.

Select the desired interlayer for the laminate construction, double click the mouse, and that interlayer will be added as the next layer in the laminate

Layer:	#1	#2	#3	Lamin.	Product name	Manufacturer	Nominal (mil)	Code	Appearance	Material	Reference
Filename	CLEAR			CalcLa	Butacite@ NC010	DuPont	15		Clear	PVB	15PVB6.DUP
solar, T	0.834			N/A	Butacite@ NC010	DuPont	30		Clear	PVB	30PVB6.DUP
solar, Rf	0.075			N/A	Butacite@ NC010	DuPont	60		Clear	PVB	60PVB6.DUP
solar, Rb	0.075			N/A	Butacite@ 0637...	DuPont	30	0637600	Blue	PVB	AZURBLUE.DUP
photopic, T	0.899			N/A	Butacite@ 2377...	DuPont	30	2377300	Blue-Green	PVB	BLUGREEN.DUP
photopic, Rf	0.083			N/A	Butacite@ 0360...	DuPont	30	0360900	Dark Brown	PVB	BRN_DARK.DUP
photopic, Rb	0.083			N/A	Butacite@ 0365...	DuPont	30	0365500	Light Brown	PVB	BRN_LITE.DUP
EmitF	0.840			N/A	Butacite@ 0362...	DuPont	30	0362800	Medium Brown	PVB	BRN_MEDM.DUP
EmitB	0.840			N/A							

The selected Interlayer has been added as then 2<sup>nd</sup> layer in the laminate construction

Layer:	#1	#2	#3	Lamin.	Product name	Manufacturer	Nominal (mil)	Code	Appearance	Material	Reference
Filename	CLEAR	BLUGR		CalcLa	Butacite@ NC010	DuPont	15		Clear	PVB	15PVB6.DUP
solar, T	0.834	0.859		N/A	Butacite@ NC010	DuPont	30		Clear	PVB	30PVB6.DUP
solar, Rf	0.075	0.000		N/A	Butacite@ NC010	DuPont	60		Clear	PVB	60PVB6.DUP
solar, Rb	0.075	0.000		N/A	Butacite@ 0637...	DuPont	30	0637600	Blue	PVB	AZURBLUE.DUP
photopic, T	0.899	0.834		N/A	Butacite@ 2377...	DuPont	30	2377300	Blue-Green	PVB	BLUGREEN.DUP
photopic, Rf	0.083	0.000		N/A	Butacite@ 0360...	DuPont	30	0360900	Dark Brown	PVB	BRN_DARK.DUP
photopic, Rb	0.083	0.000		N/A	Butacite@ 0365...	DuPont	30	0365500	Light Brown	PVB	BRN_LITE.DUP
EmitF	0.840	0.000		N/A	Butacite@ 0362...	DuPont	30	0362800	Medium Brown	PVB	BRN_MEDM.DUP
EmitB	0.840	0.000		N/A							

- Select the interlayer you want to add, and load it into the laminate (see "1.3.3. Add Layers to a Laminate")

Figure 1-5. Select the desired interlayer from the Add Interlayer tab for layer #2.

### 1.3.6. Flip Layers in a Laminate

To flip layers in a laminate:

- Select the layer to flip by clicking a layer button

- Choose the menu option **Edit|Flip Layer**  
*or*
- Right-click on the layer button to display the pop-up menu and select **Flip Layer**
- If flipping the layer would place a coating adjacent to an interlayer, and this will break the laminate-building rules (see “1.3.3. Add Layers to a Laminate”) and the laminate cannot be constructed for NFRC certification.

**Note:** Check the schematic view and the layer spectral averages if you are not sure which way a layer is oriented.

If any glass layers are flipped, make sure to add an “F” to the NFRC ID in the name of the final laminate.

### **1.3.7. View the Properties of a Laminate**

To view the calculated spectral data, spectral averages and other properties of a laminate:

- Select the laminate by clicking on the ‘Lamin.’ layer button



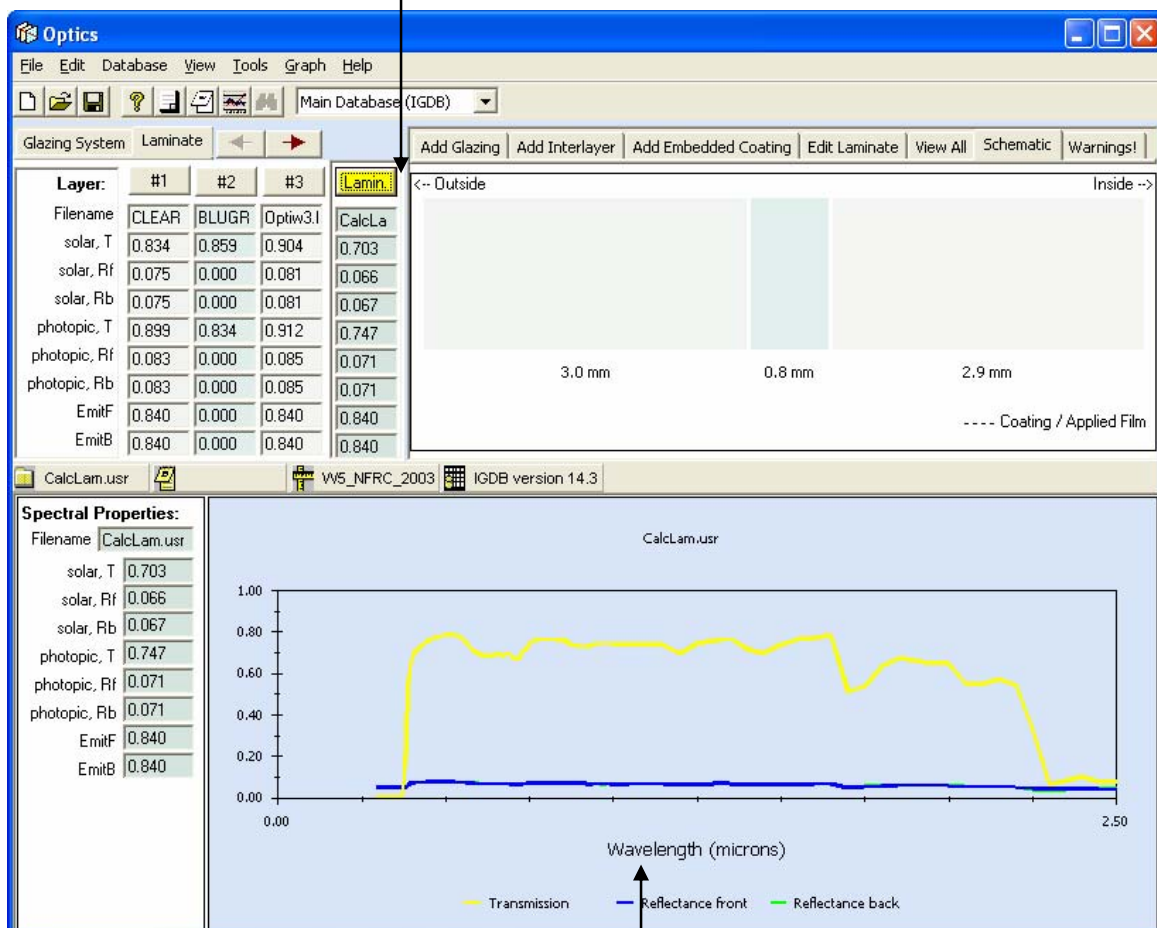
- The laminate is now the current layer, so its spectral data and spectral averages are displayed in the lower part of the screen

Figure 1-6. Click on the Lamin. button to view the optical properties of the entire laminate structure.

- To view a schematic diagram of the laminate, select the 'Schematic' tab in the upper right part of the screen
- To view the spectral data in a table, choose menu option **View|Spectral Data Grid**.
- To view calculation warnings for the laminate data, select the 'Warnings' tab in the upper right part of the screen
- To see more information about the laminate, choose menu option **View|View Details**

### 1.3.8. Replace a Layer in a Laminate

Click on the Lamin. Button and Optics5 will calculate and display the calculated properties of the laminate construction in the column below that button.



When the Lamin. Button above is selected, the graph below displays the properties of the entire laminate construction.

Replace a layer in a laminate in the same way as you would replace a layer in a glazing system – you must respect the laminate-building rules (see “1.3.3. Add Layers to a Laminate”).

You cannot insert layers into a laminate – you must delete and add layers from the interior side of the laminate to modify the structure.

### 1.3.9. Delete a Layer in a Laminate

You can only delete the last (interior side) layer in a laminate. To delete the last layer:

- Select the last layer by clicking the layer button
- Choose the menu option **Edit|Delete Layer**  
*or*
- Right-click on the layer button to display the pop-up menu and select **Delete Layer**

### 1.3.10. Save a Laminate

To save a laminate to the user database:

- Select the laminate by clicking on the ‘Lamin.’ layer button
- Click the ‘Save’ button on the toolbar:  
*or*
- Choose the menu option **File|Save filename**  
*or*
- Right-click the layer button to display the pop-up menu and select **Save filename**

**Note:** To save the laminate under a different name, choose the menu item **Save As...**

### 1.3.11. Edit a Laminate

To edit a laminate saved in the user database:

- Make sure the ‘Laminate’ tab is selected above the layer buttons
- Select the ‘Edit Laminate’ tab in the upper right part of the screen  
*or*
- Choose the menu option **File|Edit Laminate**
- Load the laminate you wish to edit like you would add a layer into any layer position – the current laminate will be cleared, and the saved laminate loaded.

**Note:** You cannot edit laminates in ‘Glazing’ mode, you must switch to ‘Laminate’ mode first. In order to use the edited laminate in a glazing system, save the laminate to the user database, switch to ‘Glazing’ mode and re-load the laminate layer into the glazing system from the user database.

**Note:** You cannot use a laminate as a component of another laminate

### 1.3.12. Calculation Warnings for Laminates

The optical properties of most laminates without coatings can be calculated without generating warnings, except that it is likely that some components will not have spectral data across the whole range of the selected wavelength set (see “1.3.2. Wavelength Sets”), so the wavelength set will be truncated.

### 1.3.13. Viewing Calculation Warnings for Laminates

To view calculation warnings for a laminate:

- Select the laminate by clicking on the ‘Lamin.’ layer button
- Select the ‘Warnings’ tab

The example below shows an warning message that says:

Results could not be calculated at all wavelengths in the selected wavelength set. Wavelength set truncated to: 0.300 – 2.500  $\mu\text{m}$

This message does not indicate a problem because the solar optical properties in WINDOW are calculated between 0.300 and 2.500  $\mu\text{m}$ .

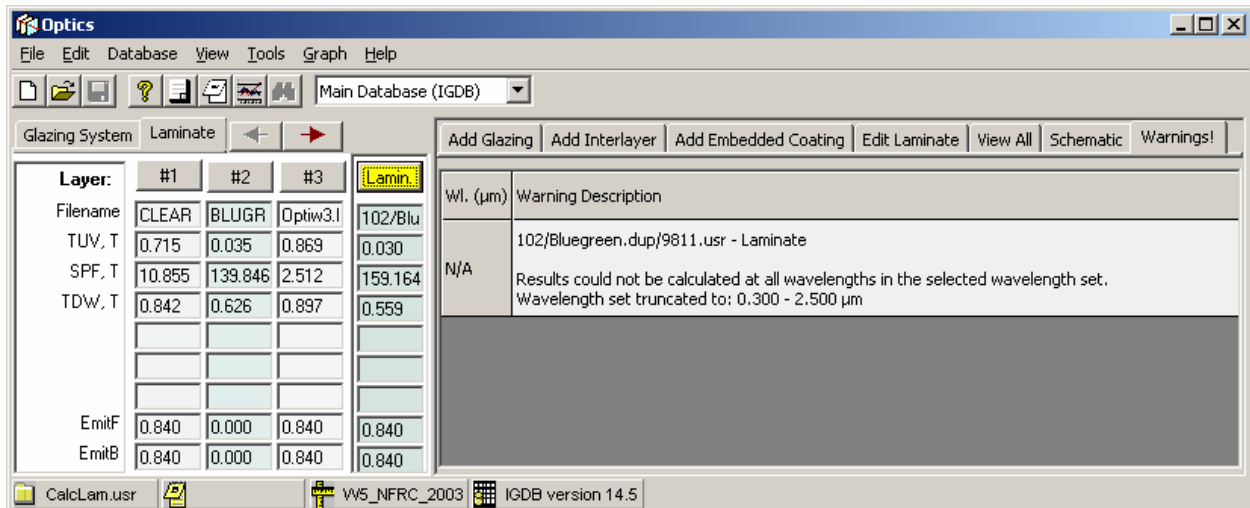


Figure 1-7. An example of a warning that is not relevant for the calculations WINDOW will be doing with the laminate.

### 1.3.14. Save the Laminate to a User Database to Import into WINDOW5

User databases have the same format as the IGDB, but they are used to store data that the user has imported, or generated with Optics5. It is not possible to add layers to the IGDB, so all new layers are saved to the user database.

The default user database is ‘UserGlazing.mdb’ in the ‘\LBNL Shared’ directory of your program installation. You can specify the location of the user database – this allows you to use as many user databases as you like (one at a time) with Optics5.

To create a new (empty) user database:

- Click on the Database menu, and select the choice “Create new user database”.

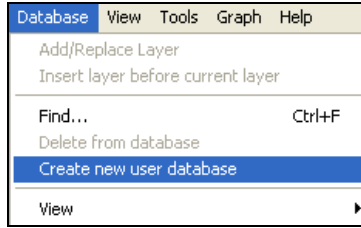


Figure 1-8. Use the Database/Create new user database option to create a blank user database.

- The program will ask you for a database name and location. Name the database as appropriate and put it in whatever directory is desired – the default directory for the default Optics User Database (called UserGlazing.mdb) is the “c:\Program Files\LBNL\LBNL Shared” directory, but any user database can be put in any directory, as long as the path is specified (Tools menu,

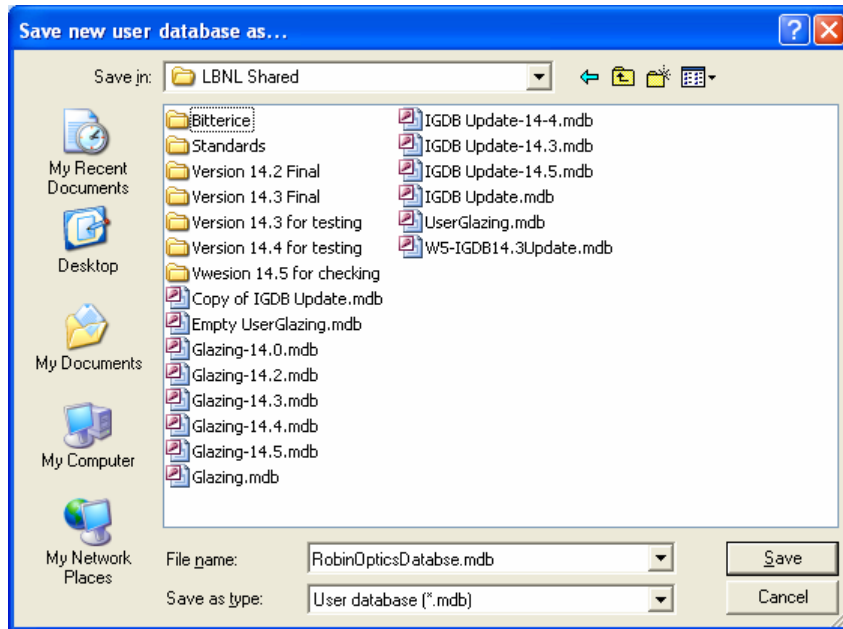


Figure 1-9. Specify the name of the new user database as well as the location where it will be stored.

- Set the default user database to the newly created database from Tool/Options

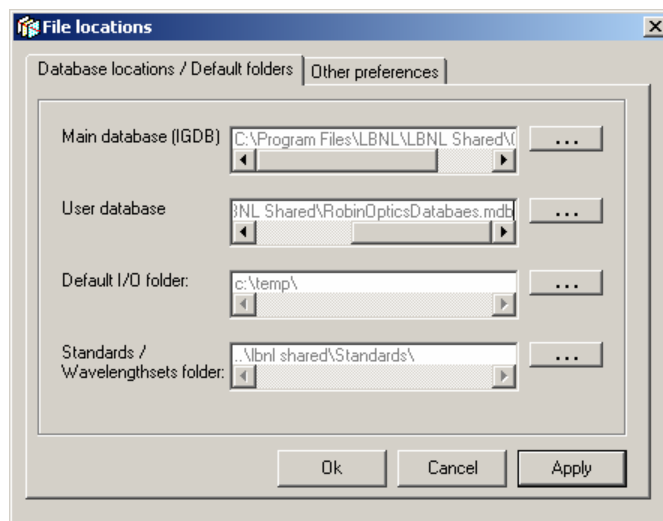


Figure 1-10. Define the location for the User Database from the Tool/Options menu, setting the “User database” field

You can save a layer to the user database if it has a different filename to any layer currently in the user database or in the IGDB. If you save a layer that has components (such as a coated layer that has a substrate, or a laminate which has component layers), the component layers will be saved to the user database at the same time (unless they already exist in the IGDB or user database). This allows you to load and edit those layers at a later time.

If you want to save an unmodified layer from the IGDB to the user database, you must change its filename first.

To save a layer to the user database:

- Select the layer or system to save by clicking on a layer button
- Click the ‘Save’ button on the toolbar:  
*or*
- Choose menu option **File|Save filename**  
*or*
- Right-click to display the pop-up menu and select the option **Save filename**
- If the layer or system you saved had components, or if the save operation fails, you will be asked ‘Do you want to view the details of the save operation?’. If you answer yes, you can view information about components that were saved to the user database, and components that were not saved to the user database along with an explanation of why some components were not saved.

**Note:** to change the filename and save in one operation, choose menu option **Save As..** instead.

**Note:** You cannot save data for a layer with the same filename as another layer in the IGDB or your current user database. If a conflict is detected, Optics will ask you to rename the layer before saving it, or cancel the import. The most common reason a component is not saved is that its filename already exists in the IGDB or user database. In this case Optics assumes that the component layer information is already available and does not need to be saved again.

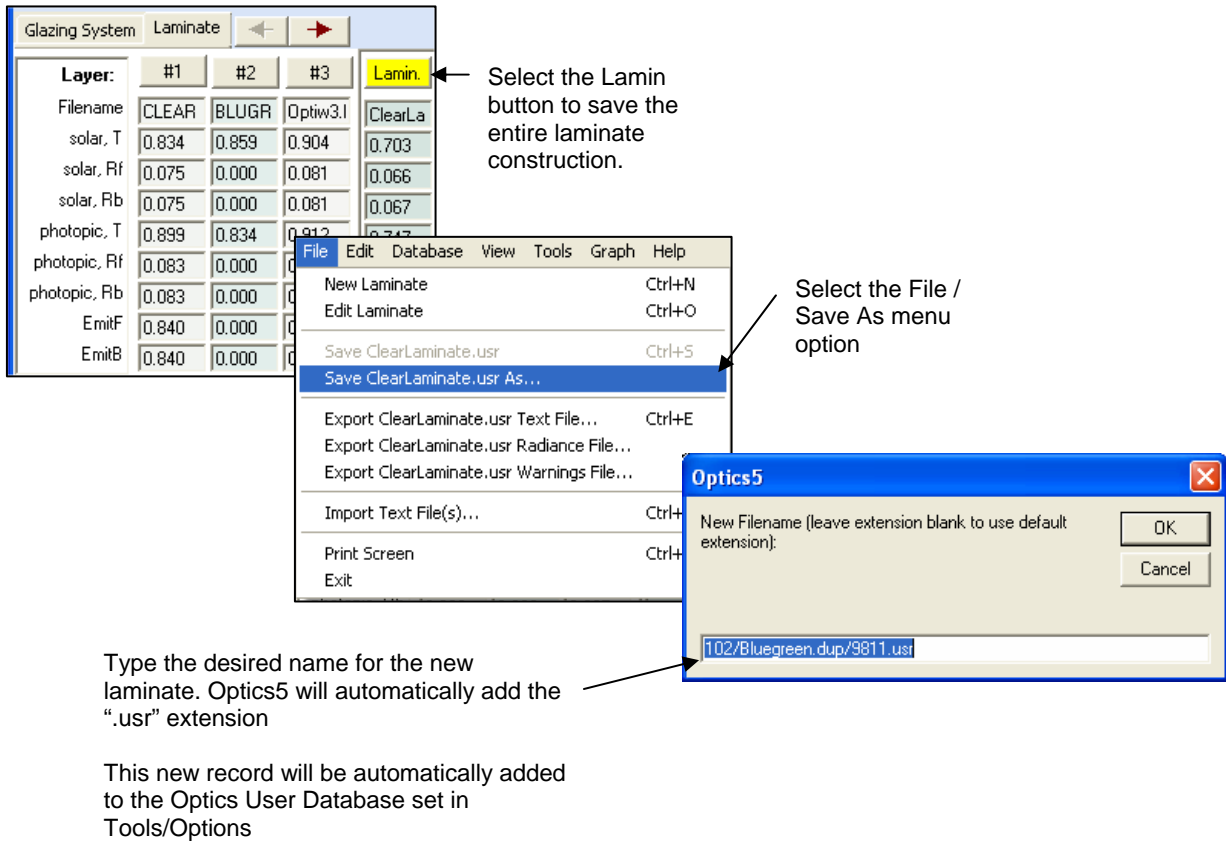
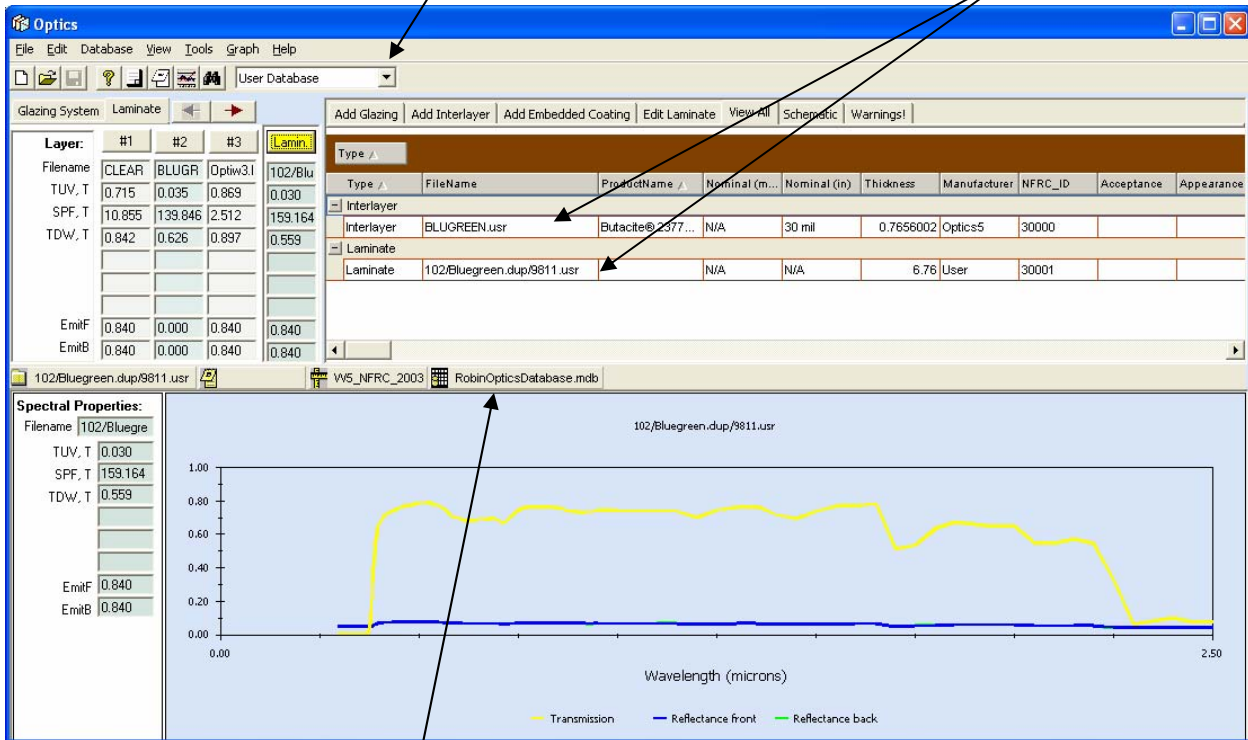


Figure 1-11. Save the final laminate using the naming convention of <glass layer ID>/<interlayer name/><glass layer ID>.

Select User Database from the pulldown list to see the records in the User Database.

The laminate construction (called in this case ClearLaminate.usr) as well as the Interlayer used in the laminate is saved in the User Database. The glass layers on either side of the Interlayer are not saved in the User Database because they are found in the IGDB



The name of the User Database is displayed on this button

Figure 1-12. Select the User Database to see the constructed laminates (and the associated interlayers)

### 1.3.15. Importing the Laminate into WINDOW5 from the Optics5 User Database

In WINDOW5, in **File/Preferences**, go to the Optical Data tab, and set the second option, Optics5 User Database, to your Optics5 user database (which by default is called UserGlazing.mdb, but it can have any name with the ".mdb" extension) -- you can browse to the file with the browse button (its default location is in Program Files\LBNL\LBNL Shared directory).

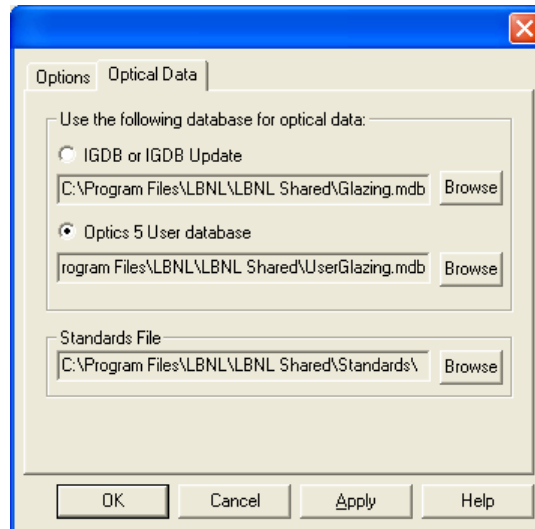


Figure 1-13. Using the File/Preferences menu, click on the radio button for the "Optics 5 User database" and use the Browse button to specify the file with the full directory path.

In WINDOW5, go to the **Glass Library List View**, click on the **Import** button, select "IGDB or Optics User Database" as the format, and click **OK**.

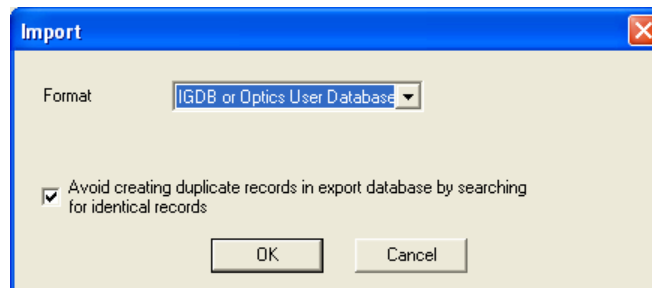


Figure 1-14. Import the data from the Optics User Database.

The program will open the user database set in the **File/Preferences** dialog box (the name will be displayed at the top of the dialog box) and you will see the glass layers that can be imported in to the existing library.



C:\Program Files\LBNL\LBNL Shared\RobinOpticsDatabase.mdb

Select Cancel Select All Clear selection Find ID 1 records found.

NFRC_ID	FileName	ProductName	Manufacturer	Acceptance	Thickness	ef	eb	Appearance	Conductivity	Database_Version
					mm				W/m-K	
30001	102/Bluegreen.dup/9811.usr		User		6.8	0.84	0.84		0.70	User

Figure 1-15. You will see all the entries in the specified user database.

You can select the records you want to import (use **Shift Click** to select contiguous records, **Ctrl Click** to select multiple non-contiguous records, or **Select All** to select all records). Then click the **Select** button, which will import the selected records into the **Glass Library**.

Glass Library (C:\Program Files\LBNL\WINDOW5\w5.mdb)

File Edit Libraries Record Tools View Help

Detailed View

Calc New Copy Delete Find ID 1829 records found. Import Export Report Print NFRC only

ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	emis1	emis2
							mm									
9930	SOLARE2.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		2.235	0.475	0.073	0.122	0.585	0.069	0.098	0.000	0.840	0.160
9931	SOLARE3.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		2.997	0.478	0.076	0.123	0.597	0.075	0.097	0.000	0.840	0.152
9932	SOLARE3.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		3.175	0.477	0.075	0.123	0.596	0.075	0.100	0.000	0.840	0.152
9933	SOLARE4.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		3.912	0.475	0.076	0.121	0.611	0.074	0.101	0.000	0.840	0.158
9934	SOLARE5.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		4.699	0.471	0.077	0.119	0.612	0.077	0.107	0.000	0.840	0.163
9935	SOLARE6.LOF	Solar Et	Pilkington North America	IGDB v11.4	#		5.664	0.456	0.074	0.113	0.607	0.074	0.097	0.000	0.840	0.161
9936	Activ2.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		2.235	0.818	0.123	0.119	0.842	0.149	0.147	0.000	0.833	0.840
9937	Activ3.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		2.997	0.801	0.122	0.117	0.838	0.149	0.146	0.000	0.833	0.840
9938	Activ3t.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		3.175	0.797	0.126	0.121	0.835	0.154	0.152	0.000	0.833	0.840
9939	Activ4.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		3.912	0.786	0.120	0.115	0.835	0.148	0.146	0.000	0.833	0.840
9940	Activ5.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		4.699	0.769	0.118	0.112	0.835	0.145	0.143	0.000	0.833	0.840
9941	Activ6.lof	Activl on Clear	Pilkington North America	IGDB v11.4	#		5.639	0.747	0.120	0.112	0.825	0.151	0.147	0.000	0.833	0.840
9989	ArcticBlue5m.LOF	Arctic BlueI	Pilkington North America	IGDB v13.9	#		5.918	0.328	0.049	0.049	0.526	0.057	0.057	0.000	0.840	0.840
9990	Sec9lam.lof	Solar Et laminate	Pilkington North America	IGDB v12.1	#		8.484	0.413	0.063	0.121	0.583	0.074	0.099	0.000	0.840	0.152
30001	102/Bluegreen.dup/9811.usr		User	IGDB User vL			6.760	0.703	0.066	0.067	0.747	0.071	0.071	0.000	0.840	0.840

For Help, press F1 Mode: NFRC SI NUM

The laminate has now been imported from the Optics5 user database to the WINDOW Glass Library. It can now be used in the Glazing System Library to create a glazing system.

Figure 1-16. The laminate has now been added to the WINDOW Glass Library.