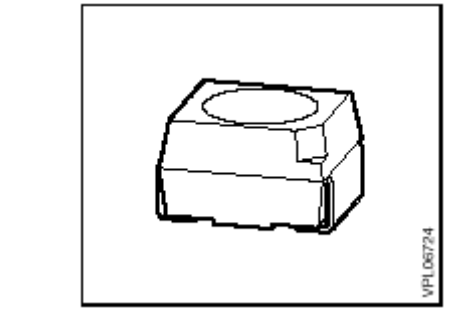
LED Tutorial

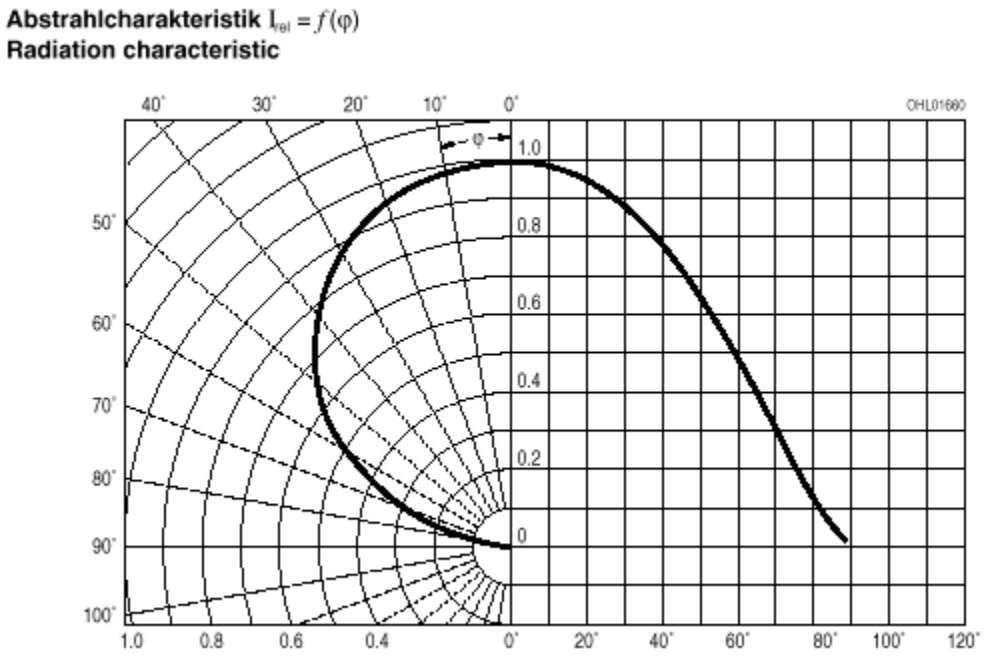
This is a general tutorial for users of TracePro LC, TracePro and TracePro Expert.

Lambda Research Corporation

Create an LED package based on manufacturer's data sheet.

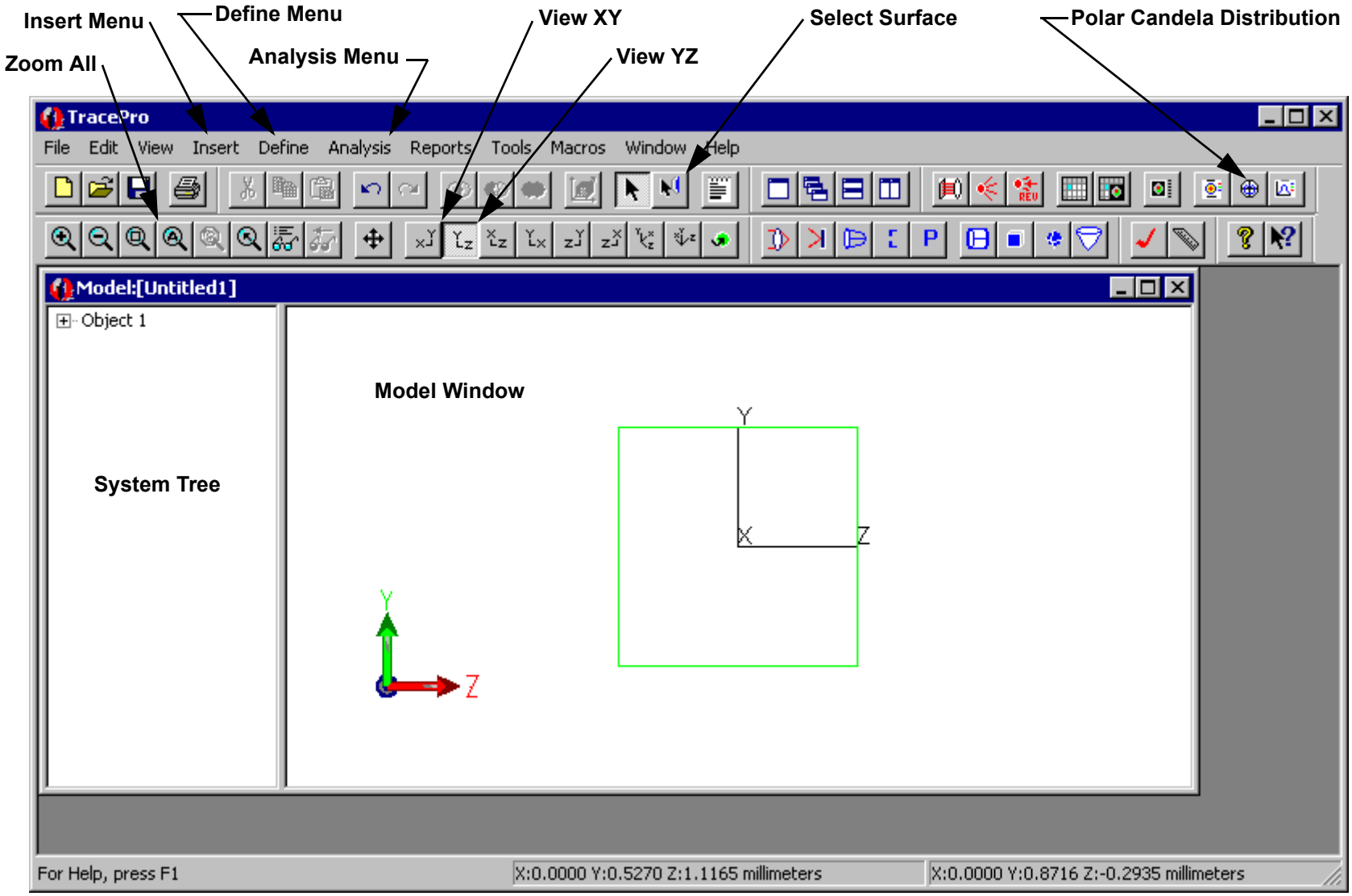
This example will build a source model for a Siemens LWT676 surface mount LED based on the Manufacturer's data sheet. The dimensions will be used to build a solid model and the source output will be defined to match the LED photometric curve.





TracePro User Interface

The figure shows a solid block in TracePro. The following user interface items will be used in this example



Create a Thin Sheet

First analyze the package to determine the best method of constructing the geometry in TracePro. The symmetry of the package suggests starting from a Thin Sheet and extrude the top and bottom halves with a small draft angle. Construct Thin Sheet in the XY plane.

1. Start TracePro and open a new model with **`File|New.`**

2. Select **`View|Profiles|XY`** or click the View XY button on the toolbar
3. Open the **`Insert|Primative Solid`** dialog and select the **`Thin Sheet`** tab.
4. Enter the four corners of the Thin Sheet in mm in the dialog box and click the **`Insert`** Button.

5. Press the Zoom All button or select the **`View|Zoom|All`** menu to see the new object

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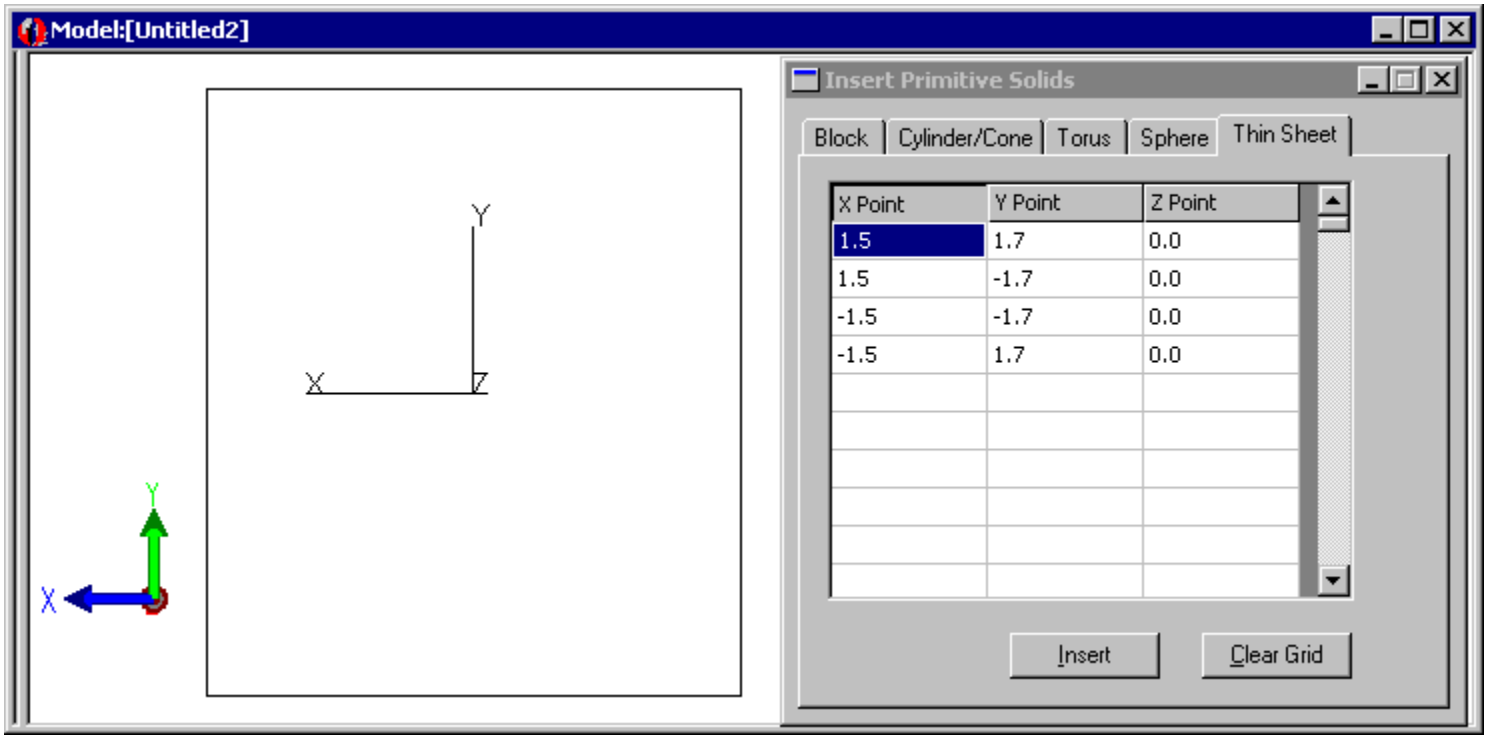
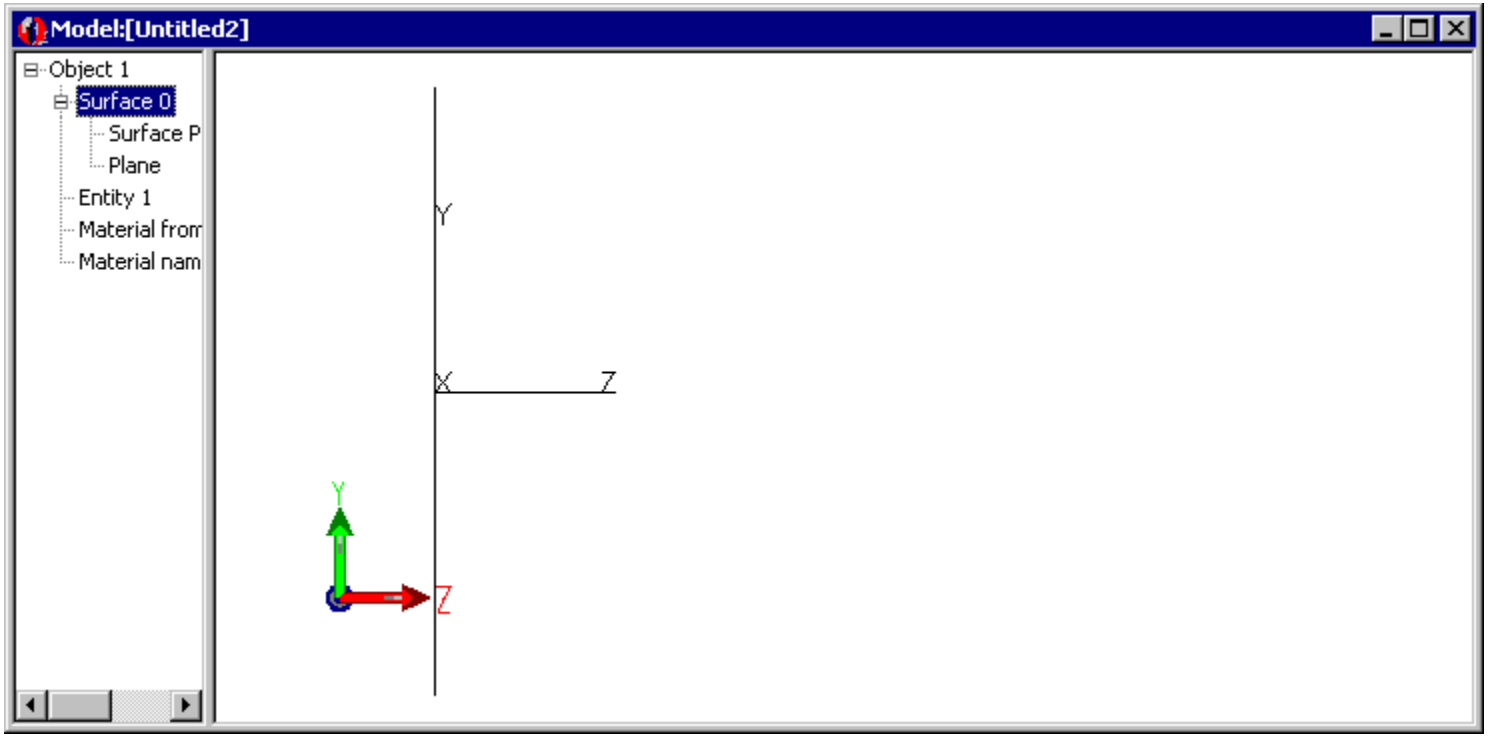


Selecting a Surface

TracePro uses surface and object selections for many operations.

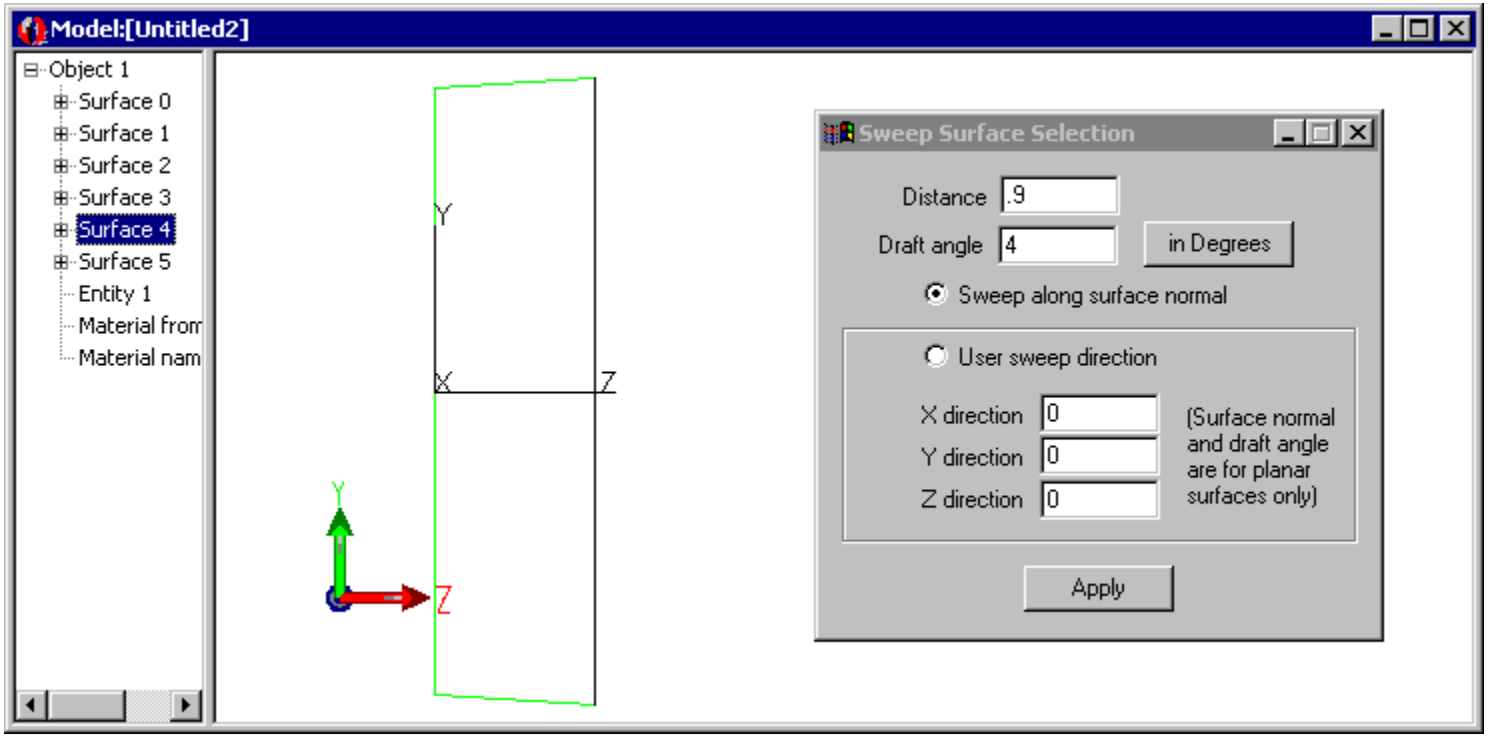
1. Close the **`Insert Primitive Solid`** dialog box. The thin sheet object has only one surface
2. Select **`View|Profiles|YZ`** or click the View YZ button on the toolbar to view the profile of the Thin Sheet.
3. Select the surface using the **`Edit|Select|Surface`** menu (or Select Surface tool), use the mouse to “pick” the rod end. You may want to use the system tree by opening the system tree with **`Window|Split`** and selecting the surface.



Use Sweep to form a solid

The package has a small angle of about 4 degrees so you will extrude the sheet using **`Edit|Surface|Sweep`**.

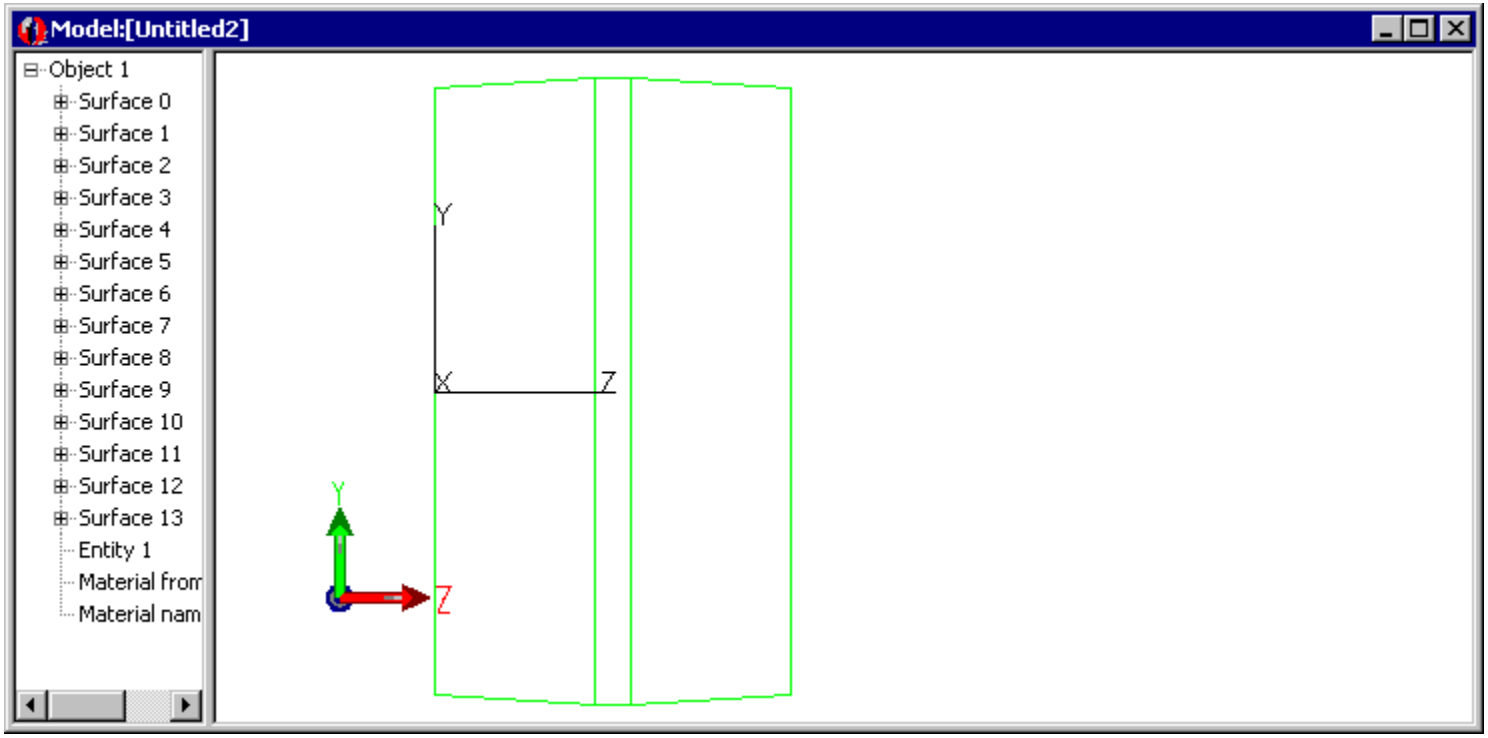
1. Select **`Edit|Surface|Sweep`**.
2. Enter a sweep distance of 0.9 mm and a draft angle of 4 degrees.
3. Click **`Apply`**. The surface will be swept along the plane's surface normal, in this case along the Z axis.
4. Make sure Surface 4 is selected for the next sweep to complete the object.



Complete the Solid

Perform two more sweep operations to complete the solid according to the data sheet.

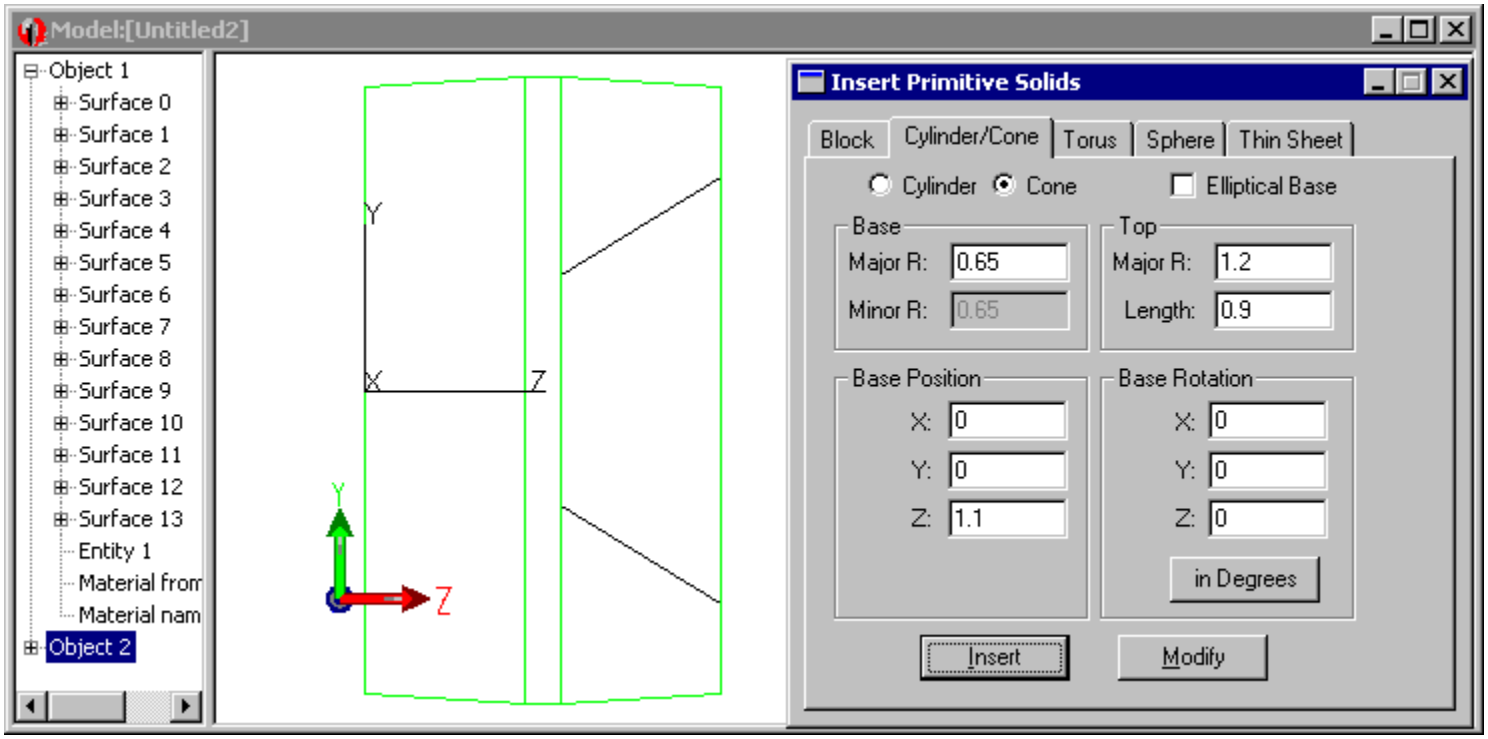
1. Select Surface 4.
2. Sweep by 0.2 with draft=0 to create the central portion of the package.
3. Select Surface 8.
4. Sweep again by 0.9 with a –4 degree draft to complete the construction.



Create a conical hole

Next you can add the cone reflector which holds the LED die. To create the conical hole, first create a cone, then perform a Boolean Subtract operation.

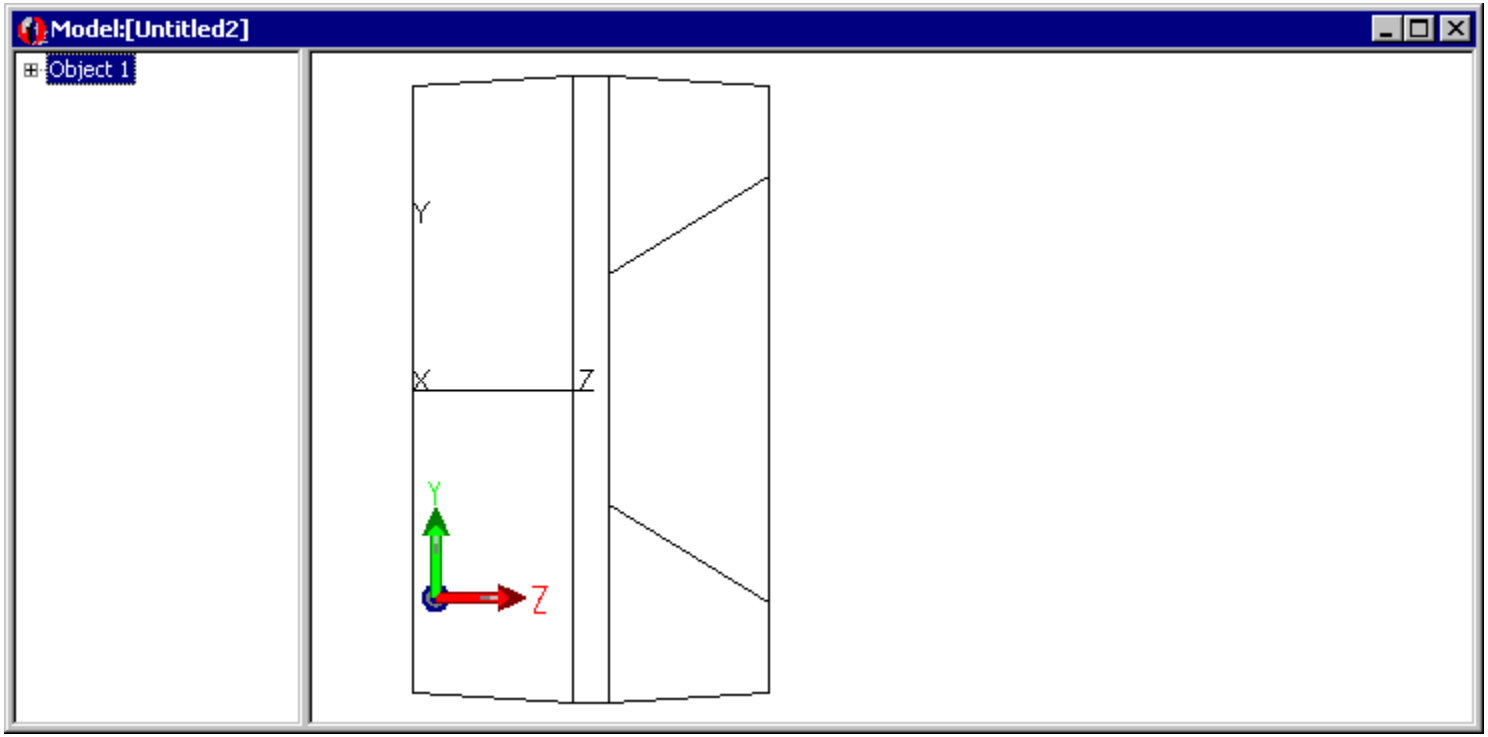
1. Select **`Insert|Primitive Solid`** and select the **`Cylinder/Cone`** tab.
2. Select the Cone option and enter the values shown, then click Insert to create the cone.



Subtract the Cone from the Package

Boolean Operations use a concept of Body and Tools. The Body is the item you wish to keep and the tools are items which will have some effect on the Body. Here you want to remove the volume occupied by the cone from the package. The Body is the package and the Tool is the cone.

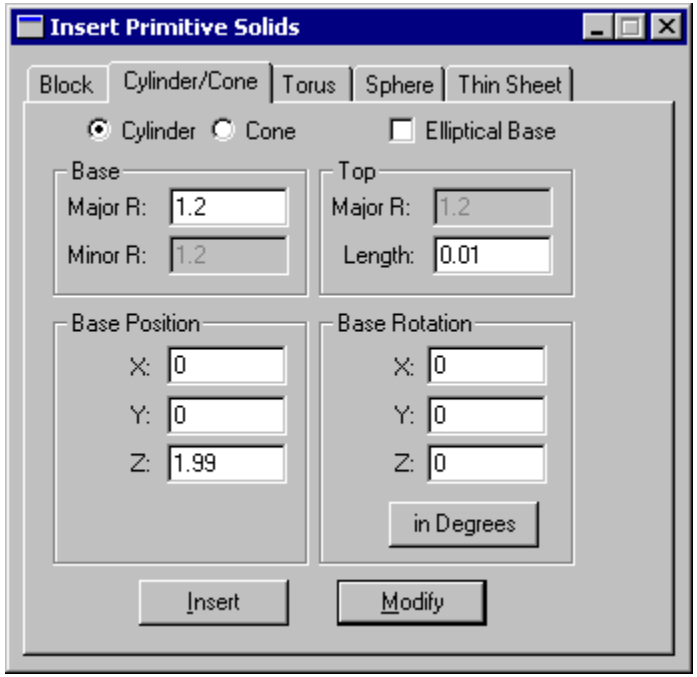
1. Select the Package object from the System Tree. Click on Object 1.
2. Select the Tool object from the System Tree. Use Ctrl+Click on Object 2. The Ctrl key allows you to add the object to the current selection.
3. Select **`Edit|Boolean|Subtract`**.
4. Object 2 will be removed from the System Tree.



Add diffuser

You also need to add a diffuser. This will be a thin cylinder joined to the package. You will make the inner surface of the diffuser scattering and the inside of the cone a perfect mirror.

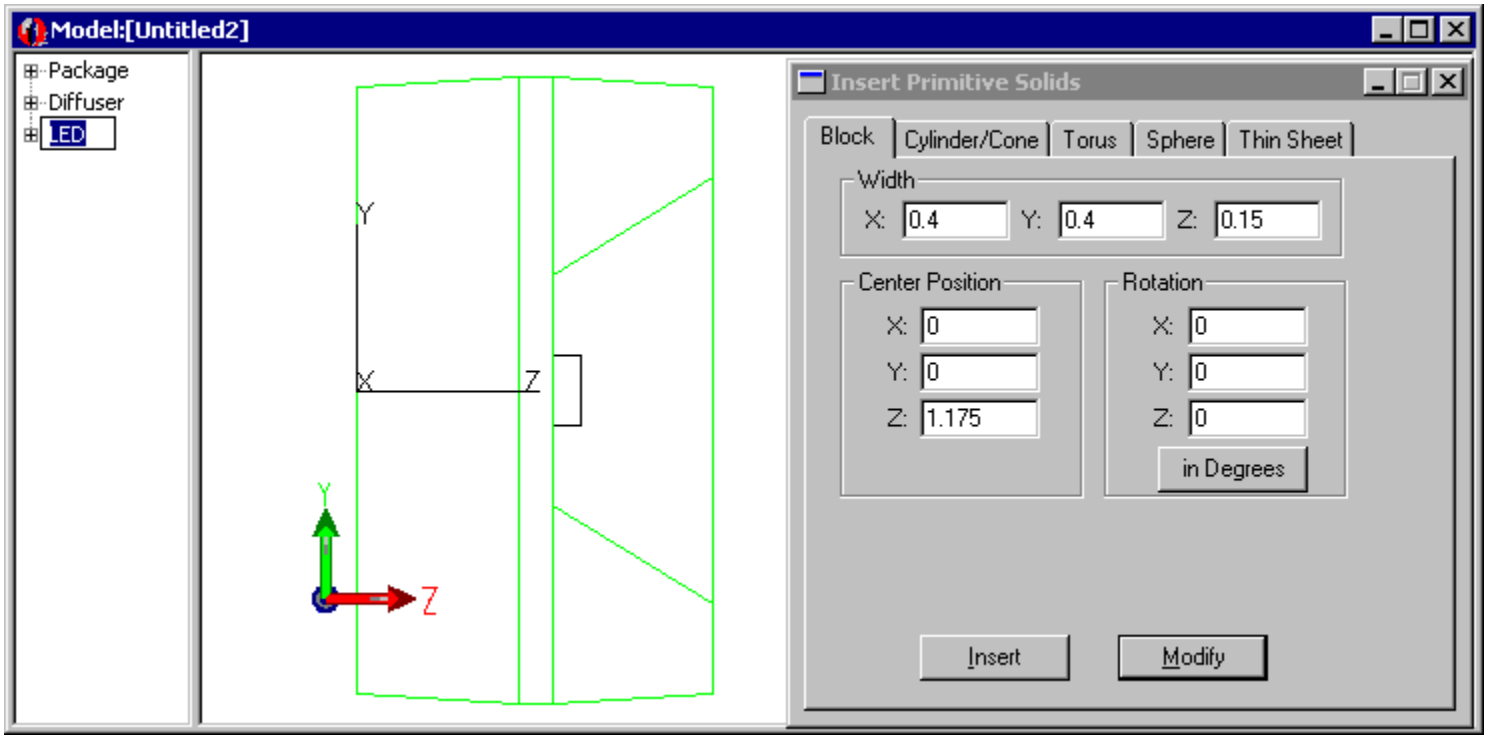
1. Select **`Insert|Primitive Solid`**, **`Cylinder/Cone`** tab.
2. Enter the values shown.
3. Click **`Insert`** to create the cylinder.



Add LED

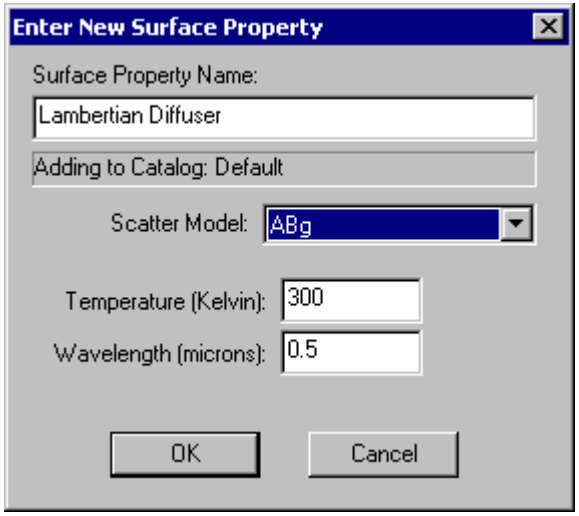
Now you will add the LED chip itself. The dimensions are not given, but you can estimate that it is 0.4 x 0.4 x 0.15 mm from the data sheet.

1. From the Insert|Primitive Solid dialog box, select the Block tab
2. Enter the values shown.
3. The center of the LED has a Z-value 1.175 to position the block so that it is on the bottom of the conical hole.
4. Click Insert to create the block.
5. You can also name the Objects by clicking in the names in the System Tree and entering a new identifier.

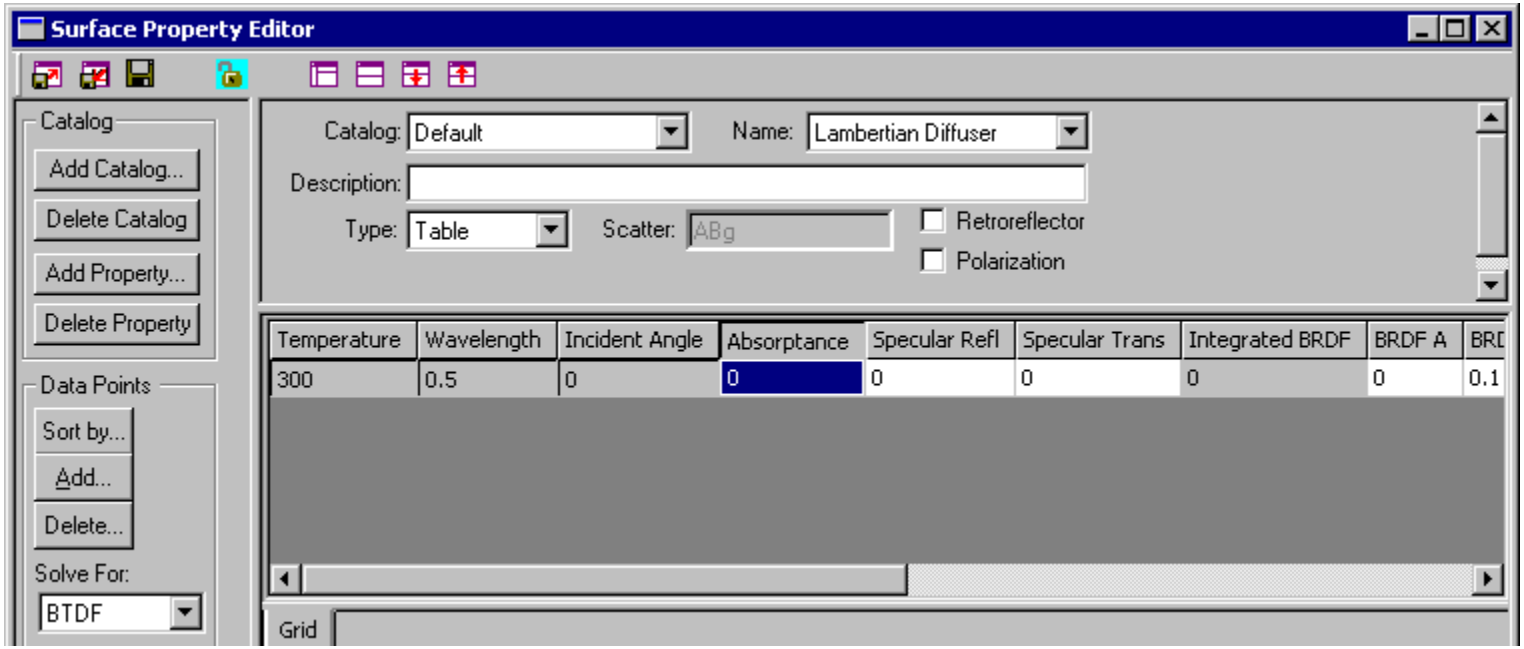


Diffusing Surface Property

You will make three assumptions about the optical properties of this LED package. First, that the Diffuser is a perfect Lambertian transmitter with no losses. Second, the inside of the conical hole is a perfect reflector without any losses. Third, the LED is a perfect reflective diffuser. These simplifications could be removed with more data from the manufacturer.



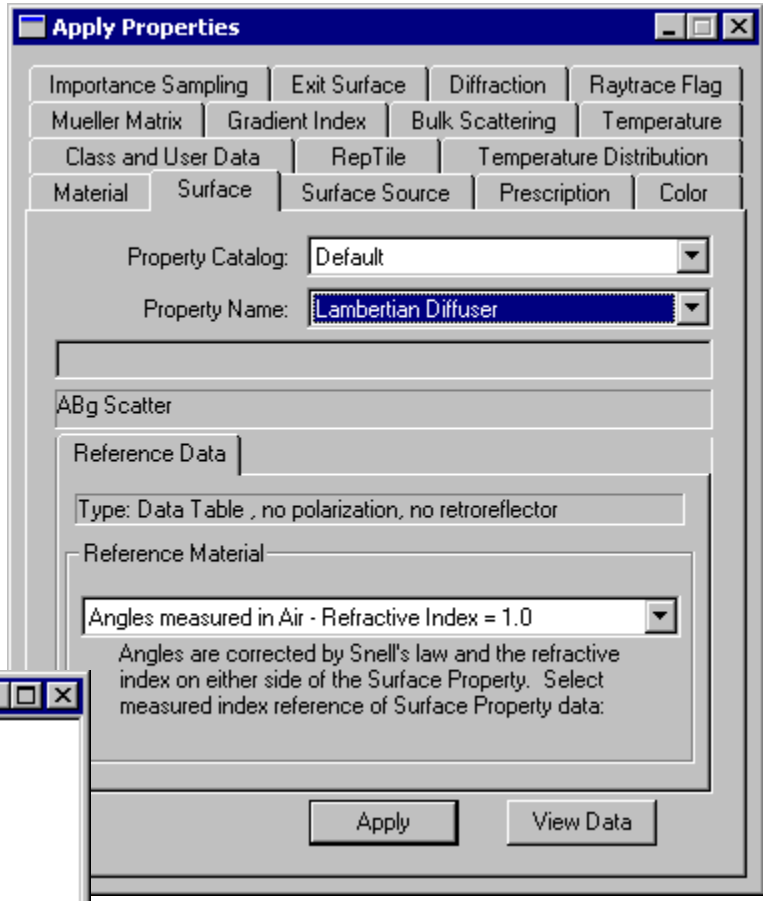
1. TracePro includes a Perfect Mirror Surface Property so you only need to add the diffuser property.
2. Select **`Define|Edit Property Data|Surface Properties`**.
3. Click the **`Add Property`** button, enter the property name Lambertian Diffuser and select ABg for the Scatter Model.
4. Set the absorptance value to 0.0 (a lossless surface) and select Solve for BTDF (Bidirectional Transmission Distribution Function) from the drop-down list. The BTDF is the scattering portion of the surface property with three coefficients. (See the manual for information about the ABg scattering model).
5. Select **`File|Save`** to store the property in the property database.

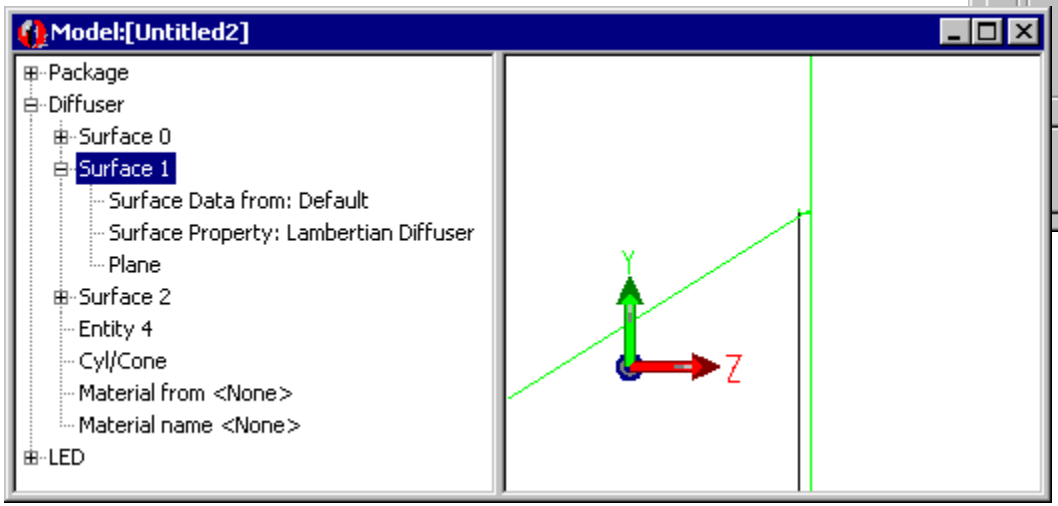


Apply Diffuser surface property

Make the inside surface of the Diffuse the scattering surface.

1. Select **`Define|Apply Properties`** to open the Apply Properties Dialog box and select the **`Surface`** tab
2. Select the inner surface of the diffuser, by either:
   - clicking on it in the System Tree
   - Selecting **`Edit|Select|Surface`** and clicking on the surface in the model window.
3. You may want to zoom in on the diffuser to see which surface is which (as shown).
4. Select Lambertian Diffuser from the Surface Property Name drop-down list.
5. Click **`Apply`** to apply the property to the diffuser.

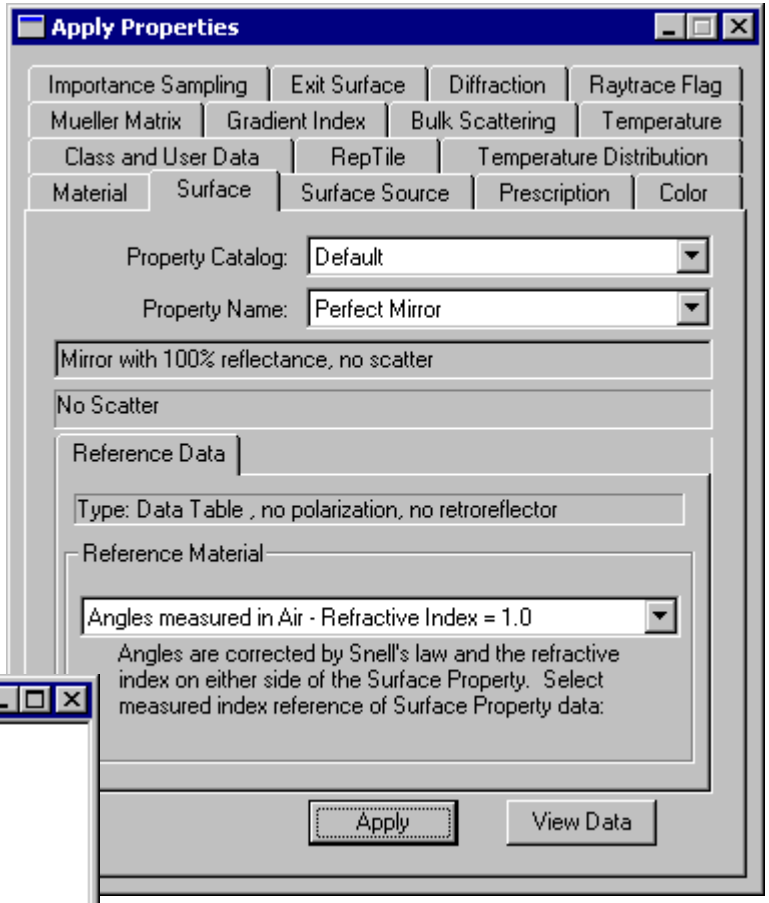


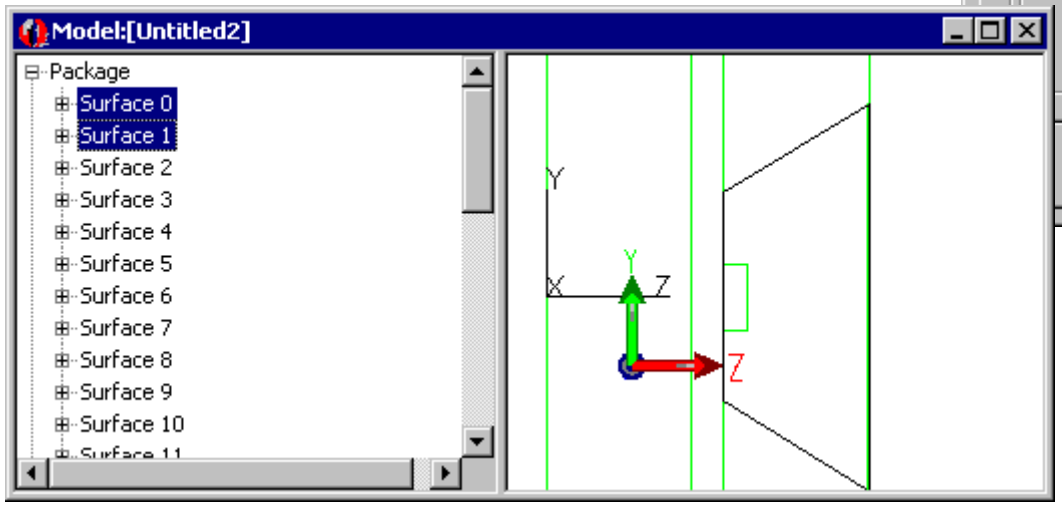


Apply Mirror surface property

The next step is to apply a Mirror Surface to the base and sides of the conical hole in the package.

1. Select the conical surface and the bottom of the conical hole. After selecting one surface, you can add to the selection by holding down the Ctrl key and selecting additional surfaces.
2. Select Perfect Mirror from the Surface Property Name drop-down list.
3. Click `Apply` to apply the property to the selected surfaces.





Define LED source

1. Select **`Analysis|Raytrace Options`** to open the Raytrace Options dialog box.
2. On the Options tab, select Photometric for the Radiometric Units type.
3. Click **`Apply`** and close the dialog box.
4. Select the top surface of the LED.
5. In the Apply Properties dialog box, select the Surface Source tab.
6. Enter the values and selections shown.
7. Click **`Apply`** to create an LED that emits 0.05 lumens in a Lambertian pattern

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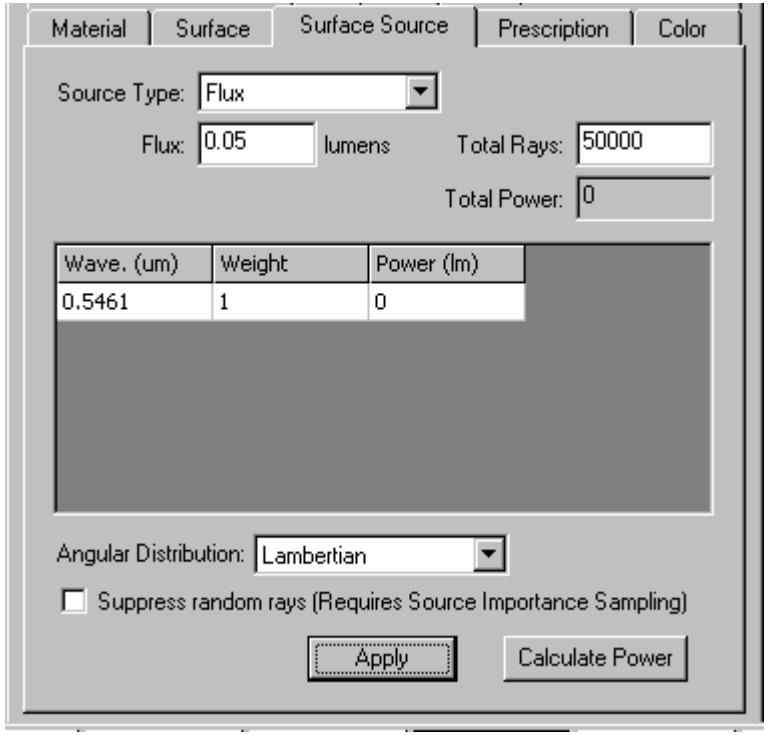
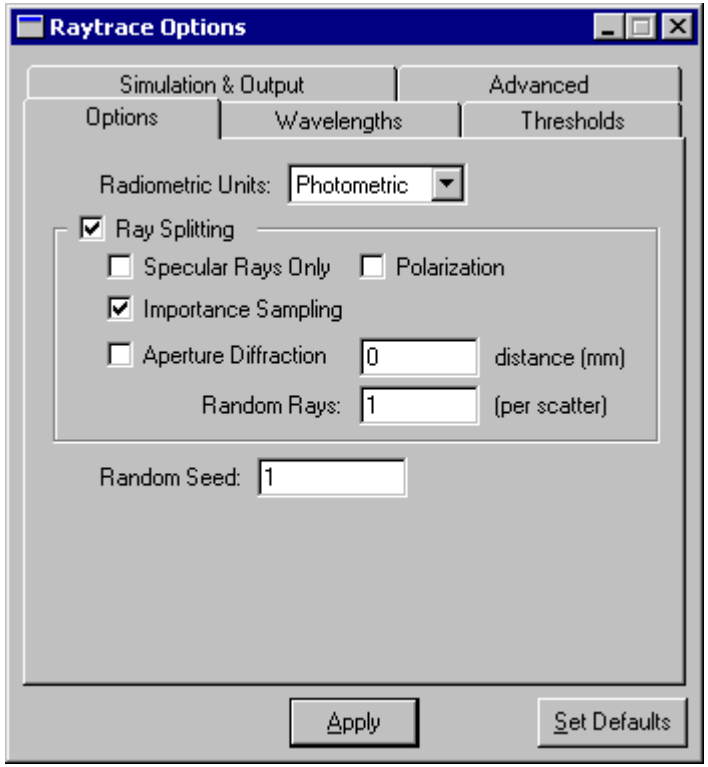
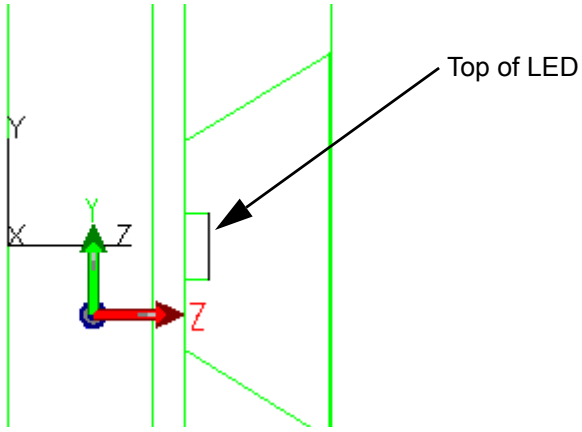






Perform the Raytrace

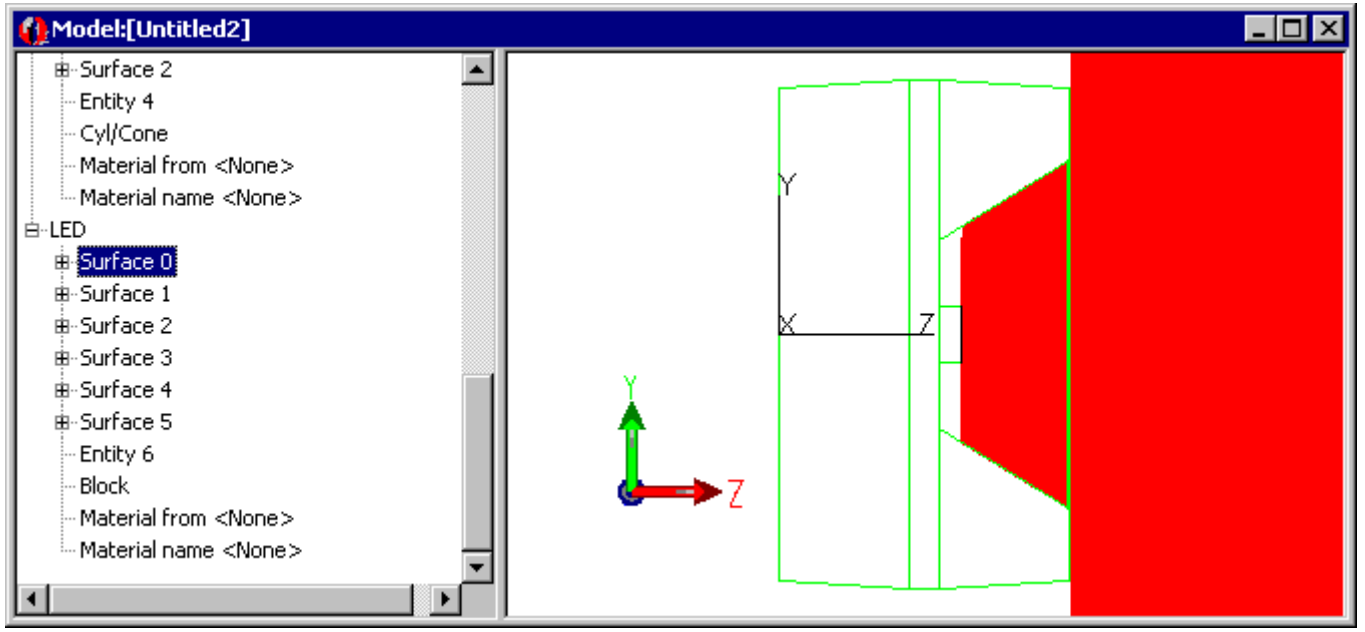
Now the model is ready for raytracing.

1. Begin a Surface Source Raytrace by either:

   • clicking the Source Trace button

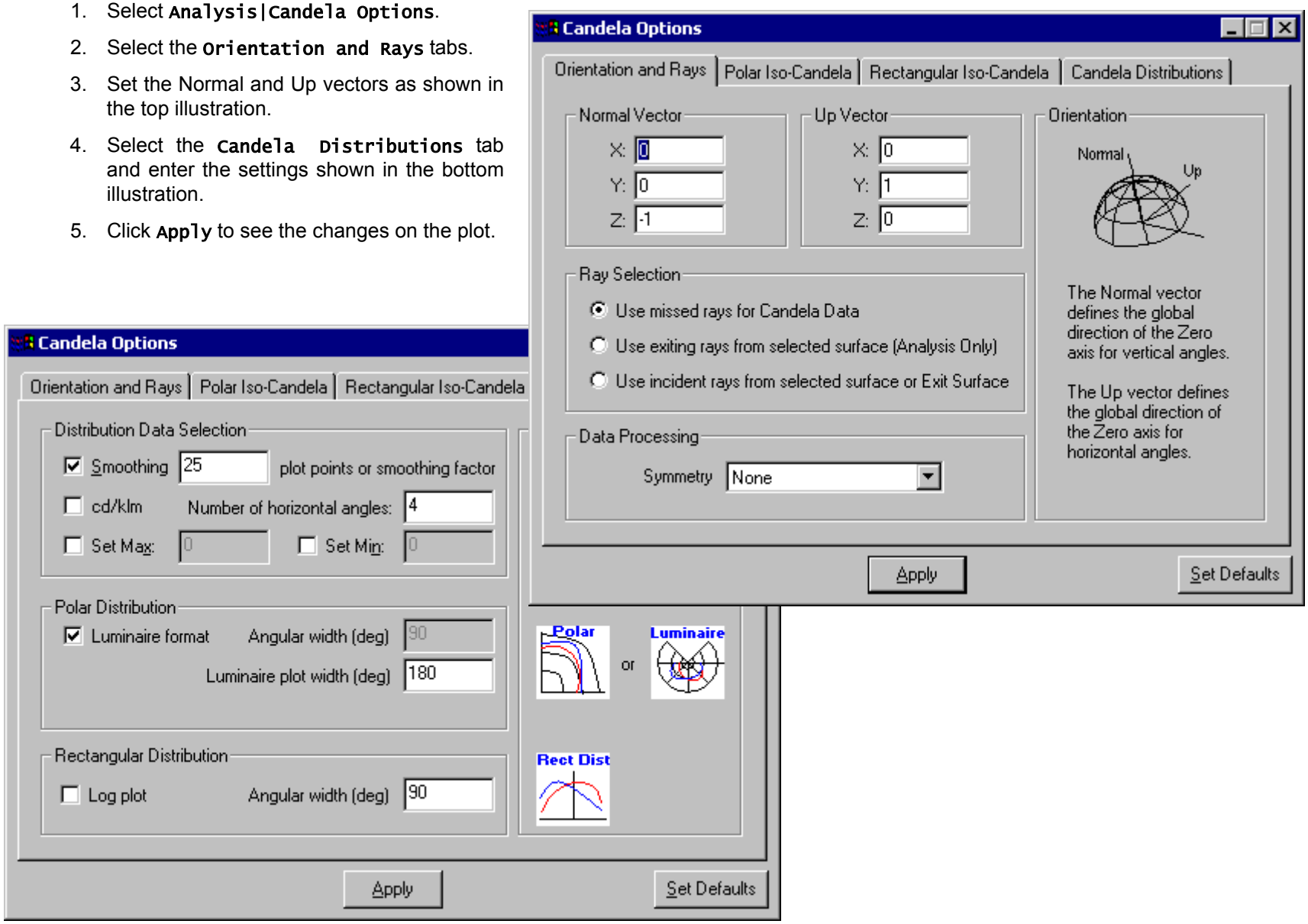
   • selecting **`Analysis|Source Raytrace`** and clicking Trace Rays.

Begin the ray-trace by one of the above options. First TracePro will perform an Audit of the model and report any invalid properties or geometry, then the raytrace will start.



Display Candela plot

1. Select **`Analysis|Candela Options`**.
2. Select the **`Orientation and Rays`** tabs.
3. Set the Normal and Up vectors as shown in the top illustration.
4. Select the **`Candela Distributions`** tab and enter the settings shown in the bottom illustration.
5. Click **`Apply`** to see the changes on the plot.



Display Candela plot

The candela plot from TracePro can be compared to the photometric curve from the data sheet.

1. Select **`Analysis|Candela Plots|Polar Candela Distribution`** or press the Polar Candela Distribution button.
2. Compare to the data.