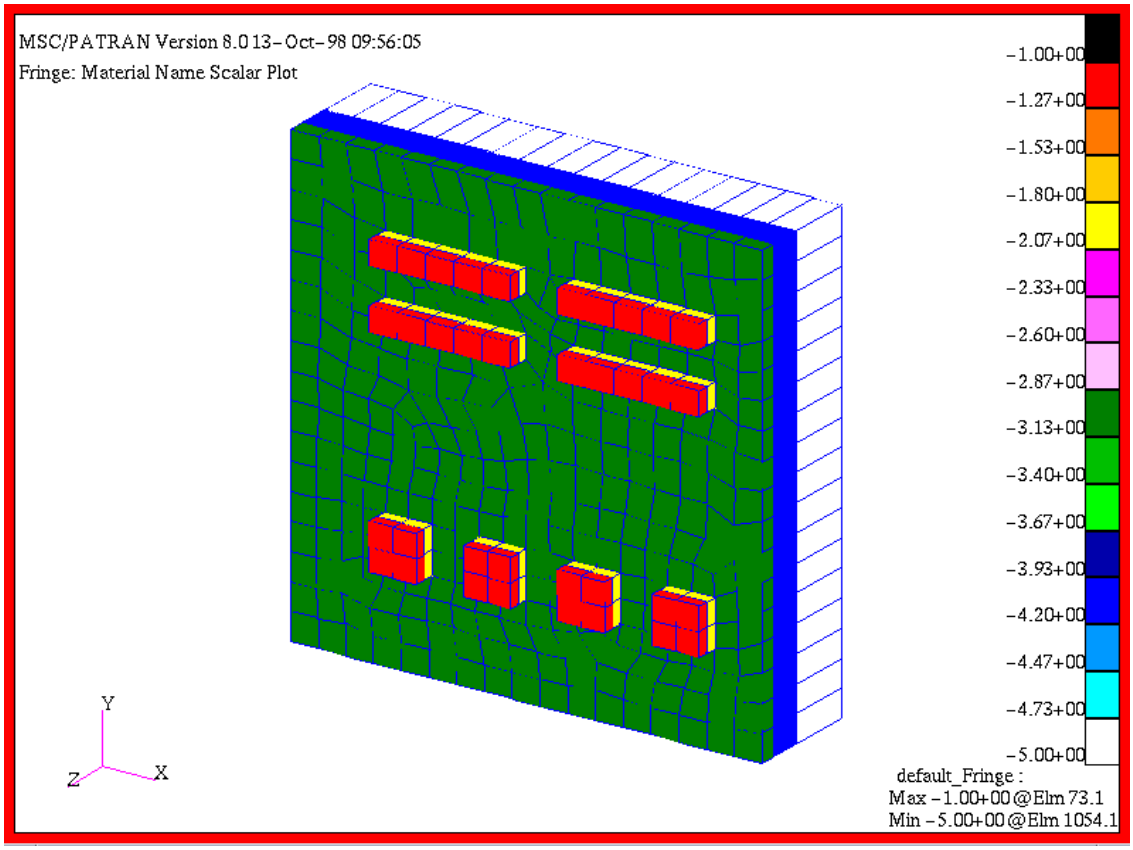
WORKSHOP 4

Materials, Lists, and Groups



Objective:

- In this exercise you will define material properties and apply them as element properties on the hybrid microcircuit mesh.
- You will also use lists and groups as tools to more easily manipulate your model.

Model Description:

In this exercise you will define several groups which will contain subsets of model entities. These groups can facilitate model manipulation. You will define materials by entering the data manually based on the information provided These materials will be applied as element properties. Lists will be used to demonstrate their utility in completing the application and verification of element properties.

As you progress, carefully review your steps to ensure that you have repeated each step, if necessary, for each material, group, and property definition.

Exercise Overview:

- Open the existing database named **microcircuit.db**.
- Use **Create//Isotropic/Manual Input** to define the five materials used in this model.
- Use **Group/Create** to define a group containing only geometry, another containing only FEM entities, and two more groups dividing the substrate FEM and the device FEM.
- Use **Properties/Create/3D/Thermal 3D Solid** to apply the material properties to 4 of the 5 material regions; intentionally ignore the silicon region.
- Use **List/Create...** and **List/Boolean...**to identify elements which have not had a material property applied.
- Complete application of material properties using the ‘listc‘ contents as input.
- **Quit** MSC.Patran.

Hybrid Microcircuit Materials

Figure 1-Material Location

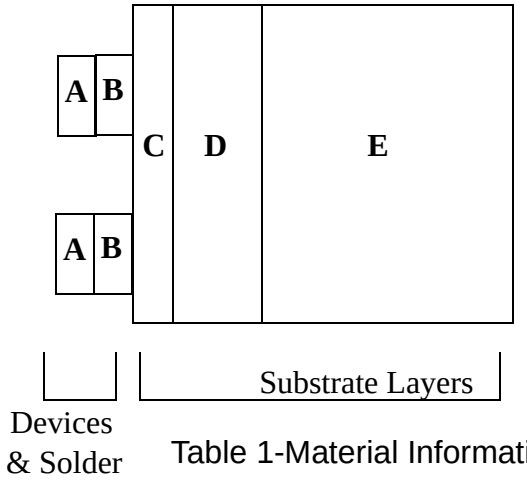


Table 1-Material Information

	Material	Conductivity (w/m-C)
(A)	Silicon	148.0
(B)	Solder	35.7
(C)	Alumina	30.1
(D)	Molybdenum	139.0
(E)	Kovar	13.9

Exercise Procedure:

Open an existing database

1. Open the existing database

Within your window environment change directories to the microcircuit.db working directory. Run MSC.Patran by typing **p3** in your xterm window.

Next, select **File** from the *Menu Bar* and select **Open…** from the drop-down menu. Select the name **microcircuit.db** from the *Database List* box.

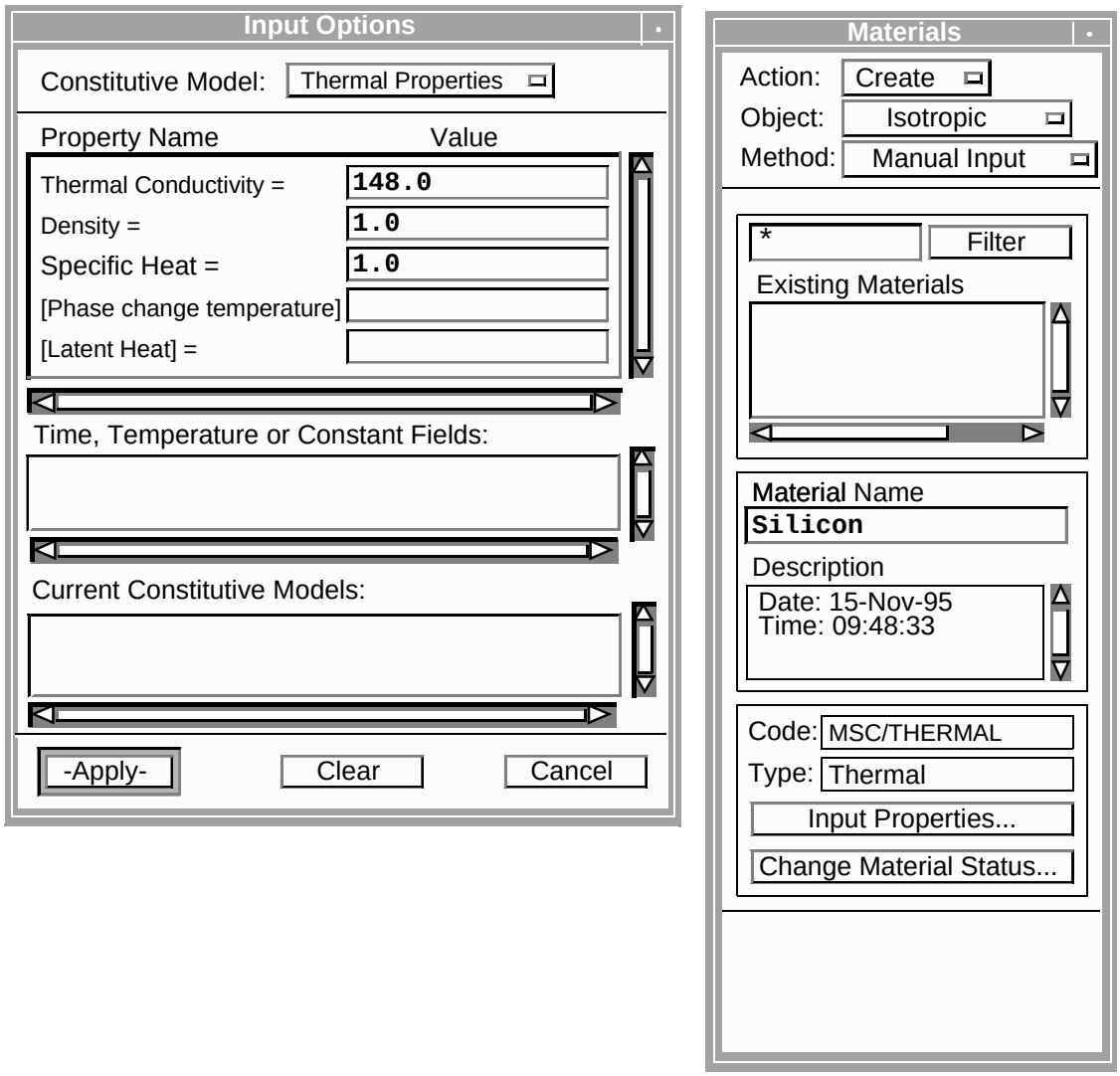
Select **OK** to open the database.

MSC.Patran will open a Viewport and change various *Main Form* selections from a ghosted appearance to a bold format.

Define materials

2. Define the five materials used in this model.

Define a material by selecting the **Materials** *Applications radio button*. Set the *Action*, *Object*, and *Method* to **Create**/**Isotropic/Manual Input**. Enter the *Material Name* **Silicon** and select **Input Properties...** to enter the data. In the Input Options form enter the **value provided in Table 1 for *Thermal Conductivity*.** Enter **1.0** for *Density* and *Specific Heat*; these are inert values which are required in the form but not used in a steady-state analysis. The completed form should look as follow.



Select **Apply** to define the material.

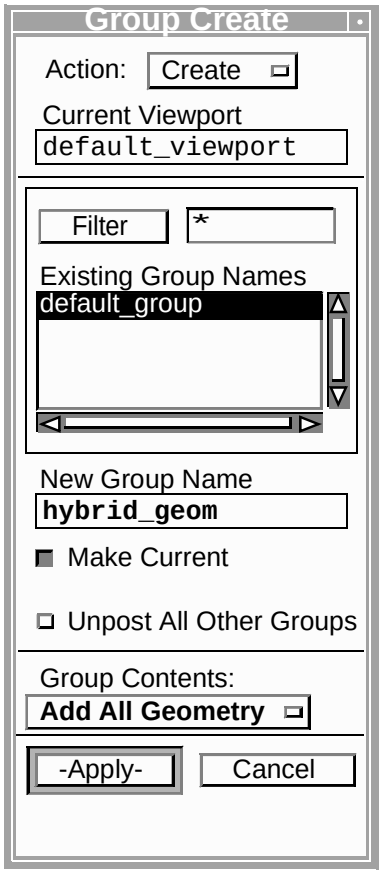
Without closing the Input Options form edit the *Material Name* and **repeat the steps for the remaining four materials renaming them appropriately, Solder, Alumina, Molybdenum, and Kovar**. Each time enter the correct thermal conductivity without changing the density or the specific heat. Hit **Apply** with completion of each material. Select **Cancel** to close Input Options.

After completing the material definitions deselect the **Material** *Application radio button*.

Define geometry and FEM groups

3. Divide the geometry and FEM into working groups.

Select **Group** from the *Menu Bar* and select **Create…** from the drop-down menu. Click in the *New Group Name* box and enter **hybrid_geom**; click in the *Group Contents:* menu and select **Add All Geometry**. The completed form is shown below.

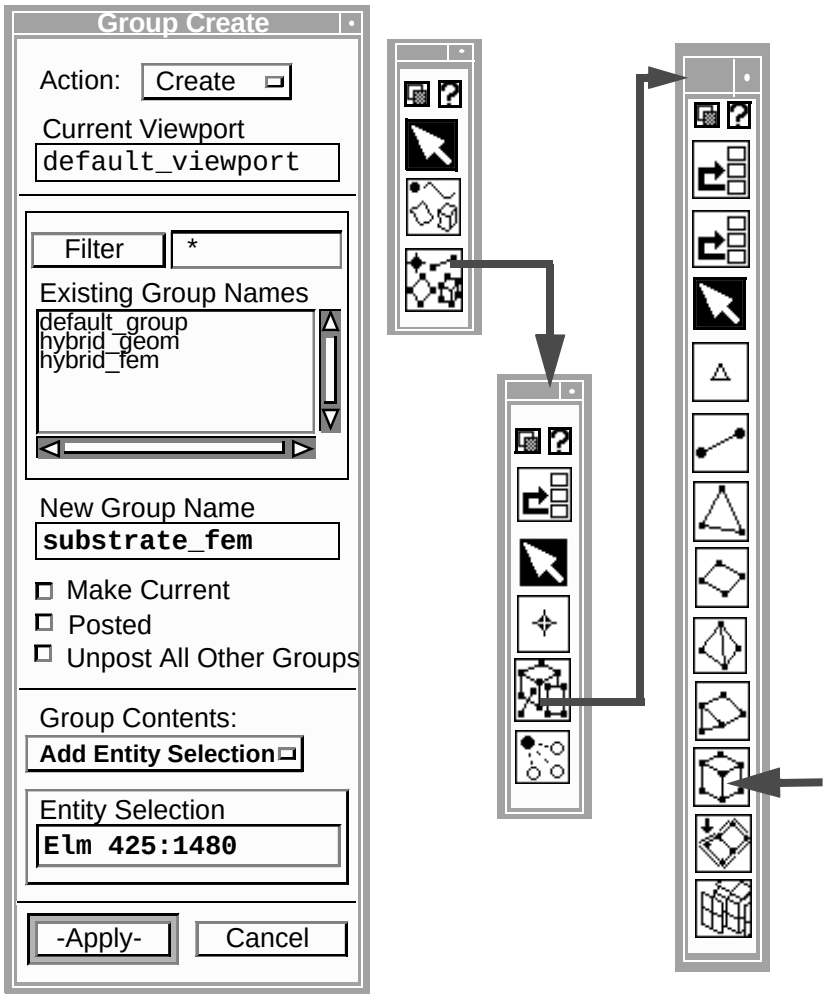


Select **Apply** to complete the function.

Reselect **Group/Create**, if necessary. Click in the *New Group Name* box enter **hybrid_fem** click in the *Group Contents:* menu and select **Add All FEM**. Turn **on** *Unpost All Other Groups*. Select **Apply** to complete the function.

From the *Menu Bar* select **Viewing/Named View Options...** Select **side_view** then **Close**. Select **Viewing/ Fit View** to readjust the display. This is a convenient view for creating the next two groups.This can also be accomplished using the Tool Bar *Right Side View* icon.

Reselect **Group/Create**, if necessary. Click in the *New Group Name* box enter **substrate_fem.** Click in the *Group Contents:* menu and select **Add Entity Selection**. Turn **off** *Make Current*, *Posted*, and *Unpost All Other Groups*. From the *Select Menu* select the *Select any FEM entity* filter, third icon from the top; from the next level *Select Menu* select the *Element* filter, also third from the top; finally, in the third level *Select Menu* select the *Hex element* filter, eighth from top. Drag a rectangle around the perimeter of the substrate selecting only the 3 layers of substrate hex elements. The form is shown below.



Select **Apply** to complete the function.

Repeat these steps dragging a rectangle around only the device area and solder to create the last group named device_and_solder.

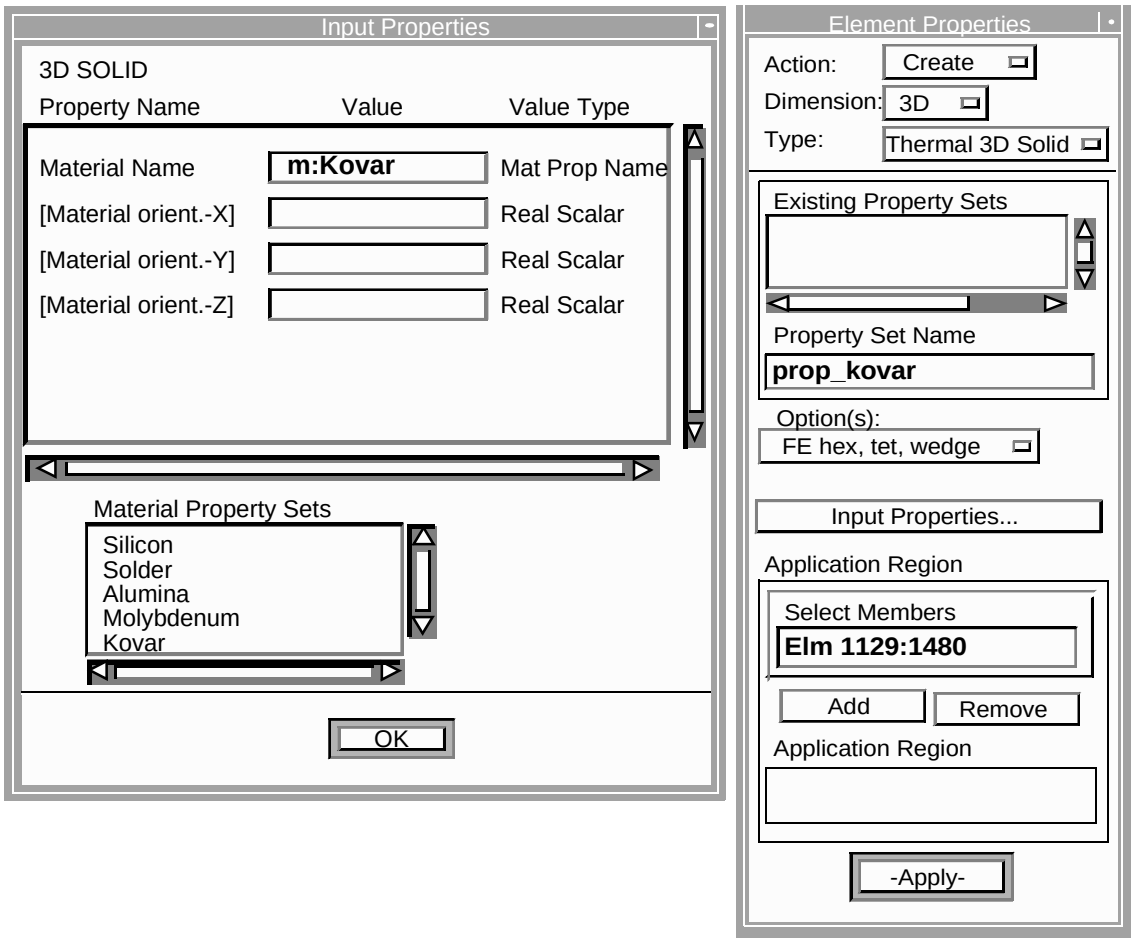
After all groups are defined, **Cancel** the **Group** Function.

Apply element properties

4. Apply the material properties to 4 of the 5 material regions; intentionally ignore the silicon region.

Select the **Properties** *Applications radio button*. Set the *Action*, *Dimension*, and *Type* to **Create/3D/Thermal 3D Solid**. Enter *Property Set Name* **prop_kovar**. Select the *Input Properties...* box. In the Input Properties form, click in the *Material Name* box and select **Kovar** from the *Material Properties Sets* list. Select **OK** to close the form.

Click in the *Select Members* box. From the at the bottom of the screen select the Select a *Solid element* filter, second icon from the top, and drag a rectangle around the lowest layer of hex elements, region E in Figure 1. The completed form is shown below. Select **Add** then **Apply** to complete the function.



Repeat these steps for the next three layers of elements naming the properties **prop_moly, prop_alumina,** and **prop_solder. Be certain to select the appropriate material for each layer. Omit assigning element properties to the silicon devices**. Refer to Figure 1 for material locations.

Using lists to find elements

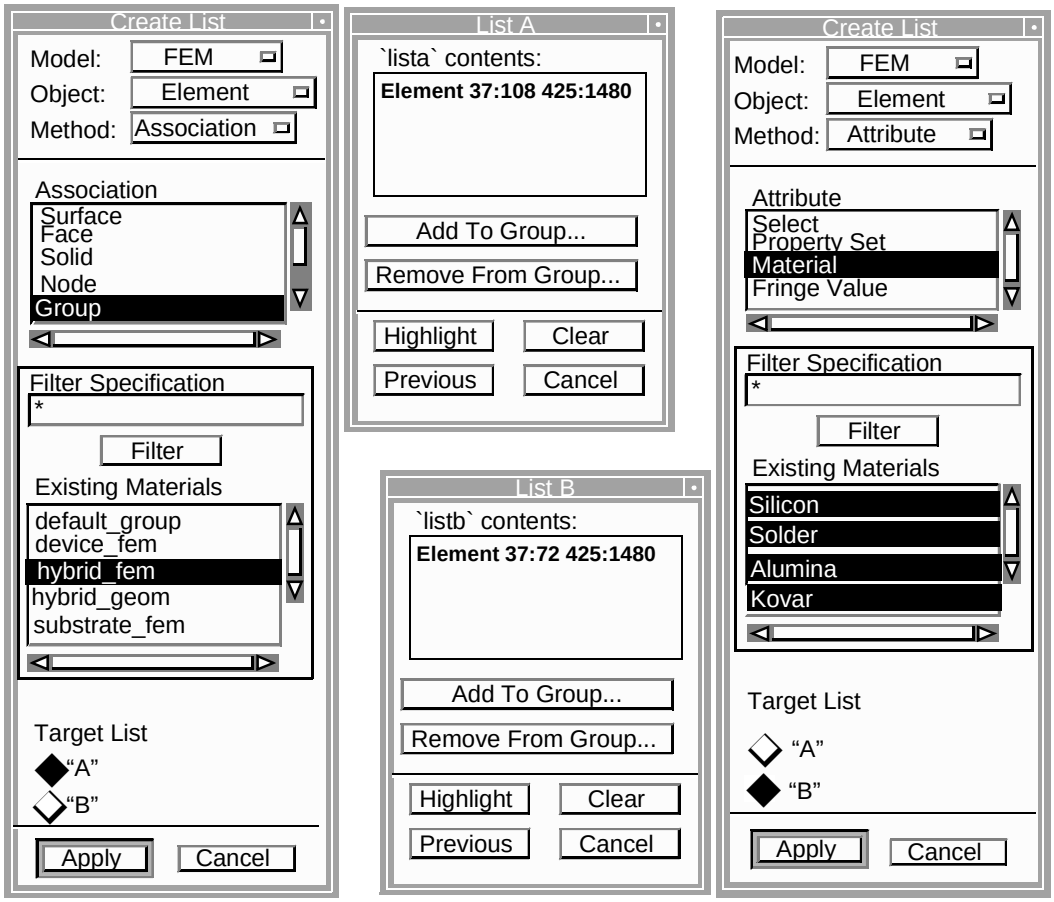
We are intentionally omitting the application of a material property to some elements. However, it is not unusual in practice to inadvertently omit assigning an element property to some elements. Use lists to recover them.

5. Identify elements which do not have a material property applied.

Select **Tools** from the *Menu Bar* and select **List** from the drop-down menu and **Create…** from the submenu. Set the *Model*, *Object*, and *Method* to **FEM/Element/ Association**. In the *Association* frame scroll to and select **Group**. In the *Existing Groups* frame select **hybrid_fem**. Select **Apply**. All elements will be listed in *'lista' contents:*.

Find *Target List* at the bottom of the Create List form select **"B"**. Set the *Model*, *Object*, and *Method* to **FEM/Element/ Attribute**. In the *Attribute* list select **Material**. In the *Existing Materials* list drag through all listed materials and **select all materials**. Select **Apply**. Elements with defined materials are listed in *'listb' contents:*.

The resulting forms are shown below.



Since Lista A contains all elements and List B contains all elements with a material attribute, subtracting List B from List A will yield List C which will contain all elements which do not have material attributes.

Select **Tools/List** from the *Menu Bar* and select **Boolean…** from the submenu. The Boolean List form will offer several options for Boolean operations, choose the *A-B icon*. The variable ‘listc‘ now contains the desired element list. Select **Cancel** to exit the Boolean List and select **Cancel** again to exit the Create List form. The contents of ‘lista‘, ‘listb‘, and ‘listc‘ are retained.

MSC.Patran supplies a set of utilities collected under the name Utilities. When installed, Utilities provides a utility, **Utilities/Group/Group Elements with No Properties...**, which accomplishes the preceding steps in three mouse clicks. We will discuss and use Utilities in later lectures and exercises.

6. Complete application of material properties using the ‘listc‘ contents as input.

Complete the element properties

To complete element properties return to **Create/3D/ Thermal 3D Solid**. Input the *Property Set Name* **prop_silicon**. Complete the Input Properties form by selecting **Silicon** from the *Material Property Sets*. In the *Select Members* box type **‘listc‘** (use reverse apostrophes). Notice that ‘listc‘ is evaluated in the *Application Region*. Select **Add** then **Apply** to complete the function.

From the *Menu Bar* select **Viewing/Named View Options...** from the drop-down menu. Select **isometric_view** then **Close**. Or use Tool Bar *Iso 1 View* icon.

In the Element Properties form set *Action* as **Show**, in *Existing Properties* select **Material Name**, and in *Display Method* select **Scalar Plot**. *Select Groups* as **hybrid_fem** and select **Apply**. The model should now appear as on the front panel of the exercise.

7. Quit MSC.Patran

Quit MSC.Patran

To stop MSC.Patran select **File** on the *Menu Bar* and select **Quit** from the drop-down menu.