Module 5: Package Design & Modelling: Building a Semiconductor Package from Scratch

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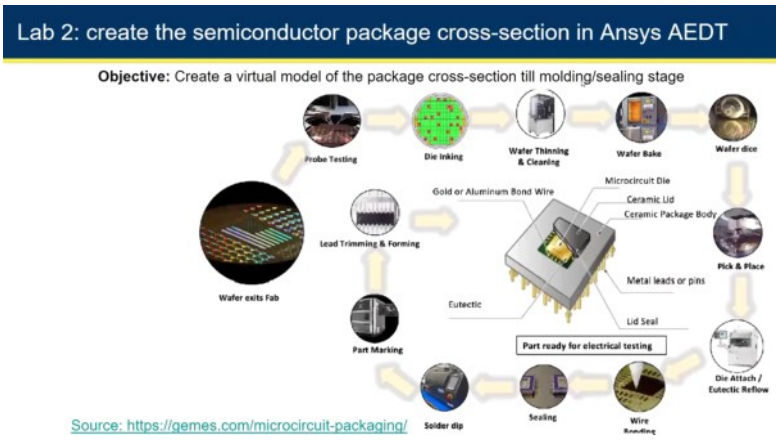
L1: Into To Package Cross-Section Modelling in Ansys Electronics Desktop (AEDT)

Here, we will be starting with a die from a wafer.
Would be covering how package materials are selected.

Package material/design selection revolves around thermal & electrical parameters.

Will be using Q3D & Maxwell Solvers to do both electrical & thermal analysis

This lecture would be limited to thermal & electrical analysis.



L2: Creating the Die Substrate in AEDT

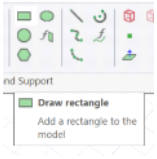
Now, we would work on Q3D as it allows for parasitic extraction.

Opening a Q3D Project:
Select "Q3D" from the home screen top ribbon or create a Q3D project.

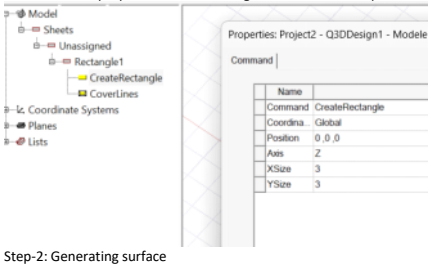
We start with creating a die.

Step-1: Creating a die
Typical die size: 15 mm X 15 mm
We start by drawing a rectangle

We select the rectangle draw tool form the top ribbon & make a rough rectangle.



Then we select properties of the rectangle & and resize it as per our requirements

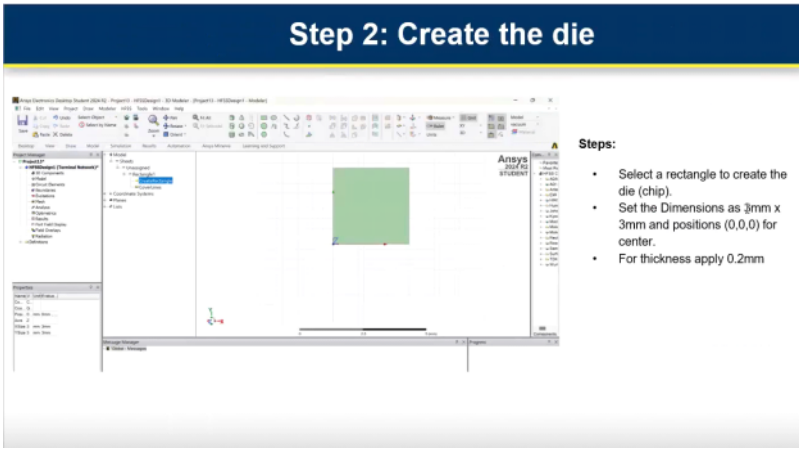


Step-2: Generating surface
To make a 3D model, we select the rectangle and select the "Modeler" option from the toolbar
Modeler -> Surface -> Thicken Sheet

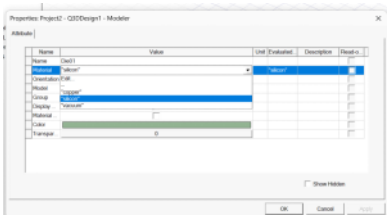
We enter the sheet thickness in the popup.

Step-3: Changing Material Type & Renaming Surface
From the models panel, right click on the rectangle made earlier & select properties.

Here, rename the rectangle & change the material type by selecting "Edit" from the material tag dropdown.



Note: State of the art dies are about 30 microns. (HBMs)

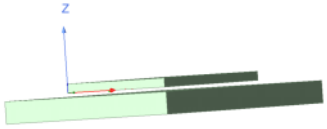


This assigns a default set of properties to the rectangle.

Step-4: Creating Substrate
Add a rectangle below the die using steps similar to the ones taken to create a die.
We also thicken the substrate, take similar steps. (Origin: -1,-1,0)
To extend the substrate below the die, we make it's thickness to be negative

But die does not sit directly upon substrate, we have bumps & die attach too. So need to add them.

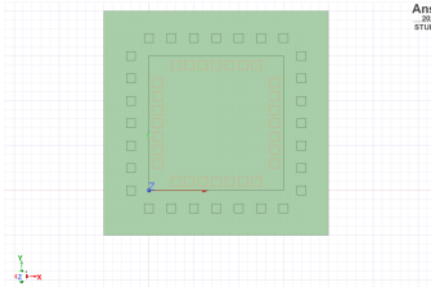
L3: Adding Die Attach Material & Bond Pads



Now, we rename the substrate layer & change its material to FR4 epoxy.
Now, we need to add a die attach material between the substrate & the die.

Firstly, we shift the substrate below by changing its Z coordinate to -0.1

Now, we add a die attach material of 100 u between the die & substrate.
The origin X,Y,Z co-ordinates are the same as the die, but we keep thickness as -0.1.
Finally, we rename the layer & assign material "Modified Epoxy".

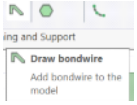


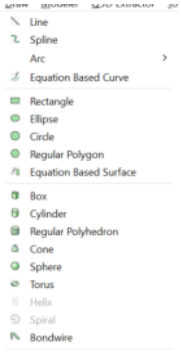
Now, we start with setting the die for wire bonding.

We create bond pads on the die & substrate for connection.

We choose copper as the material & keep thickness of 0.02 microns

L4: Wire Bond Creation & Material Alignment





Now, we ned to connect the die & substrate bond pads.
To do so, we use bond wires by selecting this icon, or from the top ribbon

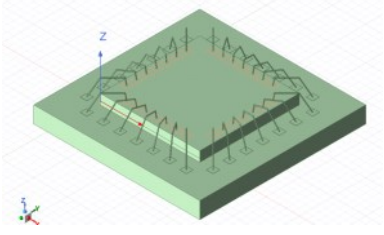
"Draw"-> "Bond Wire"

We then connect the centres of corresponding bond pads.

While doing so, we need to configure the bond wire structure.
This panel helps us select the structure of the bond wire, it's diameter & heights.

Typically, we select gold as the material for bond wires as it is highly ductile & conductive.

h1 &h2 for bond wire are also called as heat affected zone.
When purchasing wires, need to consider all specifications.



L5: Applying Mould Compound & Finalizing the Package Model

Mould compound encapsulates the substrate.

Packages thickness also depends on the client requirements & the actual package height.

For mould thickness, we consider height of all wire bonds & dies above the substrate.

For mould compound, we draw a rectangle over the substrate and give it a suitable height which is more than the wire bond heights. This is done to accommodate laser markings over the die compound to allow wires to stay unaffected on etching.

In our case, max height is 0.3 + 0.2 mm (Die Height + Bond Wire H1) = 0.5 mm

So, mould height would be 2x 0.50mm = 1 mm