

Cross-Sectional Viewer

Introduction

With the increase in complexity of IC layouts and processes the designer must have knowledge not only of layout design, but of simulation and manufacturing as well.

Cross-Sectional Viewer is a tool in the *Expert* layout editor that simulates the cross-sections of ICs along an arbitrary drawn cut-line on the layout. Cross-Sectional Viewer is a link between the layout and the resulting device and it helps the designer to understand its spatial structure. Cross-sectional drawings are useful for detecting parasitic coupling, undesired metal stacking, and other design and fabrication problems.

Expert's current implementation of Cross-Sectional Viewer is based on a simplified simulation of the process steps using rough processing parameters from the *Expert* technology file.

Cross-Sectional Viewer Setup

For the simulation of fabrication steps specific parameters must be specified in the technology file. For simplicity we assume that each fabrication step is associated with a separate layer in the layout.

The user can create and modify process simulation parameters interactively using the Cross-sectional Viewer setup panel of the Preferences window of *Expert*. (see Figure 1)

The different steps to follow for setting up of the Cross-Sectional Viewer are as follows.

Derived Layers

Before defining the process steps in the **Cross-sectional Viewer setup**, the user has to check that all these steps can be defined with existing layers of the layout. Otherwise, the missing layers have to be generated generally using boolean operations on other layers.

For example, if the user needs to define etch operation on a deposit of Metal1, the technology file should contain a layer which will be the reverse mask of Metal1.

So one must define the corresponding derived layer in *Expert* technology as follows:

- In **Layer Setup** panel (menu: **Setup>>Technology>>Layer setup**), create a new layer and define it as 'derived'.

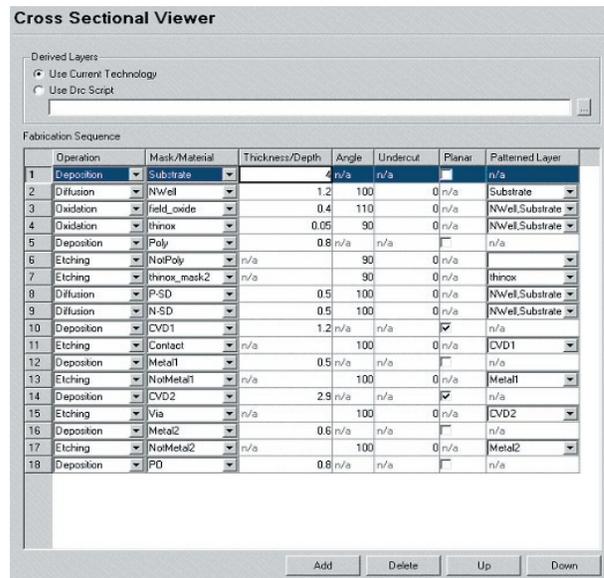


Figure 1. Cross-sectional viewer setup.

- In the **Derivation setup** panel, enter the boolean operation defining the "Etch_Metal1" layer representing the mask of etching:

Dif: Layer1=Substrate, Layer2=Metal1,
LayerR=Etch_Metal1;

- Activate menu **Derivation>>Accept derivation** of this editor in order to validate this definition and its syntax.

In this way the layer "Etch_Metal1" will be included in the technology: it can be used during the definition of process steps of the **Cross-sectional Viewer** and it will be generated automatically when launching a Cross-Sectional-Viewer like all other derived layers of the technology file.

Fabrication Sequence

The second step of the **Cross-sectional Viewer** setup is the Fabrication sequence table definition. It allows defining one-by-one all the steps of the process beginning from the bottom (substrate) to the top of the chip.

The available commands in order to define a process step are as following:

- Create a process step using the **Add** button. In order to add a process step, the user must first select the step above the place where he wants to add a process step. The user can then click the **Add** button and a new step is added in the table and the user can set the parameters of this step.

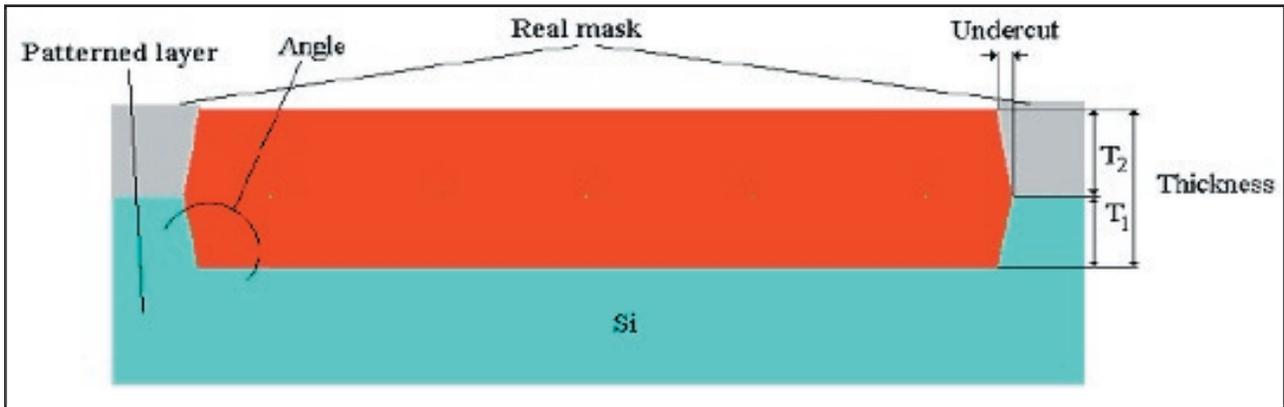


Figure 2. Local oxidation parameters.

- Define the kind of **Process operation**:

A process step is defined first by the operation it consists in. Listed below are the process operations and the meaning of necessary parameters. There are four different kinds of process operations that are available:

- DEPOSITION
- ETCHING
- IMPLANTATION / DIFFUSION
- OXIDATION

- **Mask/Material** layer:

The layer you will choose will represent either the material (in the case of a deposit or an oxidation), or the mask (in the case of an etching or an implant/diffusion.).

Note: in the case of a deposit, the geometry of the layer does not matter: the deposit will be done on all off the surface anyway.

- **Thickness/Depth** parameter:

This value will define the thickness of the material in the case of a deposit or an oxidation. In the case of a etching or an implant, this will define the maximum depth where the etch or the implant will end.

- **Angle** value:

This is equivalent to the angle between the horizontal base of the material and its side. See Figure 2 (oxidation case) and Figure 4 (etching case) for examples.

- **Undercut** value:

This parameter allows the user to introduce a shift between the border of the geometry of the mask layer and the place where the process operation will be applied. See Figure 2 (oxidation case) and Figure 4 (etching case) for examples.

- **Planar** option:

This option only concerns the deposit operation. Checking this option makes the current deposit planar. The thickness of the deposit will be calculated from the top of the last planar deposit. If the option is not checked the deposit will be conformal.

- **Patterned Layers** list:

This is available for etching, implantation or oxidation only. In the **Patterned Layer** drop-down list, you can choose which material(s) will be processed: in other words this feature allows a selective etching, implantation or oxidation.

When selecting the "Edit..." field of this list, the **Csv patterned layers** window will appear (see Figure 3). In this window the user is prompted to select the list of materials that can be etched/implanted/oxidized during this process step.

Note: Thanks to **Patterned Layers** list and **Depth** parameters the user can define precisely the etching/implant/oxidation results:

- If the process step is independent of the material the user can select all the layers of the Patterned layer list. In this way only the Depth parameter will influence the process operation.

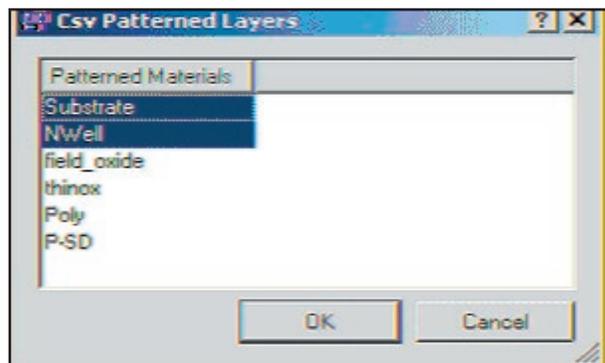


Figure 3. CSV patterned layers window.

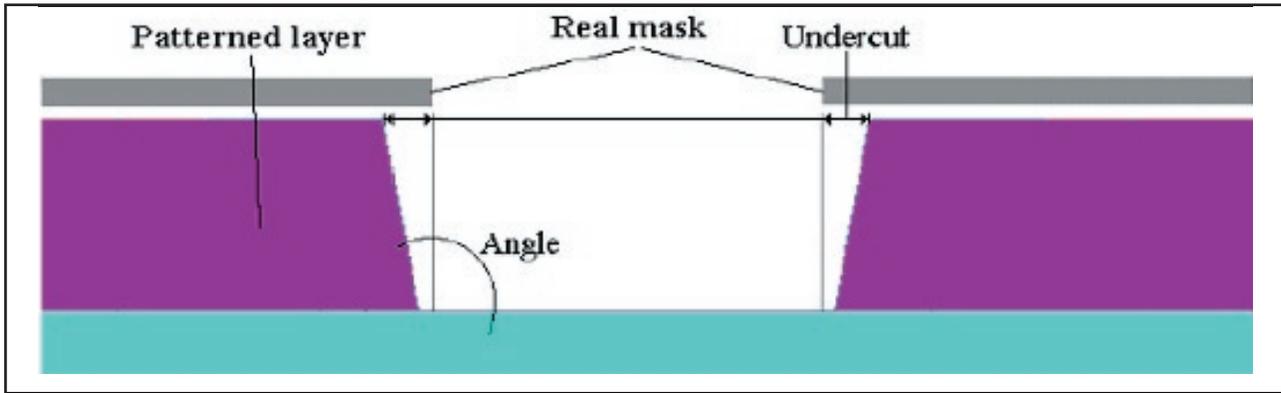


Figure 4. Etching step parameters when using "Patterned layers".

- If the process step depends only on the material(s) to be etched/implanted or oxidized, the user has to set a high value for the Depth parameter, so it will not influence the result. (See etching Figure 4 for an etching example where the Patterned layer is the purple one)
- If the etch/implant or oxidation is done on specific material(s) and with a particular depth, the user will have to specify both a Patterned layer list and Depth value.

Using the Cross-Sectional Viewer

Once the user has defined Cross-Sectional Viewer setup information, he owns a technology file which can be used for any layout of the same technology for generation of cross-sections.

The Cross-Sectional-Viewer consists of two separate dock-windows for its current use:

- The **Cross-Sections** window (see Figure 5) is used to manage the generation of new cross-sections in the opened cell of the layout, and also to switch between existing cross-sections.
- The **Cross-Sectional View** window is the output window (see Figure 6) where cross-sections are displayed with all of the visualization commands of the Cross-Sectional Viewer.

Cross-Sections Generation

Cross-sections can be generated in this way:

- One must click the green '+' button of the **Cross-Sections** window,
- Specify a cut-line in the active cell of the layout either by mouse click, or with XI script command: 'cross view (start_x) (start_y) (end_x) (end_y)'

- After drawing the cut-line, the processing is automatically launched. The **Cross-Sectional View** window displays the calculated cross-section, and the coordinates of the cut-line are displayed in the **Cross-segments** list of the **Cross-Section** window.

The user can repeat this step as many times as he needs to create several cross-sections: they will be stored as long as the project is opened. The cut-line of the active cross-section is highlighted in red (see complete example in Figure 7).

Cross-Sections Visualization

When generating a cross-section, it appears in the **Cross-sectional view** window (see Figure 6).

Beside coordinates, axes, and zoom functions, advanced features are available in this window in order to improve visualization of the materials stacking along the cross-section:

- **Step-by-step** view: The Cross-sectional Viewer has a feature that allows the user to view the individual fabrication processes one step at a time with an actual sequence of process steps. There are four buttons managing this step-by-step view in the **Cross-sectional view** window:
 - **First Operation** and **Last Operation** of the fabrication sequence,
 - **Previous Operation** and **Next Operation** buttons allow seeing respectively the material stack-

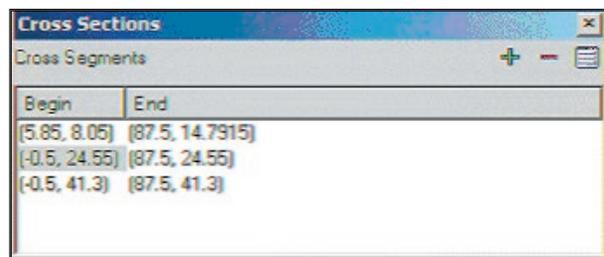


Figure 5. Cross-sections window.

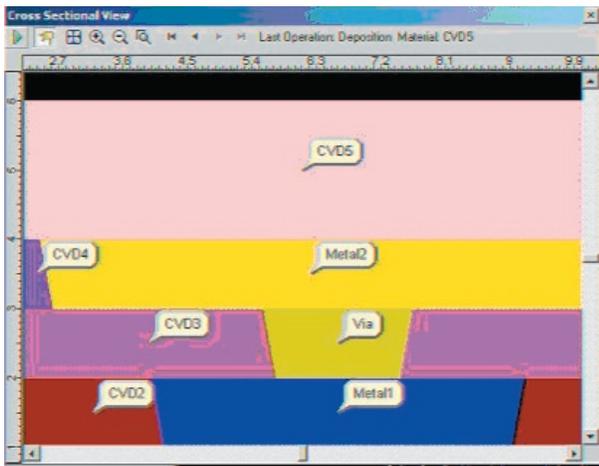


Figure 6. Cross-sectional view window.

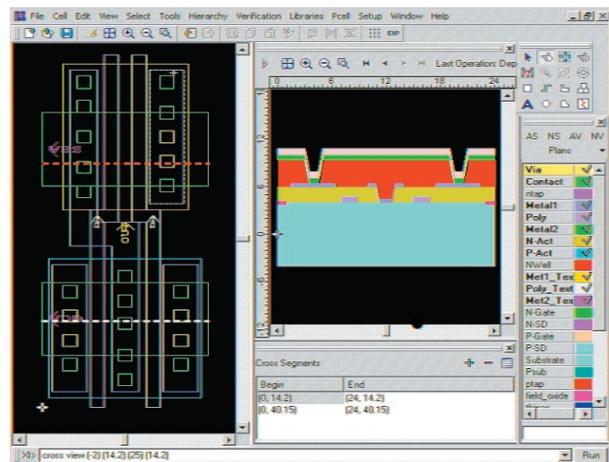


Figure 7. Cross-Sectional Viewer integration in Expert GUI.

ing before and after the current process step. The current process step is detailed on the right side of the **step-by-step** buttons with the **Material** name and the **Operation** name.

- **Cross-sectional view update:** It may be useful to update a cross-section after some changes in the layout or in the process parameters. By clicking the **Update** button (green arrow) in the **Cross-sectional view** window, the user can regenerate the selected cross-section without having to redraw the cut-line.
- **Material labels** button: This feature displays the names of materials wherever you inspect the cross-section. (see Figure 6)

The Cross-Sectional-Viewer and all the features described in this article are available now in the 2006 release of *Expert* (version 4.2.8.R) on Windows, Solaris, and Linux RedHat.