

## Integrating Phoenix FlowDesigner into the Business Model

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### **What is Phoenix FlowDesigner :**

Phoenix FlowDesigner is a very powerful piece of software that bridges the gap between the Design Engineer and the Process Engineer. In its simplest usage the software is a technical/parametric process flow drawing package. The users can store information within a process flow in text and graphics, which allow immediate updates to the flow (without the need to spend hours modifying the whole process). It documents accurately all the fabrication steps within the process allowing a 1<sup>st</sup> Order Process Flow to be available for the Process Engineer. It allows the Process Engineer to document his/her process steps in the database thus simplifying the design input to the flow. It is a geometric process simulation. When the process engineer is fully involved, the software can be used to check for process interactions and can be used as a simple way to check that the process parameters are all compatible.

### **The Design Engineer and Phoenix FlowDesigner :**

Allows design based on process variables and mathematical approximation models. Gives a 1<sup>st</sup> order process flow with complete documentation. Each process step is drawn and therefore can be chosen to be used within the process flow documentation. Simple modification to the flow can be made (a huge saving in time). All data and resulted process images are dimensionally accurate. The data can be stored, modified, and updated at the touch of a key. The Material Database and Etchant Response Database can be extended by the designer based on information from the process engineer. Sections of structures from photomasks files can be used as input. Etching can be checked. All standard processes are accepted. Allows ideas to be tried in software before implementing the process in production – saving time and money.

### **Example File :**

taken from <http://www.phoenixbv.com/examples/oxidation.spt>

### **Summary :**

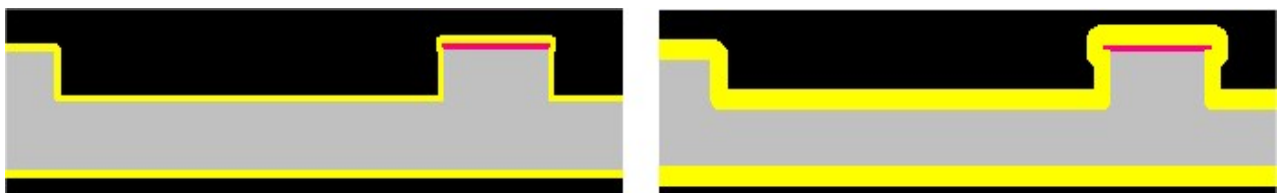
FlowDesigner is equipped with general process models of directional and isotropic etching and deposition. These general models can be used to build custom models, such as the one for oxidation of silicon. This example shows the profile of the wet and dry oxidation process on silicon. The profile is created based on an empirical model called the **Deal-Grove Model of Oxidation**. The Deal-Grove Model of Oxidation is an approximation model to predict oxide thickness prior to growth. This model does not include advanced topics, such as bird's beak forming during a LOCOS process. However this model is a good start for modeling the standard oxidation process. More details concerning geometric simulation can be read in the Phoenix Flow Designer Manual.

### **Reference :**

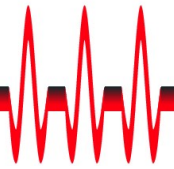
[http://www.phoenixbv.com/Fact\\_sheets/oxidation\\_Deal\\_Grove\\_Model.pdf](http://www.phoenixbv.com/Fact_sheets/oxidation_Deal_Grove_Model.pdf)

### **HTML Report :**

[http://www.phoenixbv.com/Fact\\_sheets/oxidation.html](http://www.phoenixbv.com/Fact_sheets/oxidation.html)



*Illustration 1 Silicon is gray, oxidation layer is yellow. The red layer is inert to etching and oxidation process. Left : dry oxidation. Right : wet oxidation. Both oxidation are done with the same process temperature and duration.*



## The Process Engineer and FlowDesigner :

Creates a 1<sup>st</sup> Order Process Flow with full graphical documentation. Make use of process information directly as input by the Process Engineer. Simple etch process evaluation can show the impact of layer thickness and feature proximity. It does not negate the need to do full 3-D process modeling however it will pinpoint the locations where this modeling may be necessary. It stores the process flow in a form that can be archived and/or modified at a later date. Allows simple process mistakes to be made in the simplified model and therefore reduces product iteration. Allows process variations to be tried first in software removing all the fundamental issues.

### Example File :

taken from [http://www.phoenixbv.com/examples/verification\\_example.spt](http://www.phoenixbv.com/examples/verification_example.spt)

### Summary :

One important activity in design is checking the tolerances. For example check the mask (alignment) tolerances which are easily implemented in FlowDesigner by using variables and for-loop statements. This example deals with tolerance analysis for mask alignment. We introduce variable `dx4` which define the size of the fourth opening of `mask4`.

```
var mask4[4]= {-100, -55, 45, 100-dx4};
```

The `mask4` is used to etch the metal (pink). Over-etched happens when the `mask4`'s openings are too big.

### HTML Report :

[http://www.phoenixbv.com/Fact\\_sheets/verification\\_example.html](http://www.phoenixbv.com/Fact_sheets/verification_example.html)

Illustration 2 below shows the hole in the final profile because of over-etched on metal.



Illustration 2 Over-etched when the fourth opening of mask 4 is too big ( $dx4=0$ ).

Illustration 3 below shows the correct profile when the openings' size of `mask4` are sufficient.



Illustration 3 Final profile with sufficient openings size of mask4 ( $dx4=5 \mu$ ).