Hints, Tips and Solutions

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Q: Can *ATHENA* get the STRESS in Compound Advanced material?

A: The ***ATHENA*** STRESS command has been augmented to allow the 2 Dimensional stress distribution. To get the STRESS, the simple SiO2/GaAs/AlGaAs Optical waveguide was considered.

When the temperature difference is -400 C, then the command is:

```
STRESS TEMP1=430 TEMP2=30
```

And to get the stress, the material parameters need for the SiO2, GaAs, AlGaAs as Table 1.

	GaAs	AlxGa1-xAs	SiO2
Young.m dynes/cm2	8.538e11	(8.53-0.18x)e11	7.679e11
Poission Raio	0.31	0.31+0.1x	0.186
Linear Coefficient of Thermal Expansion /K	5.73e-6	(5.73-0.53x)e-6	5.4e-7

Table 1. Material Parameters for Stress.

As the all material parameter of the AlxGa1-xAs depends on the mole fraction, in Deckbuild, the SET command is useful for the definition of the material parameters as like,

```
# for AlxGa1-xAs
set xcomp=0.3
material algaas Young.m=((8.53-
  0.18*$xcomp)*1e11)
material algaas Poiss.r=(0.31+0.1*$xcomp)
material algaas lcte=((5.73-
  0.53*$xcomp)*1e-6
```

Then the stress distribution shows in Figure 1. Figure 1 (a) shows the Stress X and (b) shows the Stress Y. And the magnitude of positive is the compressive strss and the negative is the tensile stress.

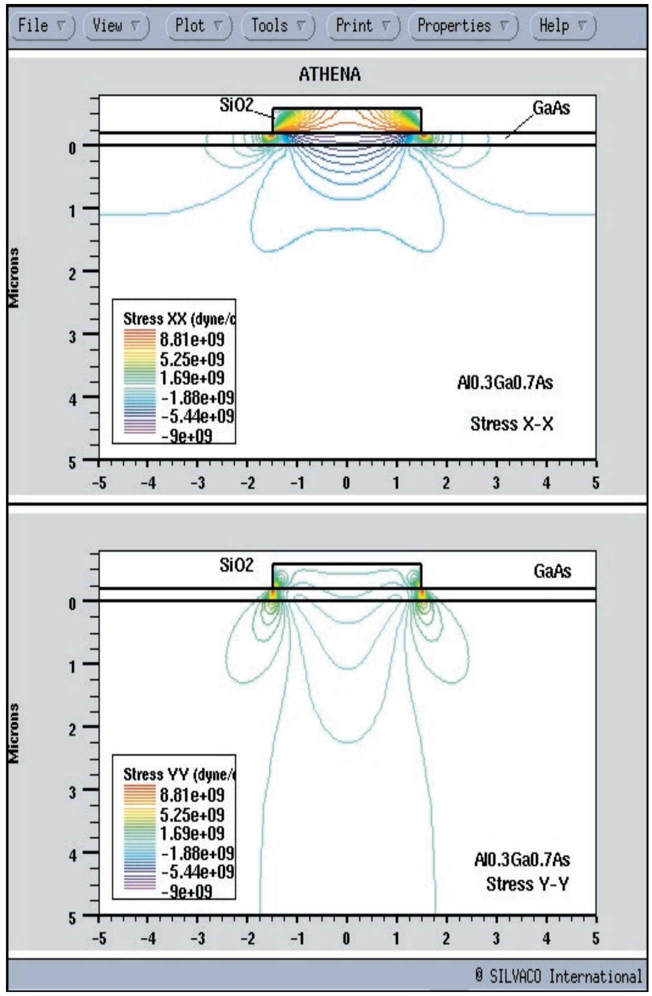

Figure 1. (a) Stress Distribution STRESS X
(b) Stress Distribution STRESS Y

Q: How can I take account of a deliberately mis-cut starting wafer orientation when using the process simulator in *ATHENA*?

A: A number of fabrication facilities now use a starting wafer surface crystal orientation which is deliberately mis-cut a few degrees off the <100> axis in order to perform vertical implants whilst minimizing channelling effects.

The usual solution for the prevention of channelling effects is to implant the wafer at an angle of approximately 7 degrees off the vertical axis which is sometimes also combined with a wafer rotation of around 30 degrees.

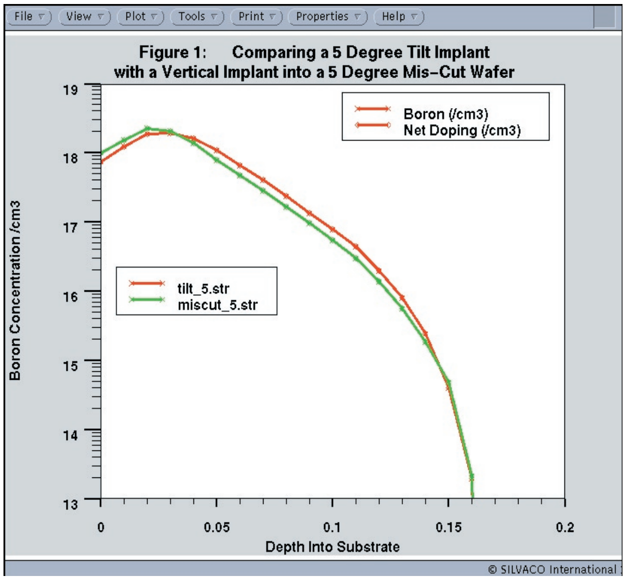

Figure 2. Comparing a 5 degree tilt boron implant into a standard <100> wafer with a zero degree tilt implant into a wafer mis-cut by 5 degrees.

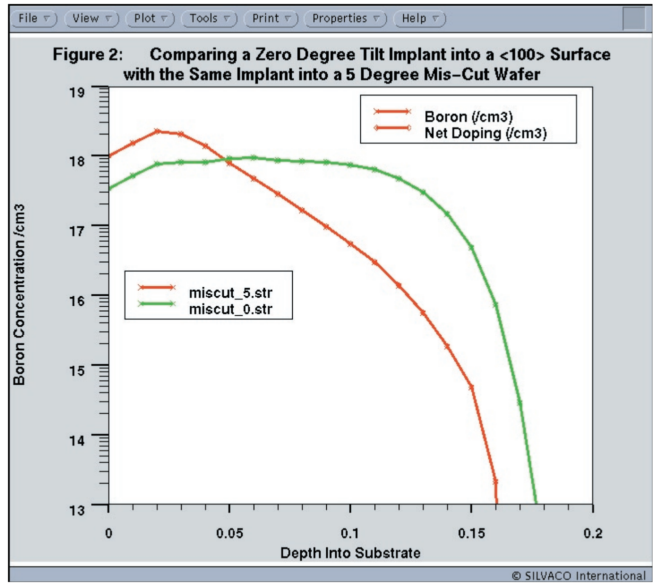

Figure 3. Comparing a zero degree tilt boron implant into a standard <100> wafer with the same zero degree tilt implant into a wafer mis-cut by 5 degrees.

Implanting at an angle of 7 degrees can be undesirable since the asymmetry of the implant for very aggressive technologies, can become a significant fraction of the total gate length. Implanting into high aspect ratio trenches also requires vertical implants. To regain dopant profile symmetry using vertical implants without dopant channelling deep into the wafer, substrate manufacturers now offer wafers where the surface crystal orientation is no longer <100>, but is deliberately mis-cut at an angle. Vertical implants will therefore no longer channel.

The problem now arises when using process simulators because the surface of the wafer is expected to have a <100> or <111> crystal orientation. If the actual wafer used in the fabrication is deliberately mis-cut a few degrees, a simulated vertical implant will give significant errors in implantation profiles.

Other crystal orientation dependent processes, such as oxidation rates etc, that are already crystal orientation dependent in the simulator are not effected to a major degree because the actual mis-cut angles are only a few degrees, so the errors here are minimal and need not be considered.

SSuprem in ***ATHENA*** now allows the specification of mis-cut wafers in the Monte-Carlo implant statement. The mis-cut angle is specified by two parameters:

`MISCUT.TH` specifies the tilt angle in the XY plane, and

`MISCUT.PH` specifies the rotation angle in the XZ plane.

The syntax can be specified by comparing implant profiles, where the tilt angle in a normal implant is replaced by a mis-cut wafer angle of the same magnitude and a vertical implant is specified. The results of such a cross check simulation are shown in Figure 2. These two simulations were identical apart from the two implant statements. The first statement specifies an implant with 5 degrees tilt angle into a normal <100> orientation wafer, whilst the second implant specifies a vertical implant into a wafer that is mis-cut by the same 5 degree angle.

```
implant boron energy=5 dose=1e13 tilt=5
  rot=0 bca miscut.th=0 sampling

implant boron energy=5 dose=1e13 tilt=0
  rot=0 bca miscut.th=5 sampling
```

The importance of specifying the wafer mis-cut angle is shown in Figure 3, where a vertical implant into a wafer that is mis-cut by 5 degrees is compared to the same vertical implant where the user did not specify that the wafer was deliberately mis-cut.

Call for Questions

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