Hints, Tips and Solutions

William French Ph.D., Applications and Support Manager

Q: Can ATLAS simulate an SEU event in 2D ? To simulate a single event upset (SEU) is inherently a 3D problem because the alpha particle may strike the chip at any arbitrary angle to the chip surface. Silvaco's 3D device simulator Device3D incorporates sophisticated algorithms to model this process accurately. However, it is possible to do this simulation in 2D with ATLAS but it should be remembered that this is only an approximation.

A: One method within ATLAS to simulate a particle strike in 2D involves the use of the C-Interpreter capability of ATLAS. This feature allows the user to write a simple C-coded ascii file that describes the generation rate of carriers (per cc per sec) as a function of location x (microns), location y (microns) and time t (secs). The C-Interpreter file is specified on the BEAM statement very simply as

```
BEAM F.RADIATE=RADIATE.LIB
```

where the file RADIATE.LIB contains the C-code.

To illustrate this with a simple example the MOSFET structure of Figure 1 was first generated. An alpha particle strike through the drain region, at 90 degrees to the surface, was modelled with the following C-interpreter model:

```
int radiate(double x,double y,double
t,double *rat)
   {
        double GEN;
        GEN = 1e20;
        if ((x>2.3) && (x<2.35)) {
           if ( (t >= 20e-12) && (t<=40e-12) )
{
              *rat = GEN;
        }
           }
           else {
           *rat = 0;
           }
        return(0);
        /* 0 - ok */
}
```

This defines that the strike occurs between t=20 ps and t=40 ps and the generation rate is a simple delta function between 0 and GEN cm-3 s-1. The strike is limited between x=2.3um and 2.35um and travels from the top of the structure to the bottom.

The ATLAS syntax to define the transient is quite simple- and in this example is :

```
SOLVE B1=1 TFINAL=1E-6 DT=1E-12
```

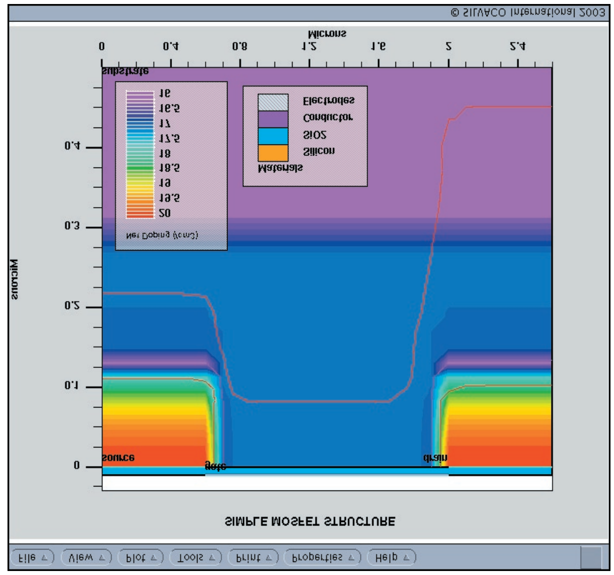

Figure 1. Simple 2D MOSFET structure for the alpha particle strike simulation. The drain bias is 3.3V so the depletion regions extend into the bulk as shown.

It should be noted that the GEN parameter in the C-code is multiplied by the value of the B1 parameter on the SOLVE statement.

Figure 2 shows the resultant drain current versus time plot of this strike for B1=1, 1e2 and 1e5. The gate is initially off and the drain voltage is at 3.3V. The familiar SEU current pulse profiles are obtained.

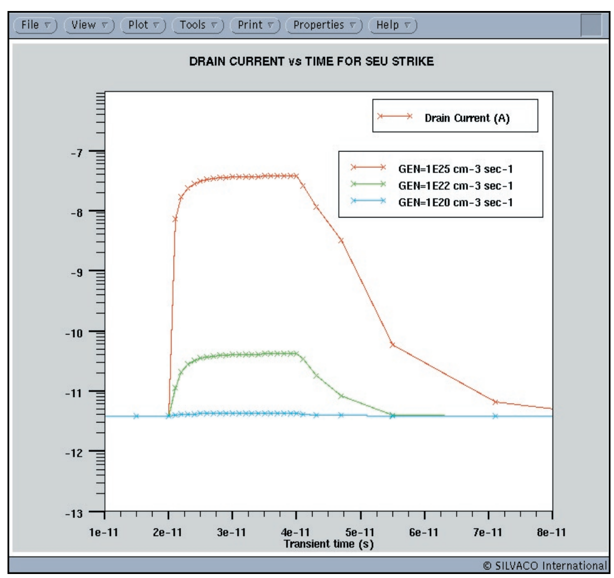

Figure 2. Simulated drain curent versus time for 3 separate particle strikes. The generation rate (or particle energy) was varied as

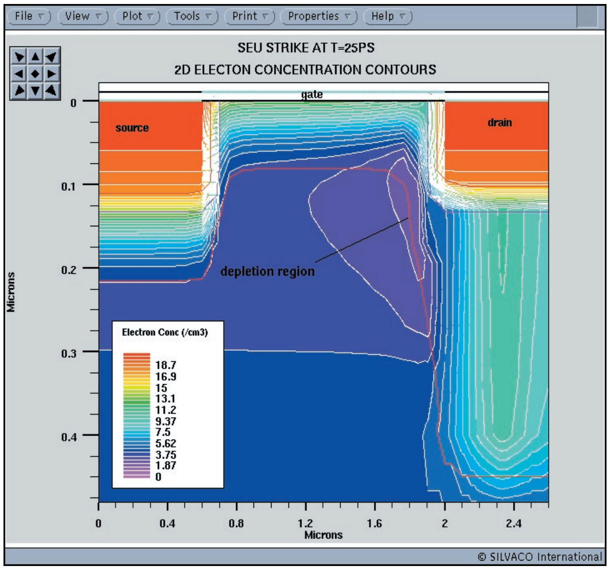

Figure 3. 2D Contours of electron concentration during the particle strike.

Figure 3 shows a plot of the electron concentration at time t=25 ps. The generated electrons are observed below the drain contact. As the generation occurs within the shown depletion region, the carriers are swept very quickly to the source and drain.

References

1. *ATLAS User's Manual.*