EEE 533: Semiconductor Device and Process Simulation

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Silvaco Energy Balance Model Example 2.5mos2ex05.in

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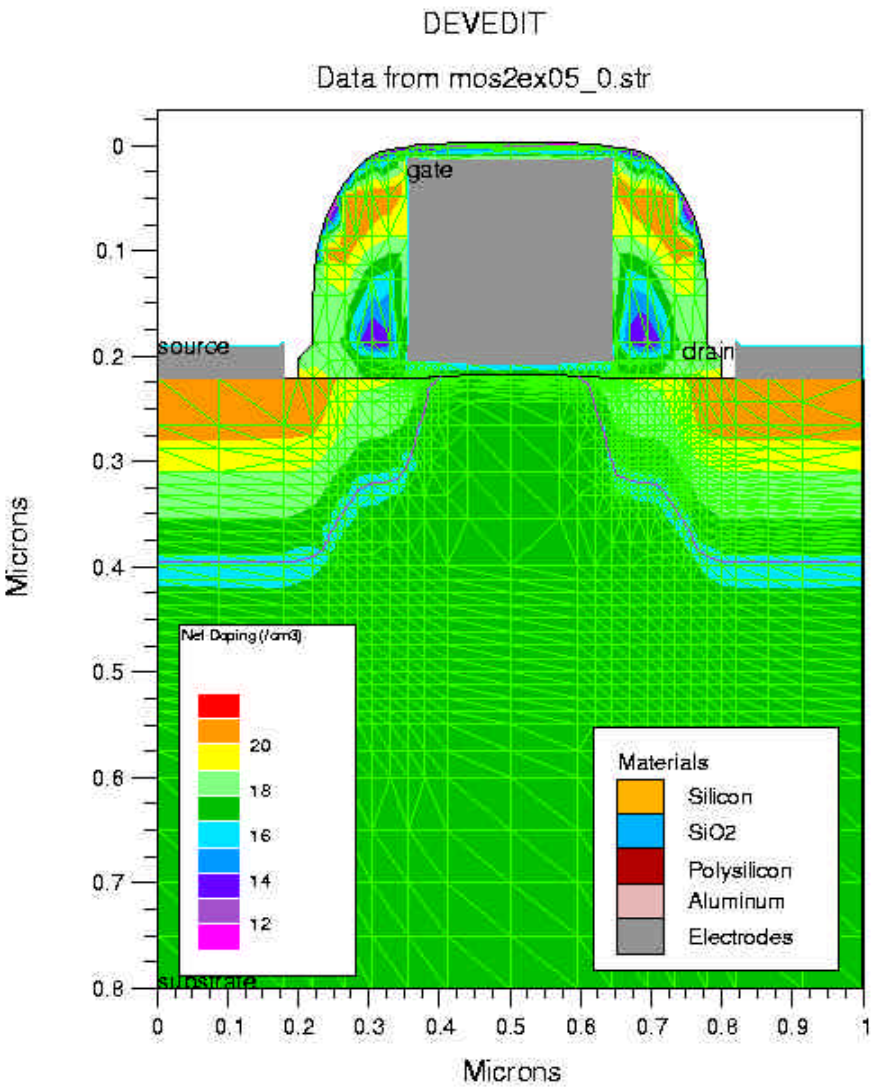
Energy Balance Model Example Description

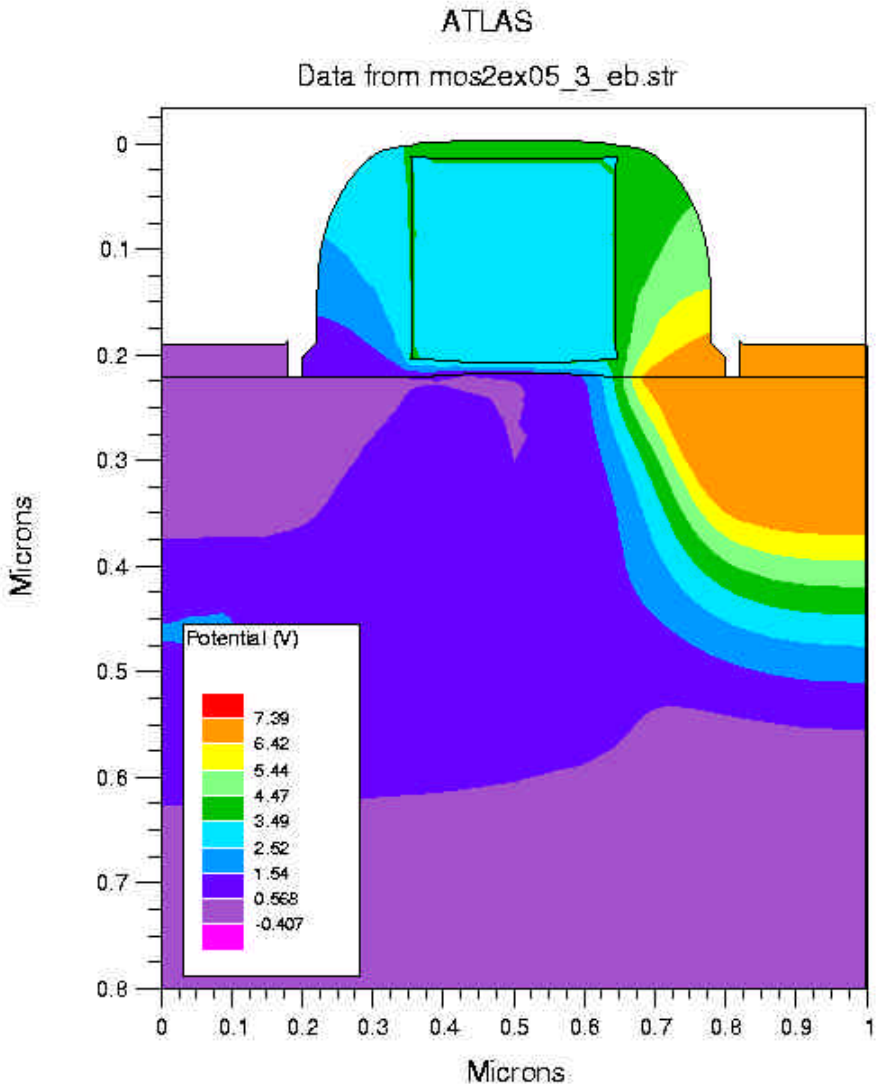
- The following is part of the commands used in the example 2.5mos2ex05.in, which gives a comparison of the I_D-V_{DS} characteristics for the case when using the EB and NEB models.
- Important features of this example are:
  - The MATERIAL statement is used to assign the energy relaxation times
  - The MODELS statement is used to select the physical models used
  - The IMPACT statement is used to assign the energy relaxation length for the Selberherr model
- Only parts of the listing that are relevant for the device simulation part are extracted below.

```
# This is the energy balance model simulation part
#########################################
go atlas
material taurel.el=0.2e-12 taumob.el=0.2e-12
models  bgn cvt hcte.el  consrh auger print
impact  selb length.rel lrel.el=0.02
contact name=gate n.poly
solve init
method newton maxtrap=6 temp.tol=1.e-4 trap
output e.velocity
solve vgate=0.1
solve vgate=0.3
solve vgate=0.5 vstep=0.5 vfinal=3 name=gate
solve vgate=3
# Id-Vd caculations with EB model
log outf=mos2ex05_3_eb.log master
method newton trap maxtrap=6  temp.tol=1.e-4
solve vdrain=0.00625
solve vdrain=0.0125
solve vdrain=0.025
solve vdrain=0.1 vstep=0.1 vfinal=1 electr=3
method  newton trap maxtrap=6  temp.tol=1.e-4
solve vdrain=1.1 vstep=0.2 electr=3 vfinal=8.3 compliance=1.6e-3
   cname=drain
save outf=mos2ex05_3_eb.str
```

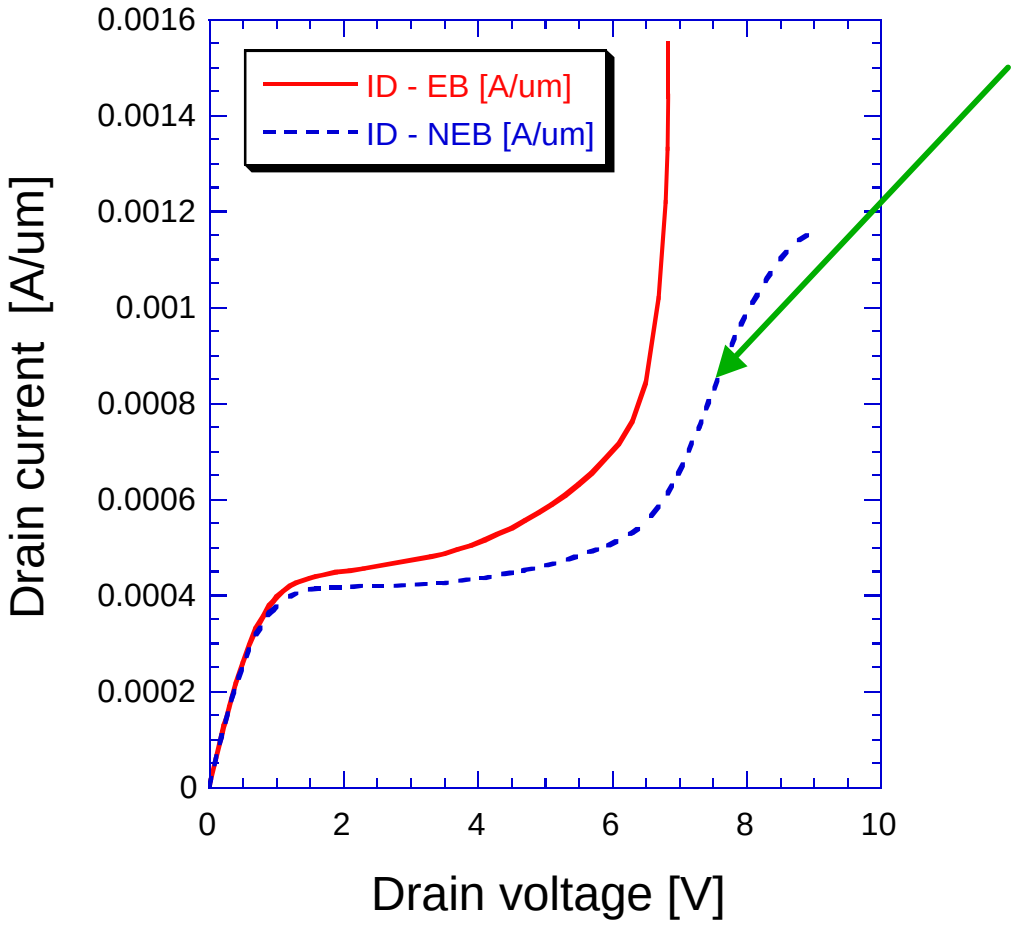
```
# This is the non-isothermal energy balance model simulation part
#######################################################
go atlas
material  taurel.el=0.2e-12 taumob.el=0.2e-12
models    bgn cvt hcte.el  lat.temp consrh auger print
impact  selb  length.rel  lrel.el=0.02
contact name=gate n.poly
thermcontact num=1 x.min=0 x.max=1 y.min=0.799 y.max=0.802 \
   alpha=3000
solve init
method  newton trap maxtrap=6  temp.tol=1.e-4
output e.velocity
solve vgate=0.1
solve vgate=0.3
solve vgate=0.5 vstep=0.5 vfinal=3 name=gate
solve vgate=3
# Id-Vd caculations with NEB model
log outf=mos2ex05_3_neb.log master
method newton trap maxtrap=6  temp.tol=1.e-4
solve vdrain=0.00625
solve vdrain=0.0125
solve vdrain=0.025
solve vdrain=0.1 vstep=0.1 vfinal=1 electr=3
method  newton trap maxtrap=6  temp.tol=1.e-4
solve vdrain=1.1 vstep=0.2 electr=3 vfinal=9.1
save outf=mos2ex05_3_neb.str
```

Representative data:





Representative data:



Thermal self-heating effects lead to a reduction of the *electron mobility* and *impact ionization rate* which, in turn, leads to smaller drain current.