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$ TSUPREM-4 N-channel MOS application
$
$ 1. Identify the graphics driver
$ Default from DEFPDEV, TERM, or S4PCAP default entry used

$ 2. Specify the mesh

MESH GRID.FAC=1
MESH DY.SURF=0.01 LY.SURF=0.04 LY.ACTIV=2.0

$ 3. Initialize

INITIALIZE <100> BORON=1E15 WIDTH=1.7 DX=0.1
SELECT          TITLE="Starting Wafer"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE          COLOR=5
COLOR           POLY           COLOR=3
COLOR           ALUMI          COLOR=2

$ 4. Plot the initial mesh

SELECT TITLE="Initial Mesh"
PLOT.2D SCALE GRID Y.MAX=3.0 C.GRID=2

$ 5. Initial oxide pad

DIFFUSE          TEMP=1000 TIME=5 DRYO2
DIFFUSE          TEMP=1000 TIME=9.5 WETO2
DIFFUSE          TEMP=1000 TIME=5 DRYO2
DIFFUSE          TEMP=1000 TIME=20 INERT

SELECT          TITLE="Oxide Pad"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE          COLOR=5
COLOR           POLY           COLOR=3
COLOR           ALUMI          COLOR=2


$ 6. Punchthrough Implant

IMPLANT          PHOSPHOR DOSE=1.2E12 ENERGY=145
SELECT Z=LOG10(PHOSPHOR) TITLE="Punchthrough Ph Implant"
PLOT.1D X.VALUE=1.6 RIGHT=3 BOTTOM=15 TOP=19 COLOR=2
LABEL X=1.8 Y=18.2 LABEL="After Vt implant" LINE.TYP=1 C.LINE=2
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$ 7. P-well implant

METHOD          PD.TRANS
IMPLANT           BORON DOSE=3E12 ENERGY=80
SELECT Z=LOG10(BORON) TITLE="Boron P-well implant"
PLOT.1D X.VALUE=1.6 RIGHT=3 BOTTOM=15 TOP=19 COLOR=2


$ 8. Etch Oxide completely

ETCH            OXIDE ALL
SELECT            TITLE="Etching oxide completely"
PLOT.2D            BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE          COLOR=5
COLOR           POLY          COLOR=3
COLOR           ALUMI          COLOR=2



$ 9. P-well drive in

DIFFUSE TEMP=1150 TIME=240 DRYO2
DIFFUSE           TEMP=1150 TIME=300 INERT


$ 10. P-well doping profile

SELECT Z=LOG10(BORON) TITLE="P-well Doping after well drive in"
PLOT.1D X.VALUE=0 RIGHT=3.0 BOTTOM=15 TOP=19 LINE.TYP=2 COLOR=2



$ 11. Pad oxidation/nitride deposition after stching oxide off

ETCH            OXIDE ALL
DIFFUSE           TEMP=950 TIME=60 DRYO2
DIFFUSE           TEMP=950 TIME=20 INERT
DEPOSIT NITRIDE THICKNESS=0.1
SELECT            TITLE="After pad oxide/nitride deposition"
PLOT.2D            BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE          COLOR=5
COLOR           POLY          COLOR=3
COLOR           ALUMI          COLOR=2
COLOR            NITRIDE COLOR=9


$ 12. Field implant and oxidation

IMPLANT BORON DOSE=1E13 ENERGY=100
SELECT Z=LOG10(BORON) TITLE="Field Implant profile"
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PLOT.1D X.VALUE=0.01 RIGHT=3 BOTTOM=15 TOP=19 COLOR=2
ETCH         NITRIDE LEFT P1.X=0.001
DIFFUSE TEMP=950 TIME=5 DRYO2
DIFFUSE         TEMP=950 TIME=280 WETO2
DIFFUSE TEMP=950 TIME=5 DRYO2
DIFFUSE TEMP=950 TIME=20 INERT
SELECT         TITLE="After field implant and field oxidation"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR         SILICON         COLOR=7
COLOR         OXIDE         COLOR=5
COLOR         POLY         COLOR=3
COLOR         ALUMI         COLOR=2
COLOR         NITRIDE COLOR=9
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$ 13. Etch to remove the nitride pad
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ETCH NITRIDE ALL
SELECT         TITLE="After etching the nitride away"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR         SILICON         COLOR=7
COLOR         OXIDE         COLOR=5
COLOR         POLY         COLOR=3
COLOR         ALUMI         COLOR=2
COLOR         NITRIDE COLOR=9
```

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$ 14. Sacrificial Oxide growth
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DIFFUSE         TEMP=950 TIME=30 DRYO2
DIFFUSE TEMP=950 TIME=20 INERT
SELECT         TITLE="After sacrificial oxide growth"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR         SILICON         COLOR=7
COLOR         OXIDE         COLOR=5
COLOR         POLY         COLOR=3
COLOR         ALUMI         COLOR=2
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$ 15. Vt adjust implant
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IMPLANT BORON ENERGY=30 DOSE=9E11
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$ 16. P-well doping profile
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SELECT Z=LOG10(BORON) TITLE="P-well profile after Vt adjust implant"
PLOT.1D X.VALUE=1.6 RIGHT=3 BOTTOM=15 TOP=19 COLOR=2
```

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$ 17. Etch oxide

ETCH OXIDE TRAP THICK=0.05
SELECT          TITLE="After oxide etching"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


$ 18. Gate oxidation

DIFFUSE TEMP=950 TIME=120 DRYO2
DIFFUSE         TEMP=950 TIME=20 INERT
SELECT          TITLE="After Gate Oxidation"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


$ 19. Poly-Si deposition

DEPOSIT POLYSILICON THICKNESS=0.45 DIVISIONS=4
SELECT          TITLE="After Poly Si Deposition"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


$ 20. Capacitor formation steps

DIFFUSE         TEMP=950 TIME=55 DRYO2
DIFFUSE         TEMP=950 TIME=20 INERT
DEPOSIT         POLYSILICON THICKNESS=0.45 DIVISIONS=4
SELECT          TITLE="After oxidation and poly deposition for
capacitor"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2
```

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$ 21. Poly and oxide etch

ETCH          POLY ALL
ETCH          OXIDE ALL
SELECT          TITLE="After top poly and oxide etch"
PLOT.2D          BOUNDARY AXES Y.MAX=3
COLOR          SILICON          COLOR=7
COLOR          OXIDE          COLOR=5
COLOR          POLY          COLOR=3
COLOR          ALUMI          COLOR=2


$ 22. Poly etch between x = 0.0 and 1.1 microns

ETCH POLY LEFT P1.X=1.1
SELECT          TITLE="After poly etch for gate definition"
PLOT.2D          BOUNDARY AXES Y.MAX=3
COLOR          SILICON          COLOR=7
COLOR          OXIDE          COLOR=5
COLOR          POLY          COLOR=3
COLOR          ALUMI          COLOR=2


$ 23. n+ Source/drain implant and anneal

IMPLANT ARSENIC ENERGY=160 DOSE=5E15
DIFFUSE          TEMP=925 TIME=75 INERT


$ 24. Oxide etch on S/D regions

ETCH OXIDE THICK=0.06
SELECT          TITLE="After oxide etch on S/D regions"
PLOT.2D          BOUNDARY AXES Y.MAX=3
COLOR          SILICON          COLOR=7
COLOR          OXIDE          COLOR=5
COLOR          POLY          COLOR=3
COLOR          ALUMI          COLOR=2


$ 25. Use an oxidation model that understands polysilicon

METHOD COMPRESS


$ 26. Source/drain reoxidation (including the polysilicon gate)
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DIFFUSE TEMP=900 TIME=30 DRYO2
SELECT          TITLE="After S/D reoxidation"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


$ 27. PSG deposition and etch to open windows for aluminum contact

DEPOSIT OXIDE THICK=0.7
DIFFUSE         TEMP=950 TIME=30 INERT
ETCH            OXIDE START X=0.7 Y=-1
ETCH            CONTINUE X=0.9 Y=-1
ETCH            CONTINUE X=0.9 Y=0.25
ETCH            DONE X=0.7 Y=0.25
SELECT          TITLE="After PSG deposition and etch to open S/D
contacts"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


$ 28. Metallization -- etch to create a source contact

DEPOSIT ALUMINUM THICK=0.9 SPACES=5
DEPOSIT PHOTORESIST THICK=1.0
ETCH            PHOTORESIST RIGHT P1.X=1.2
ETCH            ALUMINUM TRAP ANGLE=85 THICK=1.6
ETCH            PHOTORESIST ALL

$ 29. Plotting the final device structure

SELECT          TITLE="Final half device after metallization"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR           SILICON         COLOR=7
COLOR           OXIDE           COLOR=5
COLOR           POLY            COLOR=3
COLOR           ALUMI           COLOR=2


SELECT          Z=LOG10(BORON)
FOREACH         VAL (14 TO 21 STEP 1)
        CONTOUR         VALUE=VAL LINE=5 COLOR=2
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END

SELECT          Z=LOG10(ARSENIC)
FOREACH         VAL (16 TO 21 STEP 1)
       CONTOUR          VALUE=VAL LINE=2 COLOR=4
END


$ 30. Extract Gate Oxide thickness

%EXTRACT POLY X=1.6 DISTANCE=0.001 Y.EXTRACT NAME=YPOLY
EXTRACT          OXIDE P1.X=1.6 P1.Y=@{YPOLY} THICKNES

$ 31. Extract S/D Junction depths

SELECT          Z=DOPING
EXTRACT          SILICON X=0.8 VALUE=0.0 D.EXTRAC

$ 32. Plot the doping profile in channel

SELECT Z=LOG10(BORON) TITLE="Final Boron Doping in channel"
PLOT.1D X.VALUE=1.7 RIGHT=3 BOTTOM=15 TOP=19 COLOR=2

$ 33. Reflect to form the complete structure; then save it

SAVEFILE OUT.FILE=nmosfull
STRUCTURE REFLECT RIGHT
SAVEFILE OUT.FILE=nmosinput MEDICI

$ 34. Plot the complete device

SELECT          TITLE="Final device after reflection through the
middle"
PLOT.2D         BOUNDARY AXES Y.MAX=3
COLOR          SILICON          COLOR=7
COLOR          OXIDE          COLOR=5
COLOR          POLY          COLOR=3
COLOR          ALUMI          COLOR=2

SELECT          Z=LOG10(BORON)
FOREACH         VAL (14 TO 21 STEP 1)
       CONTOUR          VALUE=VAL LINE=5 COLOR=2
END

SELECT          Z=LOG10(ARSENIC)
FOREACH         VAL (16 TO 21 STEP 1)
       CONTOUR          VALUE=VAL LINE=2 COLOR=4
END
```