3C-SiC on Si Lateral Power Devices

Technical Progress & Future Plan

THE UNIVERSITY OF WARWICK

EPSRC

Fan Li
Yogesh Sharma
Phil Mawby
07/04/2014

Introduction

Device theme

Lateral Schottky diode

Lateral MOSFET

Lateral RESURF 3C-SiC SBD

Cathode (Ohmic)

Anode (Schottky)

Metal	
N+ 3C-SiC	
N 3C-SiC	
Oxide	
P Si Substrate	

15 μm

6 μm

15 μm

1 μm

Ni

TEOS

Ni

4 μm

N+ 3C-SIC (1e19 cm-3)

30 μm

25 μm

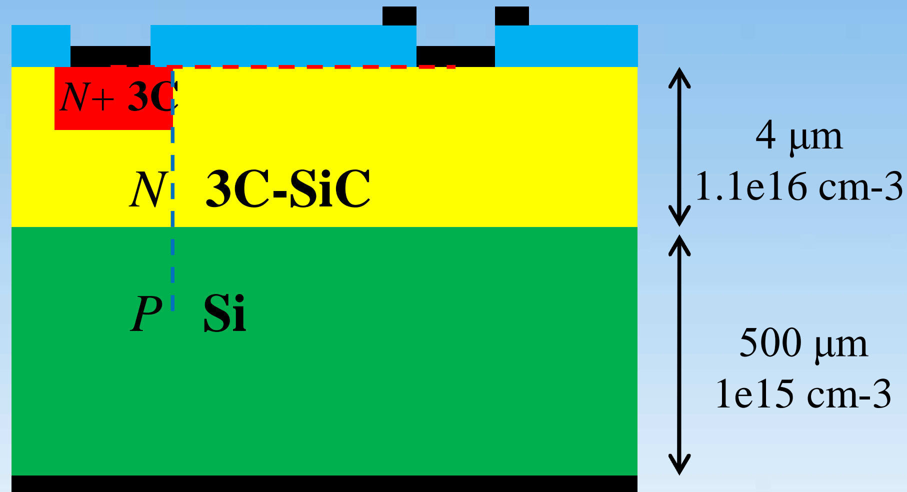
N 3C-SiC (1.1e16 cm-3)

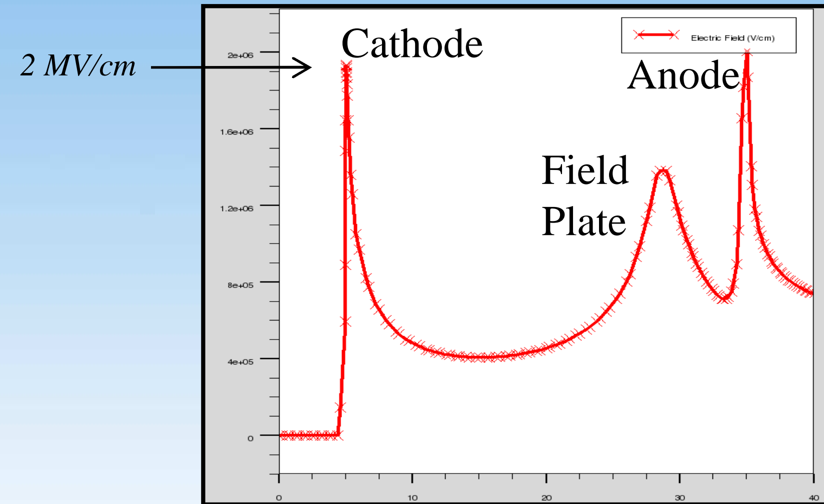
P Si (1e15 cm-3)

500 μm

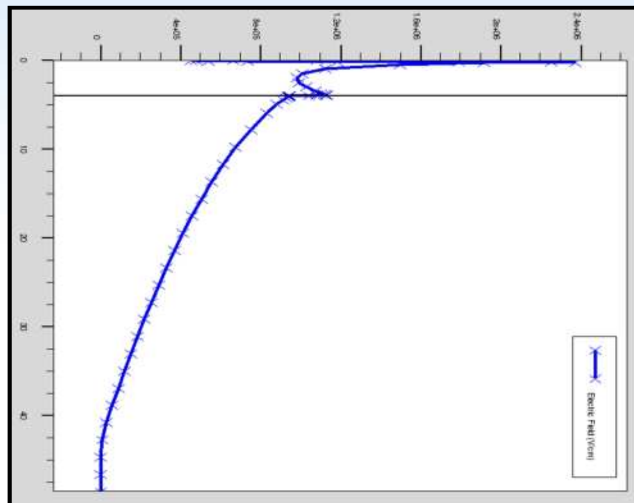
Al

2D Device Modelling





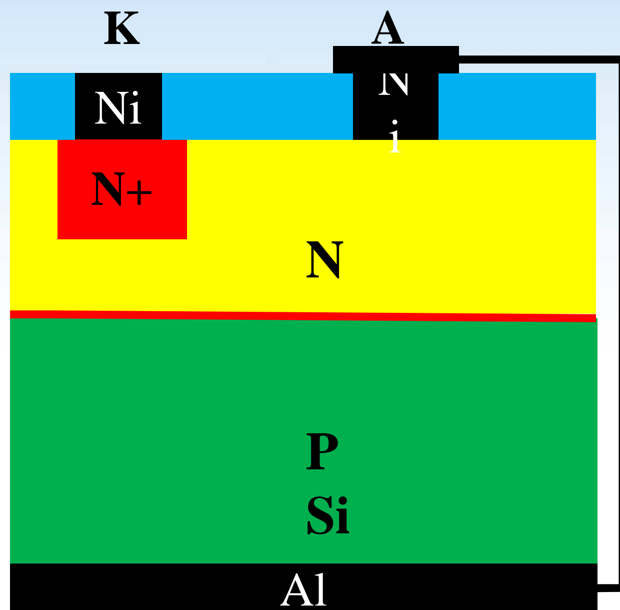
Lateral Electric Field at Contact Interface

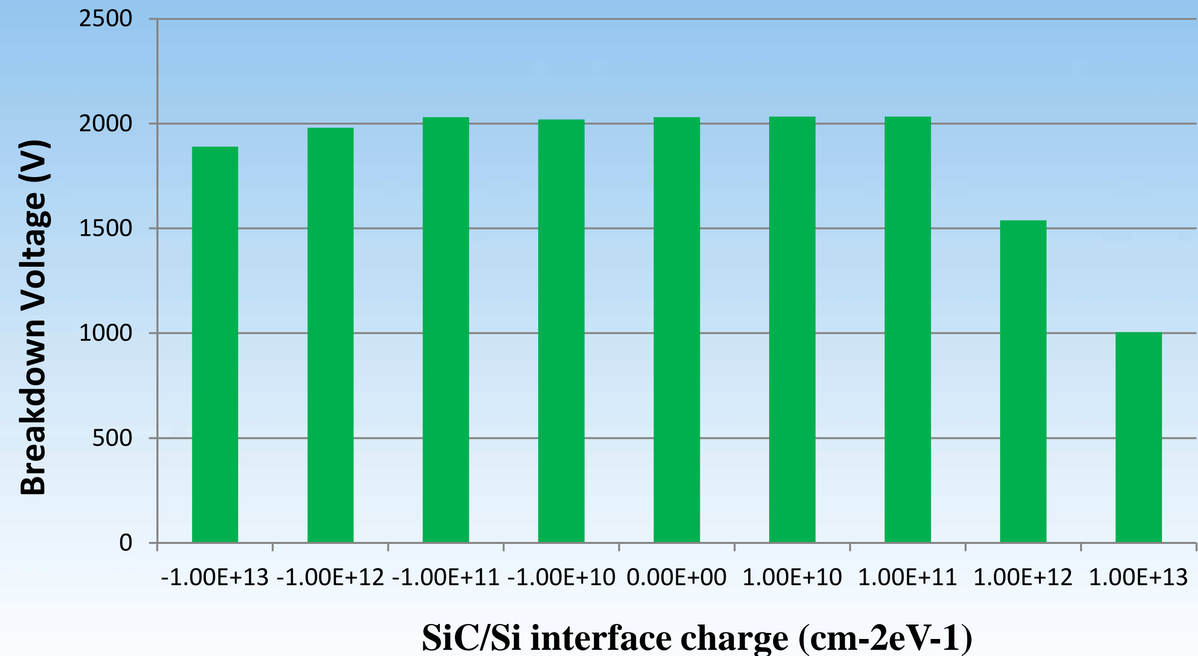


Vertical Electric Field

2D simulation showed promising results: breakdown voltage of 1870 V and forward current density of 426 A/cm2.

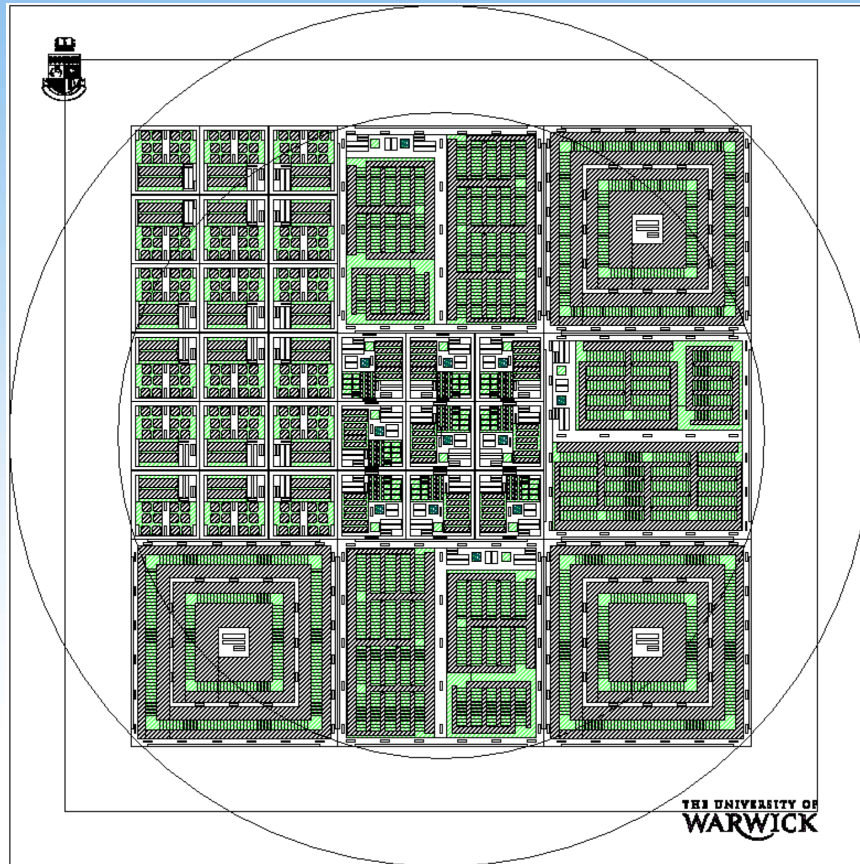
Charge at the SiC/Si interface





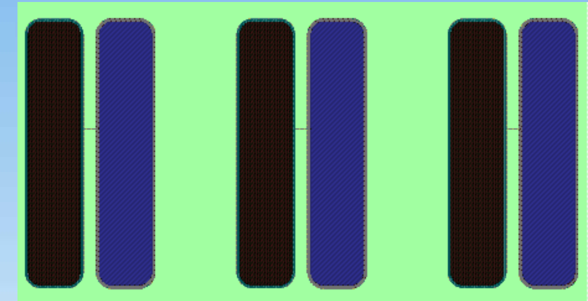
Positive charge at SiC/Si interface proved to be more influential in breakdown voltage

Mask Design for Lateral SBD

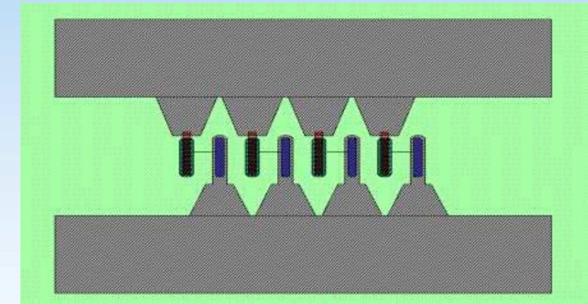


Mask design of the lateral Schottky diode, devices rated in orders of 10mA to more than 10 A are included.

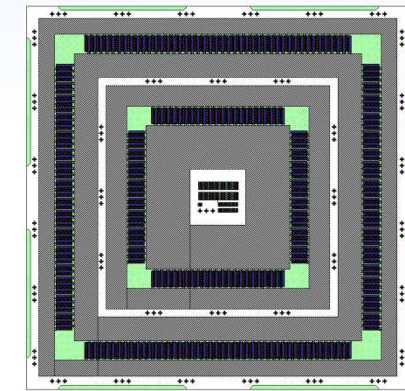
Single Cells



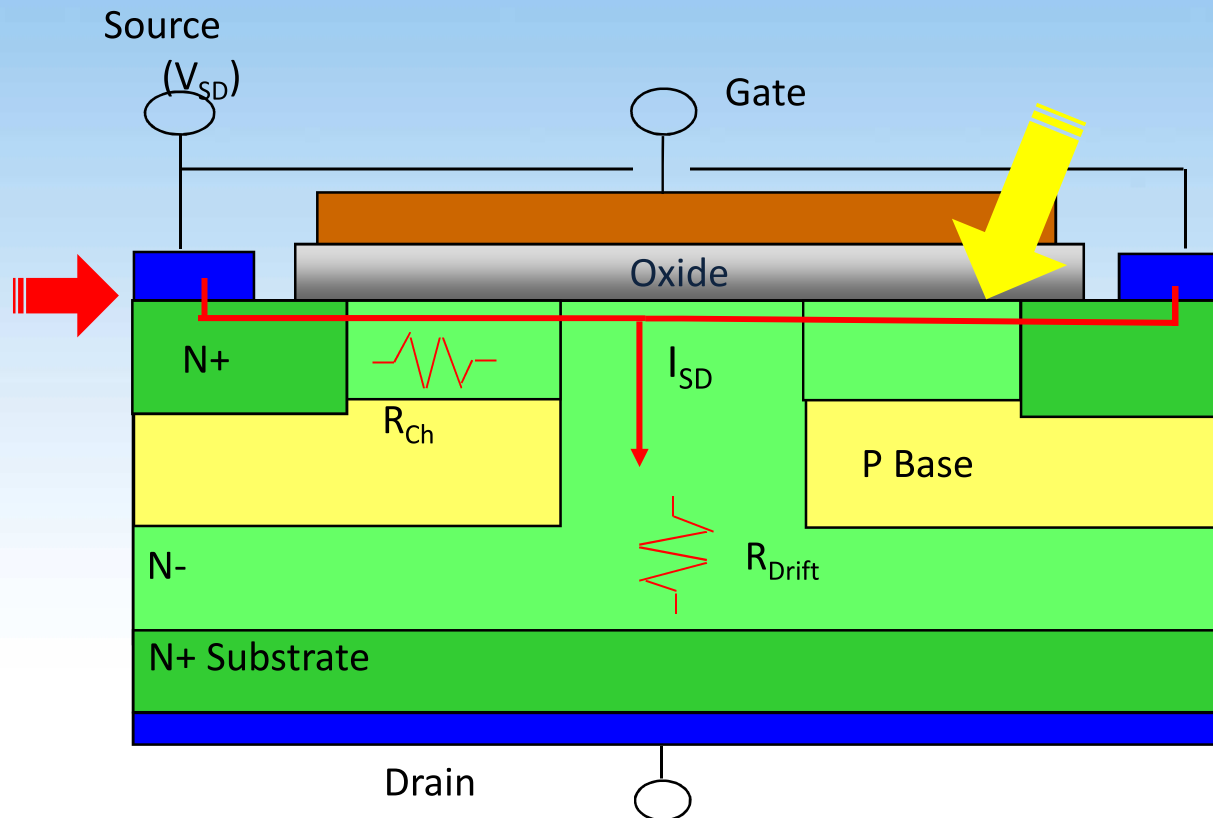
Small Device



Big Device Containing 176 Cells

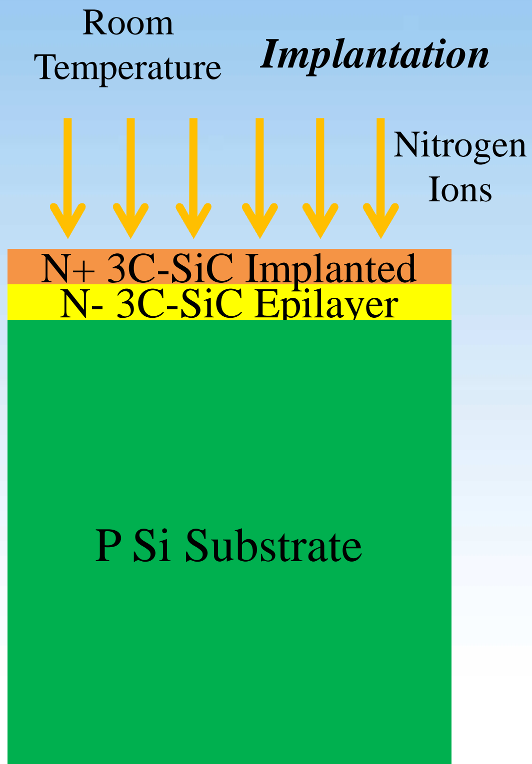


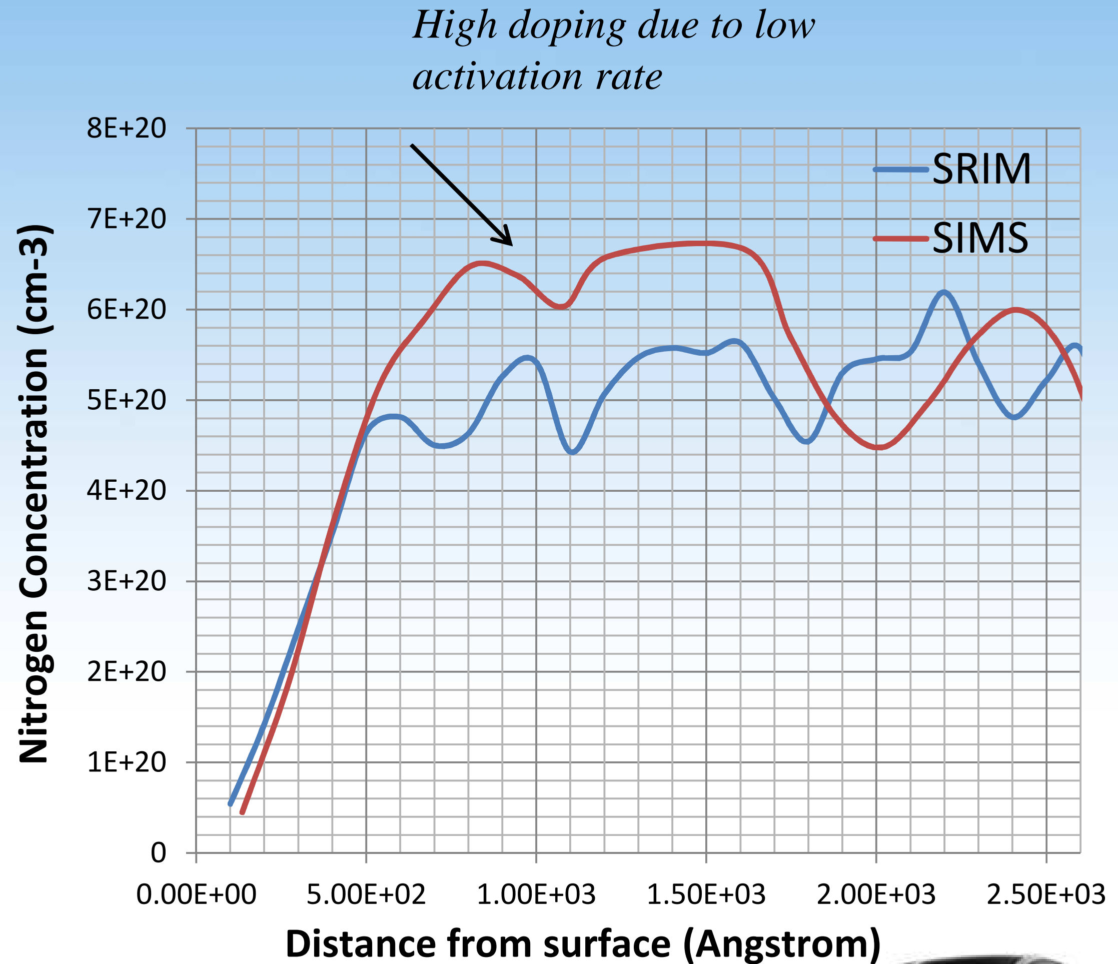
Lateral MOSFET



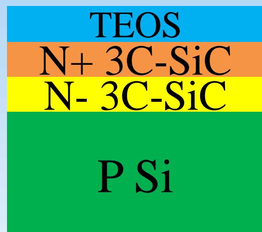
- Metal-semiconductor contacts
- SiC/SiO2 interface

Ohmic Contact on N Type 3C-SiC



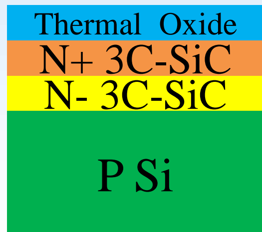


Ohmic Contact on N Type 3C-SiC



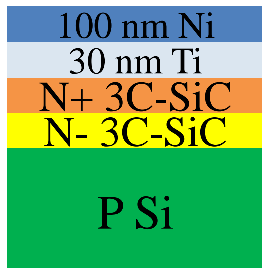
1 µm

Activated for 1 hour at 1300 °C in HighTech furnace

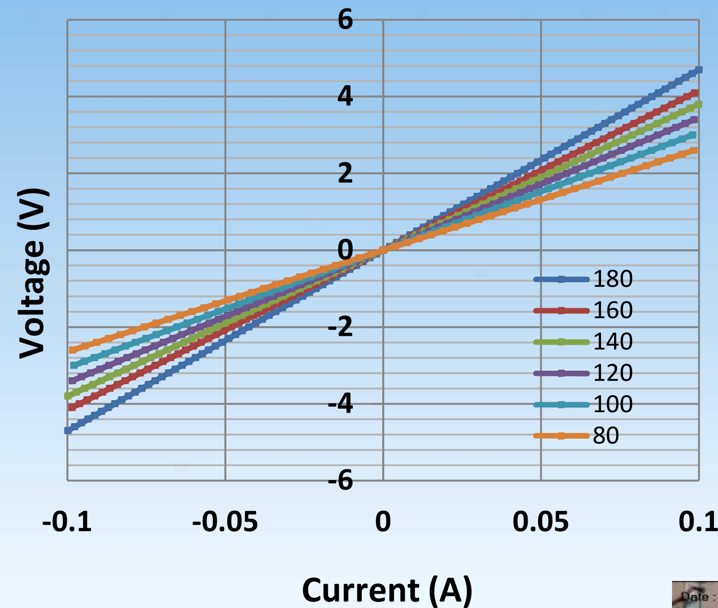


140 nm

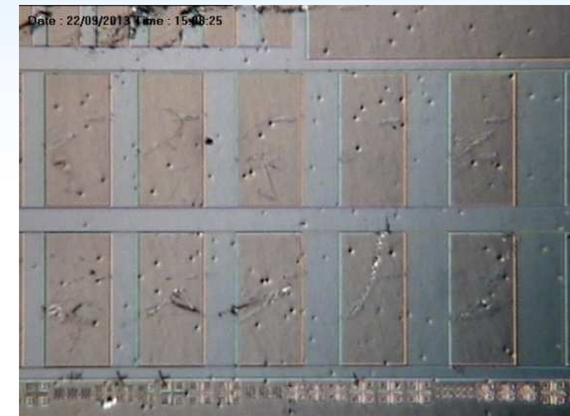
Oxidation lasted 2 hours at 1200 °C in HighTech furnace, oxygen flow 4 slm



Metallization happened at 2e-5 Torr, annealed for 1 min at 1000 °C

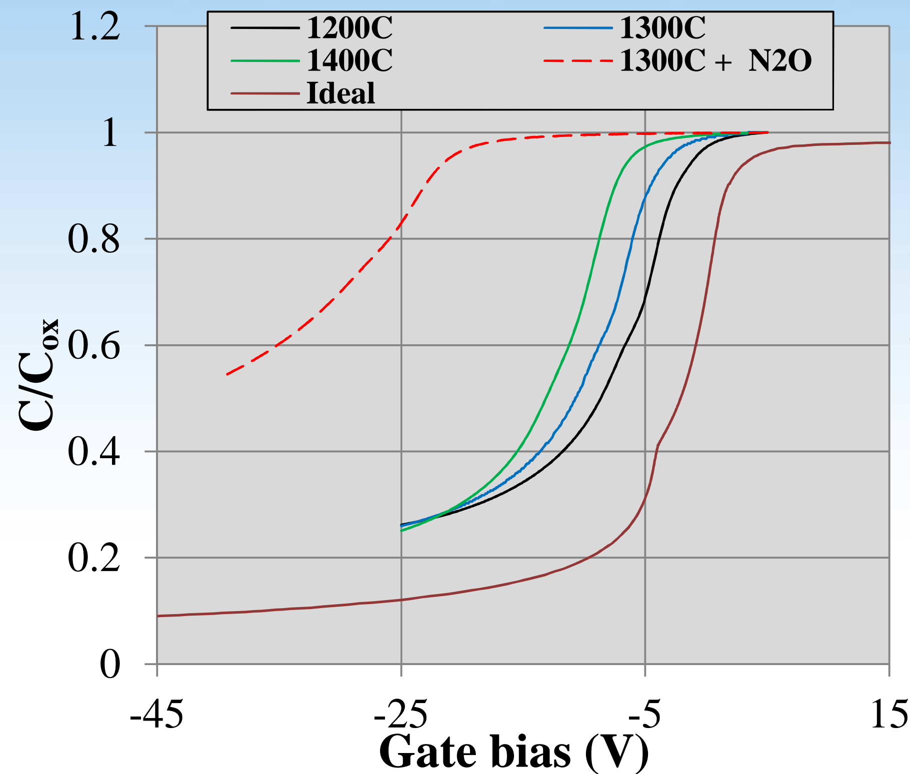


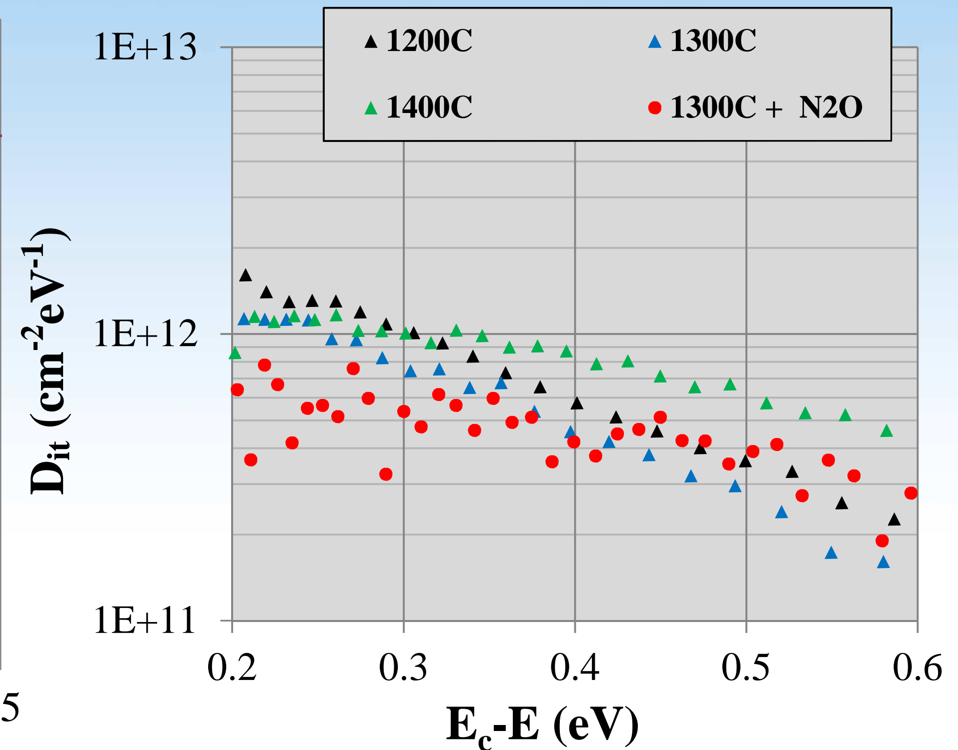
Resulting specific contact resistance 2e-5Ω.cm2.



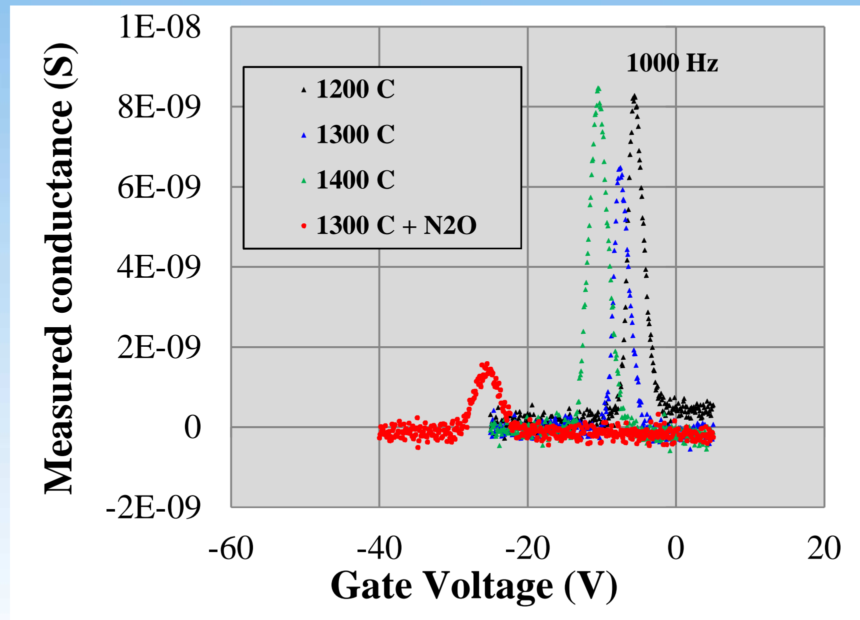
TLM feature under optical microscopy

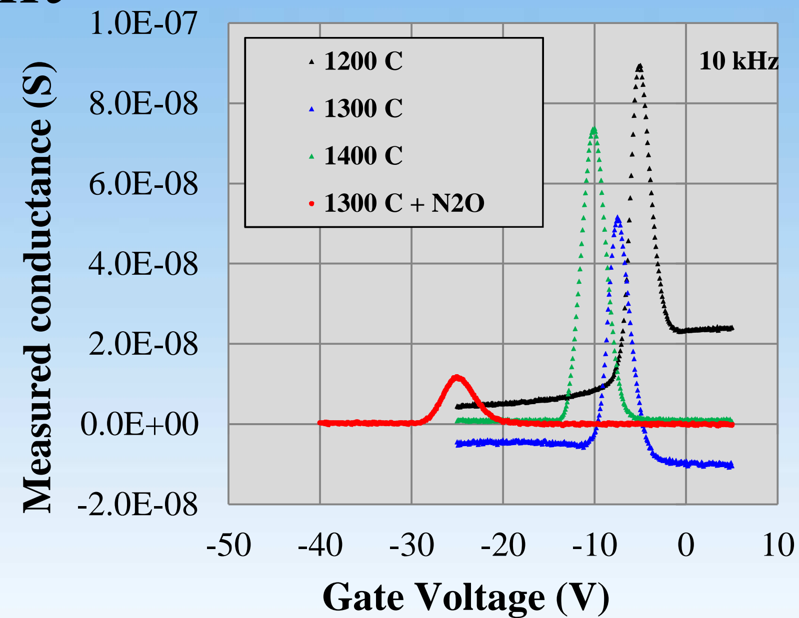
Effect of oxidation condition/passivation at the 3C-SiC/SiO_2 interface



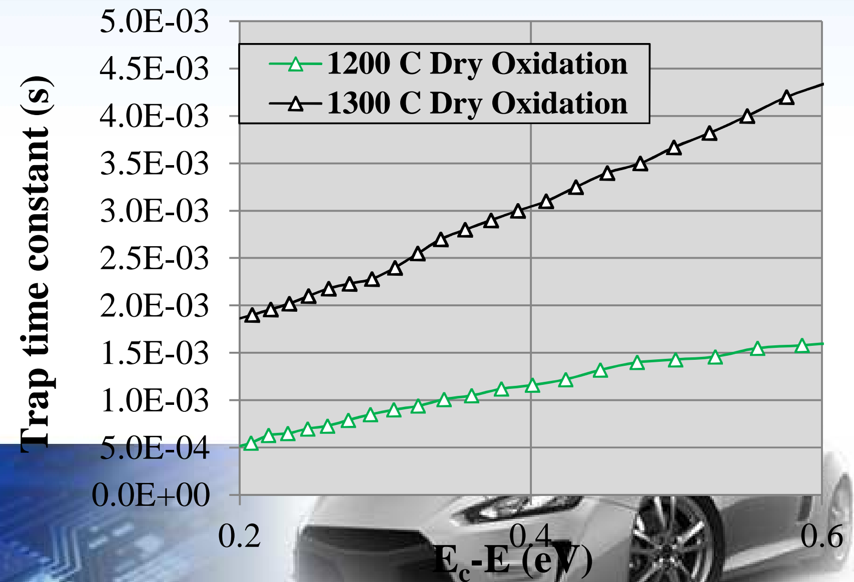


Properties of interface traps- nature, time constant





Process	Flatband voltage (V)	Effective oxide charge
1200C oxidation	-4	1.07E+12
1300C oxidation	-6	1.60E+12
1400C oxidation	-8	2.69E+12
1300C (oxidation+N2O)	-22	4.02E+12



Future Plans

- Continue working on 3C-SiC Ohmic contact –more test structures
- Use modified MOS-C structure, look more into 3C-SiC oxidation post annealing and passivation methods
- Start the Lateral MOSFET design and simulation

Conferences/Papers

12th INTERNATIONAL SEMINAR ON POWER SEMICONDUCTORS
ISPS 2014, Prague

Thank You For Listening