Planar SiC p-n diodes fabricated by selective diffusion of boron*

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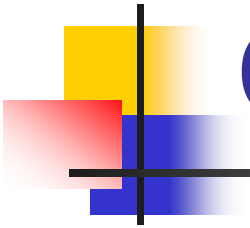
* Y. Gao etc. Solid-State Electronics, 45 (2001) 1987-1990



Outline

- Introduction
- Experiments
- Results and Discussion
- Conclusion

Introduction

Why SiC ?

- High electron saturation velocity
- Large thermal conductivity
- High critical electric field
- Wide bandgap

	Si	SiC(3C)	SiC(4H)	SiC(6H)
Bandgap (eV)	1.11	2.36	3.23	3.0
Breakdown Field (MV/cm)	0.3	1	3-5	3-5
Thermal Conductivity (W/cm.K)	1.3	3.6	3.7	4.9

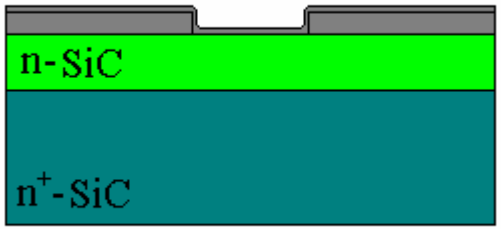
Introduction

- Problems to fabricate SiC p-n diodes:
  - Ion implantation:
    - Defects (even after 1700 ^{0}C annealing*)
  - Thermal diffusion:
    - Need extremely high temperature (>1800^{0}C)
    - Occurrence of severe etching/epigrowth
    - Unavailability of a mask for realizing selective doping (Now it is available)

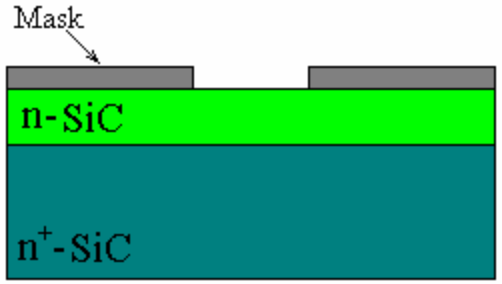
* Bakowski M. etc. Third European Conference on SiC and Related Materials. Compound Semicond 2000; 6(8):75-80

Experiments

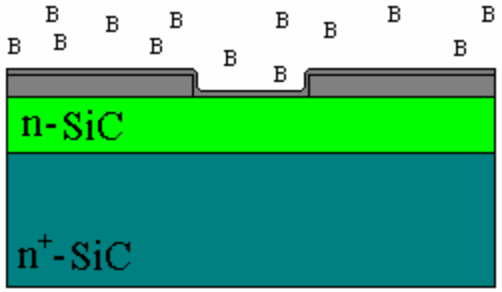
1). 4H and 6H SiC Wafer from CREE



3). Deposit Ultrathin photoresist film

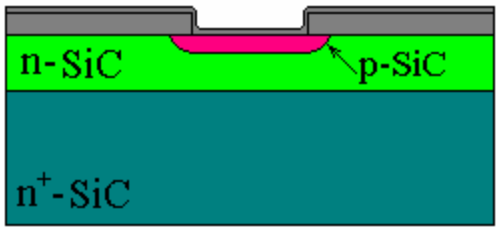


2). Form photoresist pattern by standard photolithography

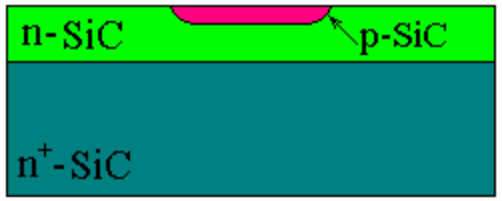


4). Boron diffusion at 2000^0C in Ar ambient

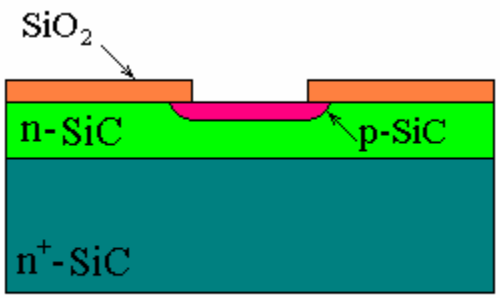
Experiments



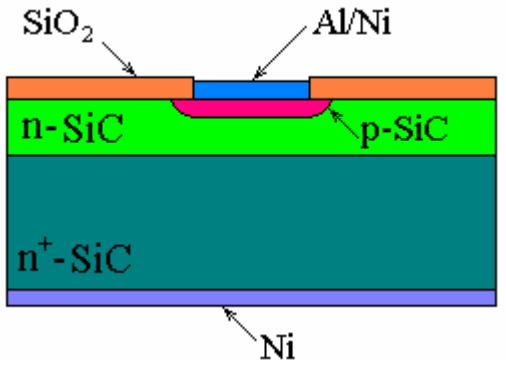
5). Stop diffusion



6). Remove mask by oxygen plasma etching

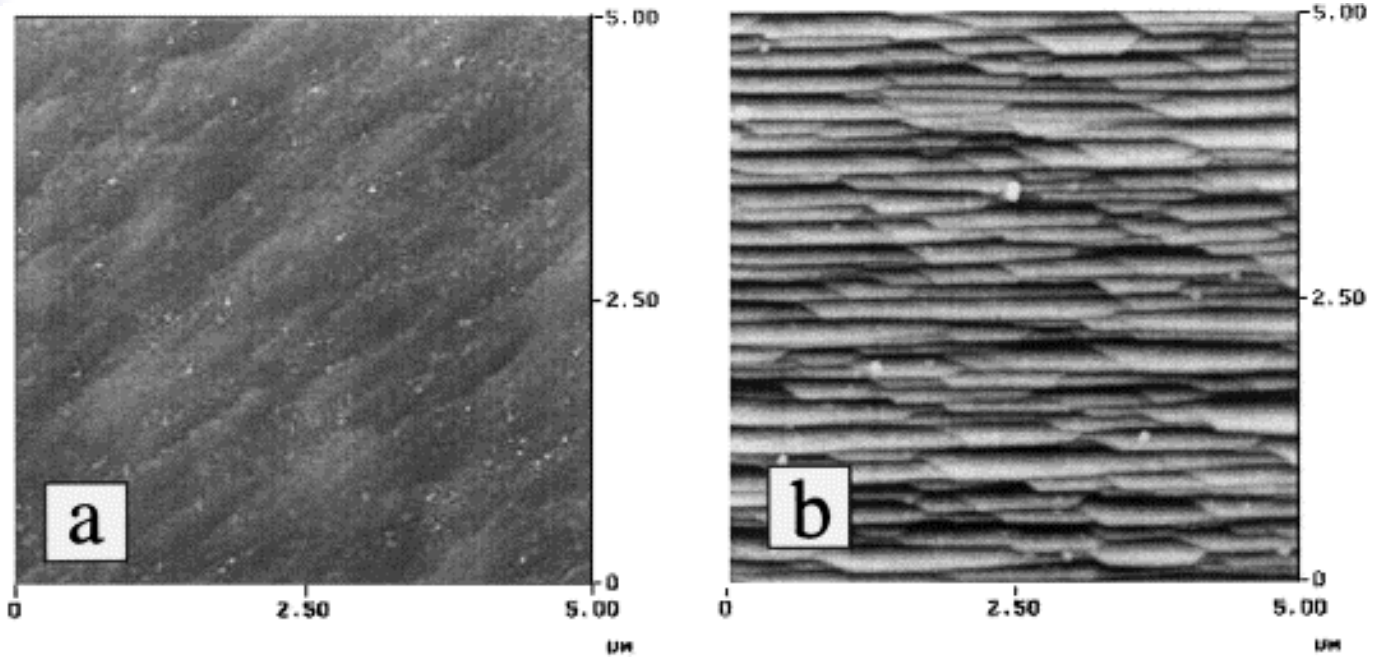


7). Form SiO_2 pattern by standard photolithography



8). Form anode and cathode contact

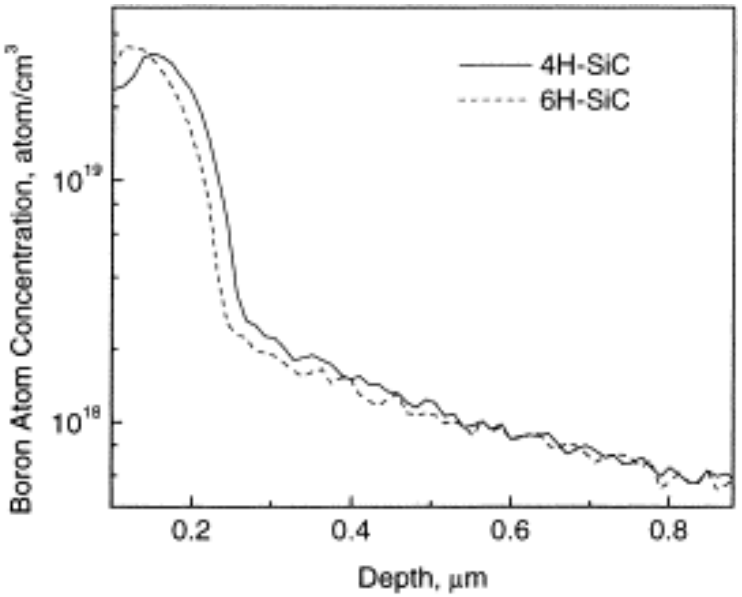
Results and Discussion



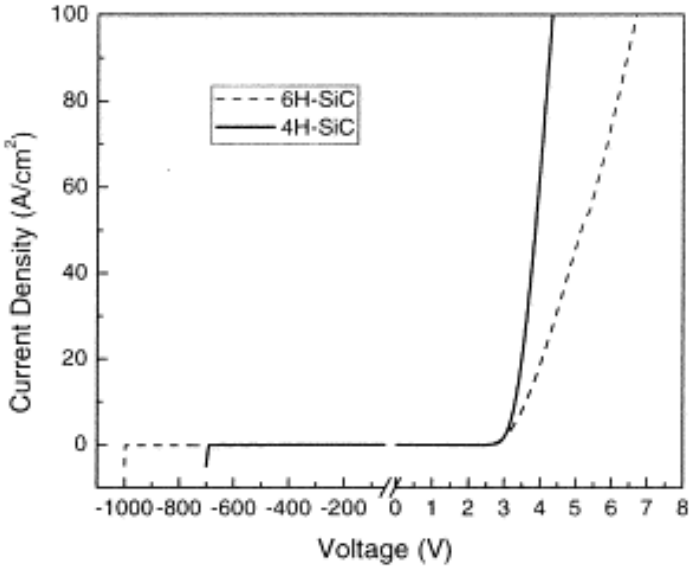
AFM image of diffused sample with (a) and without (b) protective mask

Surface roughness: (a): ~1.5nm, (b): >20nm

Results and Discussion



SIMS measurement of boron doping profiles



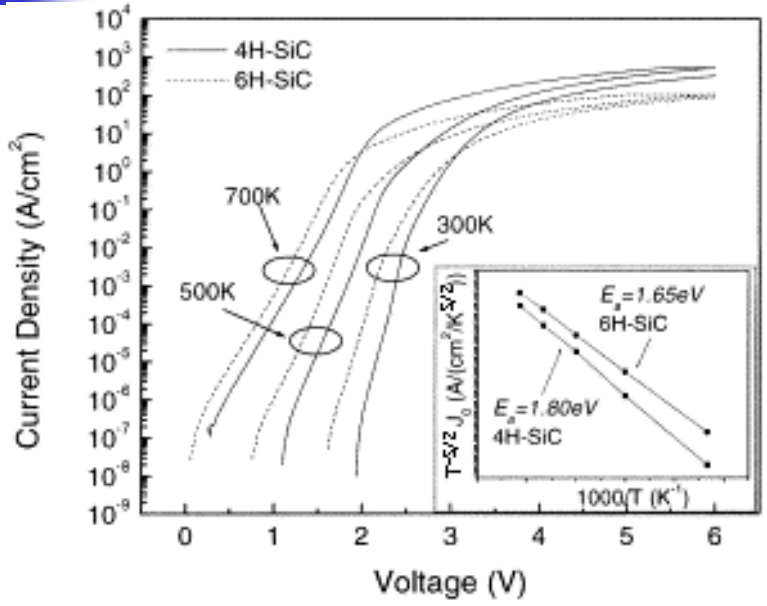
To J=100A/cm^2 V=7V (6H-SiC)

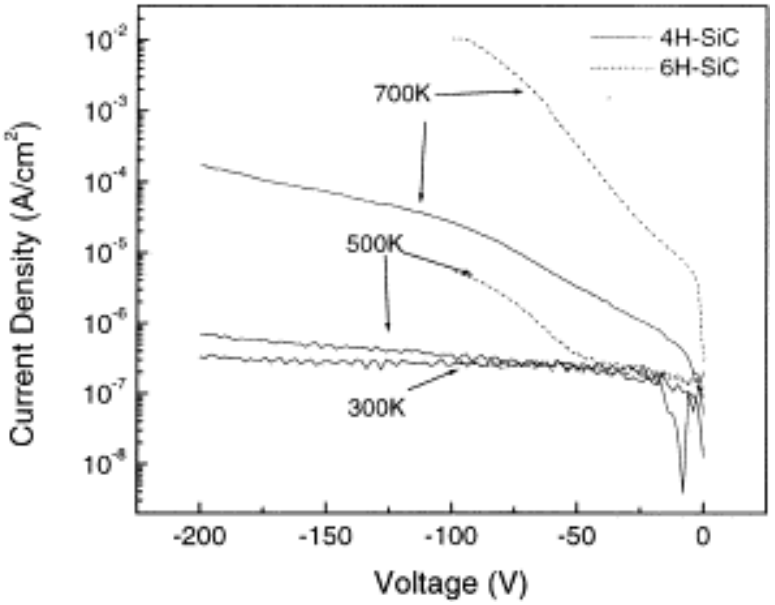
V=4.5V(4H-SiC)

Breakdown Voltage: 1000V(6H-SiC)

700(4H-SiC)

Results and Discussion





$$J \sim T^{5/2} \exp(-E_A / kT) *$$

E_A=1.8eV(4H-SiC) 1.65eV(6H-SiC)

Temperature dependence of the reverse bias characteristics

* Ramungul N, etc. IEEE Trans Electron Dev 1999; 46(3):465-70

Conclusion

- Graphite mask is suitable for realizing selective diffusion of boron in SiC
- Ultrathin layer of graphite film can protect sample surface
- 4H-SiC diode has much lower forward voltage drop but 6H-SiC diode has high breakdown voltage
- Forward bias thermal activation energies is 1.8eV(4H-SiC) and 1.65eV(6H-SiC)
- 4H-SiC diode has less T sensitivity