Dependence of Ti/C Ratio on Ohmic contact with TiC electrode for AlGaN/GaN structure

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Introduction

Decrease in specific on contact resistance by 10\% reduces power consumption by 60\% at about 750 V.

Approach for Ohmic contact

Common approach①

■ Formation of TiN through dislocation and direct electron conduction to 2DEG

BAD : Thinner AlGaN by forming TiN causes decrease in 2DEG

Common approach②

■ Silicon based layer with Ti-Al mixed metal formed AlN and V\(_N\).
Formed pyramid AlN have been formed at dislocation in AlGaN.

BAD : Controlling conditions for forming AlN is difficult

Utilizing local dislocation presented in AlGaN

High contact resistance would be caused in future substrate with less dislocation

New Material for achieving Ohmic contact

(Condition for Ohmic contact)

① Thinning thickness of AlGaN layer
② Nitrogen vacancy V\(_N\) cause band bend of AlGaN
⇒ Increase tunneling current into 2DEG

TiC (melting point : 3200 °C)

- Probability of forming V\(_N\)
- High thermal stability

Device Fabrication

- SPA/MF last etch TEOS
- SiO\(_2\) deposition by TEOS
- Photolithography
- Dry etching by RIE(TEOS)
- SiO\(_2\) deposition by TEOS
- Photolithography, Wet etching by BHF

- TiN(50nm)/Ti/L(C,20nm) deposition(x=1.13,1)
- TiN(50nm)/Ti(20nm) deposition
- TiN(50nm)/C(20nm) deposition
- Lithography, Dry etching by RIE(O\(_2\))
- Ti measurement

Conclusion

- The dependency of Ti atom composition in Ti-C electrodes for AlGaN/GaN structure is examined.
- TiC can be confirmed as a new material for Ohmic contact electrodes.
- C atoms reduce AlGaN thickness with thermal treatment and enhances reaction of Ti atoms.
- The border of interface layer and AlGaN remained has almost uniform.
- Higher Ti atom composition has revealed lower Ohmic contact resistance, especially 2.9 \(\times\) 10\(^{-4}\) Ωcm\(^2\) with Ti:C of 7:1.
- The proposed reaction mechanism gives a new guideline to achieve uniform electron conduction for lower contact resistance.