Contact resistance depending on AlGaN layer thickness for AlGaN/GaN HEMT


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Introduction

Low loss operation of power devices used in inverter systems is required.

AlGaN/GaN HEMT

Channel 2DEG is induced by polarization of AlGaN layer.

Advantages of AlGaN/GaN HEMT

- Low-cost production by using large diameter Si wafers
- High electron mobility

Problem

On-state resistance (2Rc+Rcb) should be further decreased.

Low contact resistance is necessary.

Alloy and Non-alloy ohmic contacts on AlGaN/GaN

Contact metal->Low Shottky barrier high metal: Ti, Al...

Alloy contact

Non-alloy contact

Properties

Non-uniform alloying correlated with dislocations.
Formation of n-type region.

Advantage

Low contact resistance is easy
Independent of dislocations in AlGaN layer.
Contact resistance is high at present.

Problem

High quality ohmic contacts may degrade the contact properties.

Example

Au/Mo/Al/Ti, 850°C (1)

2DEG

2DEG

Non-alloy contacts will be important in future.

Modeling of contact resistance

There is an AlGaN layer between Metal and 2DEG

Barrier for electrons->Thinner is better.
Generation of high-density 2DEG->Thicker is better.

Trade-off on AlGaN layer thickness.

Modeling of contact resistance considering AlGaN layer thickness is important for low-resistive contact formation technologies.

Purpose of this work

- Relationships between AlGaN thickness and contact resistance are clarified.
- Dominant factor of contact resistance is extracted from the analysis.
- The analysis is demonstrated to be useful for development of low resistive contact on AlGaN/GaN HEMTs.

Conclusion

In order to decrease contact resistance of non-alloy contacts, lowering of the resistance at Metal/AlGaN interface will be effective.

The proposed analysis is useful to separate the individual component of contact resistance.

Discussion of the AlGaN layer thickness dependence will be useful for new low-resistive contact formation technologies on AlGaN/GaN HEMTs.[4]

Experimental procedure

Contact resistances depending on annealing temperature

The proposed analysis is useful to separate the individual component of contact resistance.

Optimum thickness was larger for the alloy contacts.

The model was found to be appropriate.

The trade-off relationship was confirmed.

Constant for AlGaN thickness variation

Lowering of the RcMetal/AlGaN will be effective, e.g. Doping, Material search...

Contact resistance vs. AlGaN thickness

The resistance for non-alloy contacts is higher than that of alloy contacts.

Non-alloy contacts need higher temperature for low contact resistance.

Non-alloy contacts will be important in future.

Optimum thickness was larger for the alloy contacts.

The model was found to be appropriate.

The trade-off relationship was confirmed.

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