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Various Schottky Contacts of AlGaN/GaN Schottky Barrier Diodes

Woojin Ahn[1], Ogyun Seok[1], Min-Woo Ha[2], and Min-Koo Han[1]
[1]School of Electrical Engineering and Computer Science, Seoul National University, Gwanak-gu, Seoul, Korea
[2]Korea Electronics Technology Institute, Seongnam, Gyeonggi-do, Korea

1. Introduction

AlGaN/GaN Schottky barrier diodes (SBDs) have attracted an attention for next-generation power devices due to wide bandgap properties such as a high critical electric field and a low intrinsic carrier concentration. In addition, a low on-resistance by two dimensional electron gases attributes a fast switching speed [1-2].

Ni based Schottky metals have been widely used for an anode of the AlGaN/GaN SBDs due to a high work function and a good adhesion with GaN materials. However, Ni is easily oxidized so that thick Au on the Ni is required [3]. Moreover, metal based Schottky contact may not be stable during the high current and high temperature operation due to the inter-diffusion between metal and the AlGaN/GaN heterostructure by slight melting [4]. A rather stable Schottky metal contact is desired even under the harsh environment.

The purpose of our paper is to fabricate and to find rather stable various Schottky contact such as TaN, Indium-tin-oxide (ITO) for AlGaN/GaN SBDs. It is well known that TaN is stable at high temperature and an unoxdizable ceramic material so that TaN is a suitable material for Schottky metal in the AlGaN/GaN SBDs [5]. Also, ITO has been widely employed to many opto-electronic devices for its highly conductive, good adherence to many substrates, and good transmission characteristic properties [6].

2. Devices Structure and Fabrication

The cross-sectional view and top view of the proposed device are shown in Fig. 1. The AlGaN/GaN hetero-structure was grown on Si (111) substrate. Mesa isolation using Cl_2 based ICP-RIE was performed in order to define an active region. Ohmic metals of Ti/Al/Ni/Au (20/80/20/100 nm) for cathode were formed by e-gun evaporation. We annealed ohmic metals at 880 °C for 40 s under N_2 ambient for ohmic contact formation. Prior to Schottky contact formation, we dipped the samples into the 30:1 BOE for 30 s in order to remove the native oxide.

Both TaN and ITO for anode were deposited by sputtering and lift-off. Specific deposition conditions are listed in table 1.

Table 1. Specific deposition conditions of sputtering

	TaN	ITO
Sputtering power (W)	300 (RF)	300 (DC)
Sputtering pressure (mtorr)	1	3
Temperature	R. T.	R. T.
Ar gas flow (sccm)	20	15

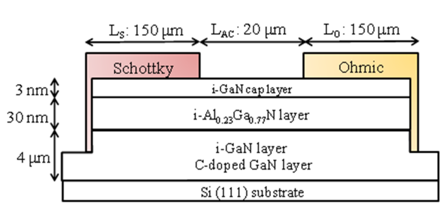

Fig. 1. Cross-sectional view of fabricated AlGaN/GaN SBDs

3. Experimental Results

Fig 2. shows the forward characteristics of the fabricated devices at room temperature. The device of Ni/Au Schottky contact shows forward current of 240.0 mA/mm at 5 V while TaN and ITO Schottky device shows 91.5 mA/mm, and 131.6 mA/mm, respectively. A forward current reduction may be caused by the high Schottky barrier height of contact. Also the higher resistance of TaN (244.3 μΩ·cm) and ITO (216.0 μΩ·cm) than that of Ni (6.9 μΩ·cm) and Au (2.2 μΩ·cm) may be attributed to reduction of forward current.

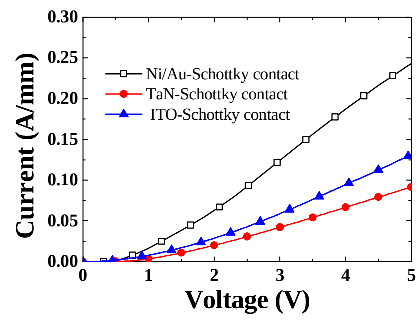

Fig. 2. Forward characteristics of AlGaN/GaN SBDs for various Schottky contact

Fig. 3 shows the rectifying characteristics of each devices at room temperature. The Ni/Au Schottky device shows high leakage current of 1.55 mA/mm at -100 V due to the amount of surface trap-assited Schottky tunneling current. However, TaN and ITO Schottky device shows decreased leakage current of 111 μA/mm and 530 μA/mm, respectively. The results may indicate that the TaN and ITO Schottky contact shows better stable blocking characteristics than Ni/Au Schottky contact.

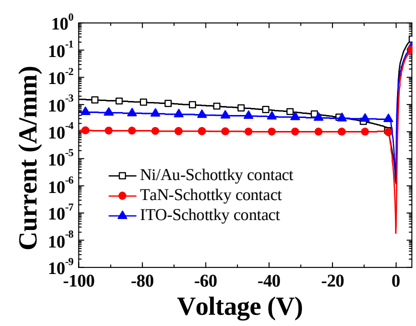

Fig. 3. Rectifying characteristics of AlGaN/GaN SBDs for various Schottky contact

4. Conclusion

We proposed and successfully fabricated AlGaN/GaN SBDs employing various Schottky contact by sputtering without Au layer. Even though, the proposed TaN and ITO Schottky contact shows rather decreased forward on current, improved reverse blocking characteristics compared to Ni/Au schottky contact was investigated. Thus, TaN and ITO deposited by sputtering method may be a suitable anode material for high voltage operation in the power AlGaN/GaN SBDs.

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