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Effect of Annealing Temperature on the Sheet resistance of AlN/GaN HEMTs

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Abstract.

AlN/ GaN high electron mobility transistors (HEMTs) intrinsically have high two-dimensional electron gas (2DEG) densities with good mobility and high breakdown fields, due to both, higher band gap and charge polarization at AlN/ GaN interface. Enabling the use of ultrathin barrier structures, which offers extreme gate scalability for high frequency applications, figure1 shows a schematic layer structure of AlN/GaN wafer involved in this work. As high Al content in the barrier allows such many advantages, relatively high ohmic contact resistance (R_c) and very sensitive barrier are main problems for such devices. Conventional Ti/Al/Ni/Au ohmic contacts are known to exhibit very low R_c, however, it requires annealing at high temperatures (>800 ^oC) beyond the melting point of Aluminum. This causes the sheet resistance (R_{sh}) to largely deteriorate especially in GaN HEMTs with AlN barriers, since they have 100% Aluminum content. In this paper, a different metallization stack based on Molybdenum for the ohmic contact will be reported. The two stacks of Mo/Al/Mo/Al/Ti/Al and Mo/Al/Mo/Au, require a much lower temperature down to 550 ^oC. The conventional Ti/Al/Ni/Au based stack which is annealed at 800 ^oC results in an increase of R_{sh} to ~1.1 KΩ/□, while the Mo based stack which is annealed at 550 ^oC results in a sheet resistance of 377 Ω/□ as shown in table I below. R_c and R_{sh} values were obtained via circular transmission line measurement (CTLM), while Annealing conditions were optimized to give a good compromise between R_c and R_{sh}.

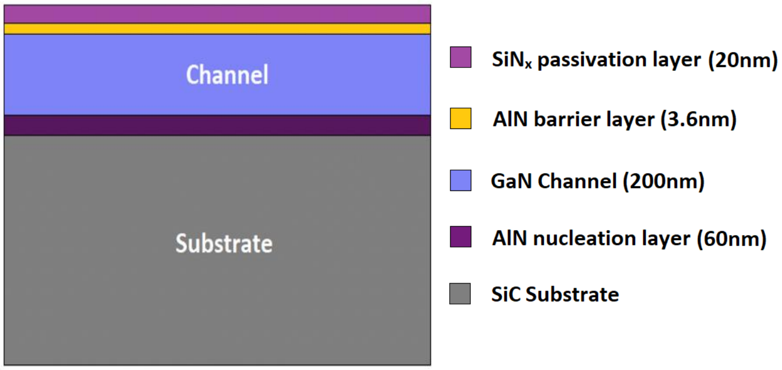

Figure 1: AlN/GaN wafer structure.

Ohmic contact	R_{sh}(Ω/□)	R_c(Ω.mm)	Annealing temperature (°C)
Ti/ Al/ Ni/ Au 30/180/40/100 nm	1089.9	0.57	800
Mo/ Al/ Mo/ Al/ Ti/ Al 10/40/20/20/30/200 nm	479.9	1.62	700
Mo/Al/Mo/Au 15/60/35/50 nm	377	1.52	550

Table I: Comparison between conventional Ti-based and Mo-based metallization schemes.