Study of Metal Contacts to Gallium-face and Nitrogen-face n-type GaN Material

by

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Abstract

In this Master Thesis, polarization fields in wurtzite GaN material are studied, both Ga-face and N-face GaN. The performance of ohmic metal contact structure towards both surfaces are analyzed.

N-face GaN samples are characterized using KOH wet etching. The change in surface morphology caused by this etch is found to be a good way to identify the Ga-face and N-face.

The conventional Ti/Al/Ti/Au ohmic metal scheme, applied to both Ga-face and N-face n-type GaN, works very well in Ga-face situation, and the fabricated Ga-face samples showed the lowest specific contact resistivity of $1.10 \times 10^{-5}\ \Omega\,\mathrm{cm}^2$.

For the N-face n-type GaN situation, however, the contacts shows very low resistance as-deposited. A specific contact resistivity of $6.68 \times 10^{-5}\ \Omega\,\mathrm{cm}^2$ is achieved for as-deposited N-face n-type GaN, but the resistivity increases quickly, even after annealing at temperature as low as $300\ ℃$. Several surface treatments such as chlorine reactive ion etching (RIE) and fluorine plasma etching are conducted, and a slight improvement is obtained but somehow limited by the quality and uniformity of N-face GaN wafer samples.

Besides the routine Ti/Al/Ti/Au metal scheme, a novel indium-based contact scheme to N-face n-type GaN consisting of In/Ti/Au multi-layers is proposed and tested. The results show improvement over Ti/Al/Ti/Au contact structure. A specific contact resistivity as low as $5.25 \times 10^{-5}\ \Omega\,\mathrm{cm}^2$ was obtained for In/Ti/Au after annealing at $150\ ℃$. The thermal stability of the In/Ti/Au contact for low temperature annealing (below about $400\ ℃$) and the overall linearity of *I-V* curve are also better. We believe that even further improvements to this result is possible with the thickness of each metal layer optimized.