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Current Spreading Layer with High Transparency and Conductivity for near-ultraviolet light emitting diodes

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Abstract— Transparent conductive aluminum-doped zinc oxide (AZO) layer was deposited on GaN-based near-ultraviolet (NUV) light emitting epitaxial wafers as current spreading layer by a sputtering process. Efforts were made to improve the electrical properties of AZO as its contact to GaN is not perfect due to the high specific contact resistivity of Ni/Al. The electrical behavior of AZO based LEDs with flip-chip configuration, with Al reflector forms AZO-based reflective current spreading layer. Ni/AZO was used as Ni/Au. Ni/AZO was fabricated on the mesa of NUV LED wafers. Ni and AZO were deposited by e-beam evaporation and DC sputtering respectively. After deposition, Ni was annealed in air at 550 °C for 5 min. 110nm AZO and 250nm AZO were annealed at 550 °C for 5 min in N2 and at 800°C for 1 min in N2 respectively.

I-V measurement was carried out on the 6 types of CSLs. In the end, annealed 5nm Ni/annealed 250nm AZO gives the best I-V properties since it almost presents ohmic behavior. One NUV LED device with annealed 5nm Ni/annealed 250nm AZO as its CSL was fabricated and its electroluminescence (EL) graph together with that of an LED using conventional Ni/Au CSL were displayed in Figure 1. The EL intensity of the LED with Ni/AZO is weaker than that of the LED with Ni/Au due to the high specific contact resistivity of Ni/Al.

III. SUMMARY

I-V behavior of CSLs with different compositions, AZO thicknesses and annealing conditions were tested and compared. The annealed 5nm Ni/annealed 250nm AZO presents the best electrical properties. Afterwards, an NUV LED with transparent conductive Ni/AZO was fabricated. Although EL can be observed, its intensity is still lower than that of the LED with Ni/Au. This is because the contact between Ni/AZO and p-GaN is not perfect ohmic indicating much larger specific contact resistivity than that of Ni/Au. Although Ni/AZO possesses higher transparency than that of Ni/Au, its electrical behavior still needs further modification.

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REFERENCES

