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P-side up Thin Film AlGaInP-Based Light Emitting Diodes with Mesh Patterned Ohmic Contact

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Light emitting diodes (LEDs) have been widely used in traffic signals, lighting, and communication applications since they were developed. With the increasingly advantages of epitaxy growth and processing, it is not difficult to grow high quality AlGaInP-based layers. Owing to the AlGaInP layer lattice matched to the GaAs substrate, AlGaInP-based LEDs can generate the better internal quantum efficiency. However, the GaAs substrate will absorb the heat and poor heat transfer characteristics during lighting. These factors would lower the external quantum efficiency. To solve these problems, recently researches have been focused on the wafer bonding technology, transferring the epitaxial layer to the transparent substrate.[1,2] The other technology was to fabricate a reflectivity mirror substrate.[3] However, the fabrication method of the wafer bonding technology is complex, uneconomical, and needs high temperature treated (over 500°C). The reflectivity mirror substrate strategy also needs a high temperature treated process (over 300°C). It will lower the reflectance of the substrate. Consequently, it is necessary to explore another fabrication method to transfer the GaAs substrate.

The epitaxial structures for red light LEDs are p-GaP/AlGaInP/GaAs, which the p-GaP layer was served as a current spreading layer and a window layer. The LEDs structure of transferring the wafer bonding technology for one-time is n-side up. However, the p-GaP layer was embedded in the multiple quantum wells and mirror substrate, which was unable to develop its current and electricity spreading characteristics. In this work, we introduce a ttwice transferring of wafer bonding methods.Thus the p-GaP layer remains up-side. In order to obtaining the Ohmic contact with low resistivity, the mesh pattern Ohmic contact was fabricated into the p-side thin film AlGaInP LEDs. The electrical performance of the I-V curves are shown in Fig. 1. It shows a low cut-in voltage 1.8 V. On the basis of the design, the p-GaP layer provides the current spreading property and combines with the reflectivity mirror substrate. The twice transferring of wafer bonding technology with mesh patterned can increase the luminous intensity as shown in Fig. 2.

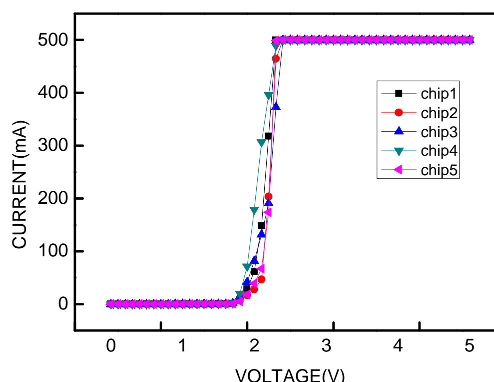

Figure 1. I-V curves for five chips of twice transferring of wafer bonding LEDs.

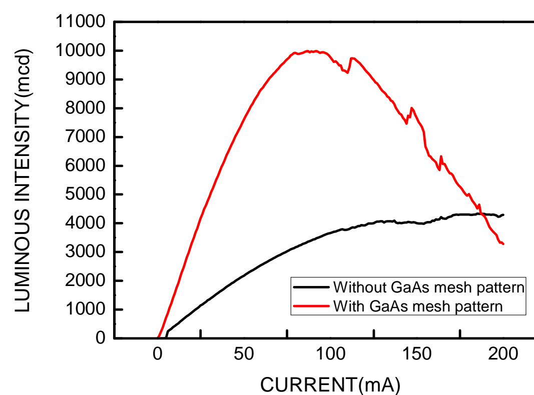

Figure 2. Luminous intensity performance of thin film AlGaInP LEDs with and without mesh patterned after twice transferring of wafer bonding LEDs.

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