# AlGaN-based Deep-UV Micro-LED for High-Efficiency Quantum Dots Converted Display


***Feng Feng*, Zhaojun Liu**, Hoi-sing Kwok******

*Hong Kong University of Science and Technology, Hong Kong S.A.R.

**Southern University of Science and Technology, Shenzhen, China

*** Hong Kong University of Science and Technology, Hong Kong S.A.R.


Displays based on inorganic micro light-emitting diodes (Micro-LED) are considered one of the most promising display technologies for the next generation [1]. While the traditional tristimulus display technology requires three different active regions to address different colors on the same chip [2], the quantum-dot-based Micro-LED display becomes an accessible solution. Blue-violet and near-UV Micro-LED with tricolor (RGB) quantum dots (QDs) were proposed to improve the color rendering and increase the excitation efficiency [3]. However, the blue and near-UV light could pass through mammalian eyes to reach the retina and cause permanent vision damage. As entirely absorbed in the cornea or eye fluids, the Deep-UV light is more suitable for color conversion technology. While the research on AlGaN-based Deep-UV Micro-LED is still challenging, few efforts were invested in its application of excitation source of RGB QDs.

The cross-section view of an investigated flip-chip Deep-UV Micro-LED was shown in Figure 1 (a). A series of different-sized square devices (in 10×10, 15×15, 20×20, 25×25, 30×30, 50×50, 80×80, 100×100, 150×150, and 200×200 μm$^2$) were fabricated and characterized for optical and electrical investigation. To optimize the electrical characteristics, two types of electrode metal combinations were designed in the fabrication split: a widely researched Cr/Al/Ti/Au metal stacks as electrodes for type A, and Ti/Al/Ni/Au electrodes deposited for type B. After the fabrication process, the SEM morphology of a single 10×10 μm$^2$ device was shown in Figure 1 (b).

The current density-voltage (J-V) curves were shown in Figure 2. The forward bias at the current density of 10 A/cm$^2$ was defined as the forward voltage ($V_F$) for Micro-LED, widely adopted in the display industry for a typical operating condition. The same definition was introduced to Deep-UV Micro-LEDs. The $V_F$ of type B devices was about 30% lower than that of type A devices, confirming that titanium and n-AlGaN formed better contact with lower series resistance.

To compare the experimental excitation efficiency of photons with different wavelengths, a Deep-UV Micro-LED and a violet Micro-LED in the same size were used to excite the same green QD film under the same measurement configuration. As the spectra shown in Figure 3, the Deep-UV source showed much higher excitation efficiency than the violet one. 147% of Effective quantum yield (EQY)was achieved by Deep-UV Micro-LED, while the violet Micro-LED only generates 5.24% of EQY.

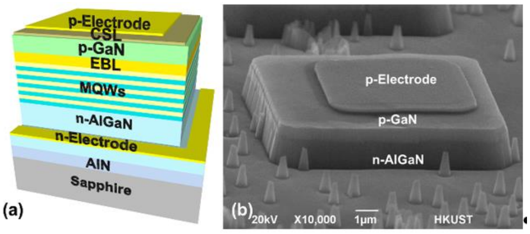


**Fig. 1.** Figure 1. (a) The cross-section view of a Deep-UV Micro-LED, (b) SEM of a 10×10 μm$^2$ device.

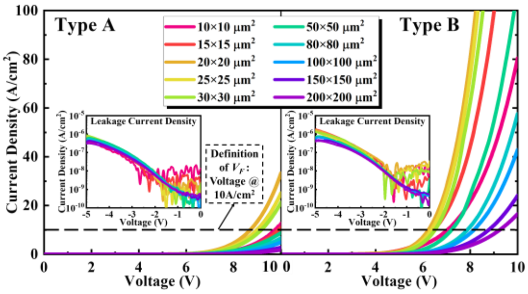


**Fig. 2.** The linear *J-V* curves for type A devices (left) and type B devices (right).

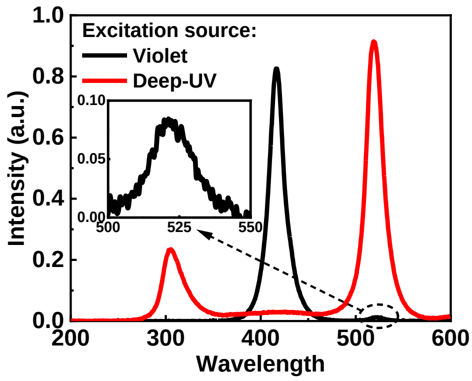


**Fig. 3.** The spectra of green QD films excited by Deep-UV and violet Micro-LEDs.

## References


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