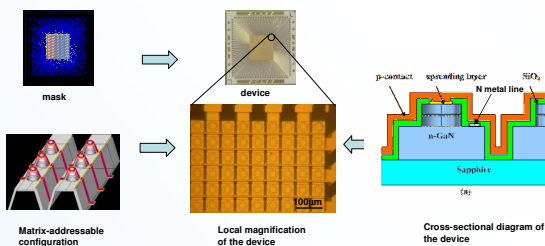


Flip-chip matrix-addressable InGaN micro-LED arrays with high pixel density and increased light output

Flip-chip InGaN micro-LED arrays with high pixel density and improved device performance are demonstrated. The devices, which have 64X64 elements, are fabricated with a matrix-addressable scheme. The devices are subsequently flip-chip bonded onto Si-mounts. With introducing a micro-metal line along each n-GaN mesa, the emission uniformity of the new device is greatly improved, compared with the earlier counterparts[1]. Also, due to the improved heat dissipation capability and the increased light extraction efficiency, the optical power of the new device is substantially enhanced. These superior characteristics make these devices excellent candidates for robust micro-displays and a range of other using in areas such as micro-instrumentation and cell manipulation.

Device design and fabrication



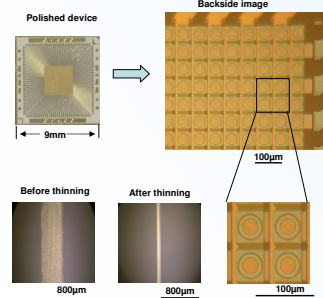
- The devices are fabricated with a matrix-addressable scheme, i.e., all pixels along one row share a common p-contact, and all pixels in one column share a common n-contact.

- Parallel-mesa structures for isolation are formed by RIE and ICP etching; SiO₂ is used to isolate the crossed n contact and p contact. No planarization for interconnection is required thanks to the mesa structures with sufficient slope.

- To enhance the conductivity of n-GaN, a metal line is inserted along each column (n-GaN ridge).

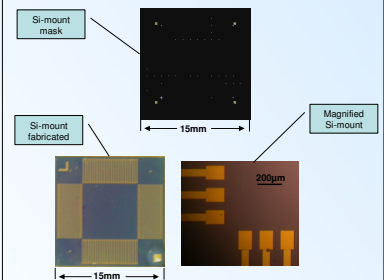
- thick multi-layer metals serve as the reflective p-electrodes, which guarantee a low contact resistance and high light output

Substrate thinning and polishing



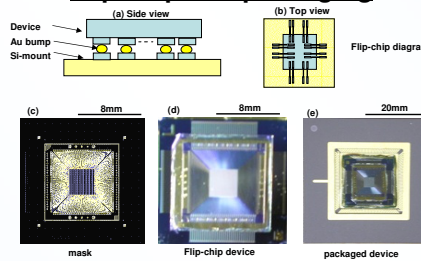
To allow the transmission of the light from the sapphire substrates, the backside of the device has been polished and thinned down to 80µm.

Si-mount design and fabrication



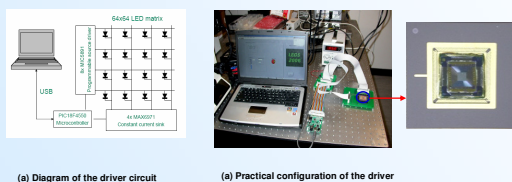
Corresponding Si-mounts are fabricated to accommodate the devices

Flip-chip and packaging



Polished devices are then flip-chip bonded onto the Si-mount. The flip-chip devices are subsequently wire bonded onto the 144-pin package

Driver circuit

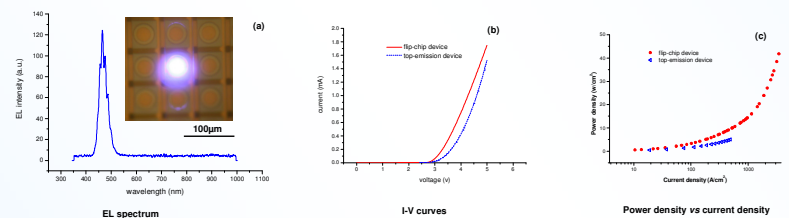


to demonstrate the use of these devices as high-quality micro-displays, a suitable driver is designed, which can be externally programmed via a personal computer interface.

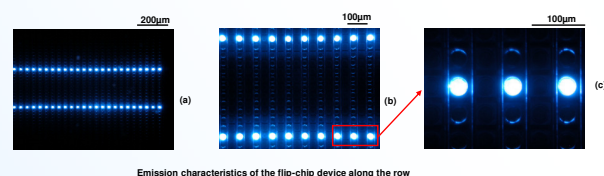
Conclusions

1. matrix-addressable InGaN micro-LED arrays with high density, good emission uniformity and remarkably increased light output were demonstrated by adopting flip-chip technology.
2. These devices are superior candidates for microdisplay and micro-instrumentation

Device performance



Each pixel in the array can be turned on independently, demonstrating the matrix-addressable capability. A much higher power density has been achieved compared with the top-emission counterparts



Good emission uniformity has also been achieved, thanks to the inserted n-metal lines along each n-GaN mesa.

Reference

- [1] C.W. Jeon, H.W. Choi, E.Gu, and M.D. Dawson, IEEE Photon. Technol. Lett. 16, 2421(2004)