Micro-pixellated InGaN light-emitting diode arrays with improved device performance

Basic Technology Research Programme

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A 1000 micro-emitters per square millimetre

Z.Gong, H. Zhang, E.Gu, and M.D. Dawson

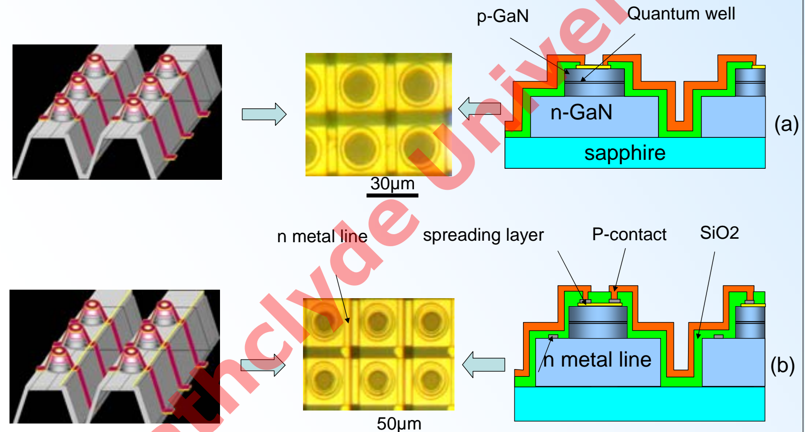
Institute of Photonics, University of Strathclyde, Wolfson Center, Glasgow G4 0NW

University of Strathclyde · Imperial College London · The University Of Sheffield · Heriot Watt University

Micro-pixellated InGaN light emitting diode arrays with improved device performance are demonstrated. The devices, which have 64X64 elements, are fabricated with a matrix-addressable scheme. With introducing a micro-metal line along each n-GaN mesa, the emission uniformity of the new device is greatly improved , compared with the traditional device[1]. Also, by adopting a new p-type ohmic contact formation scheme, the optical power of the new device is enhanced by 25% at an injection current of 1.6mA. These superior characteristics make these devices excellent candidates for robust micro-displays and a range of other using in micro-instrumentation

Device design and fabrication

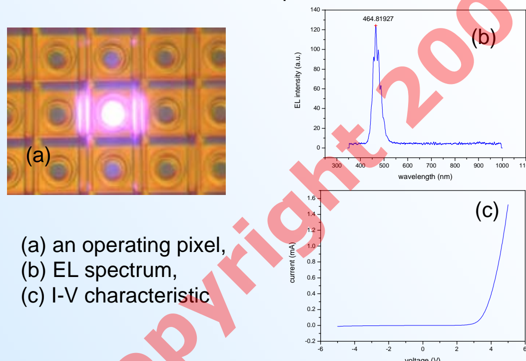
- The devices are fabricated with a matrix-addressable scheme, i.e., all pixels along one row share a common p-contact, and all pixels in one column share a common n-contact.
- Parallel-mesa structures for isolation are formed by RIE and ICP etching; SiO_2 is used to isolate the crossed n contact and 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).
- A new p-type ohmic contact formation scheme is adopted, which enables much more light output



Cross-sectional schematics of (a) the old device and (b) the new device

Results and discussions

single pixel can be turned on, demonstrating the matrix-addressable ability of these devices. the light emission shows a well-defined circular pattern



(a) an operating pixel,
(b) EL spectrum,
(c) I-V characteristic

With introducing the metal lines, the series resistance of each pixel shows a less dependence on the pixel position [see figure (a)]. Similarly, the measured current variation is also greatly suppressed, as shown in (b)

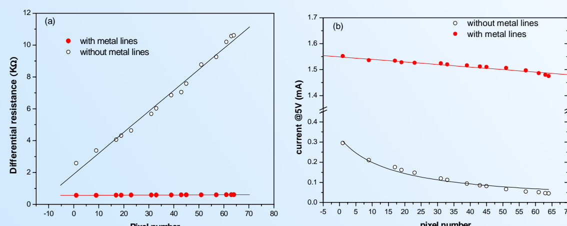
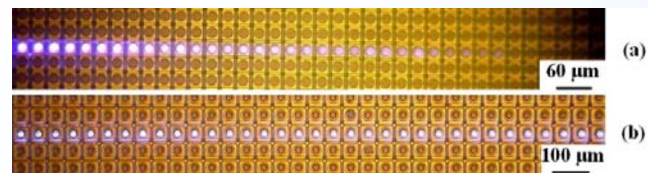
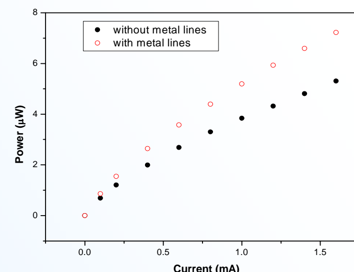


Image (a) reveals the uniformity issue of the old device without metal lines. After a metal line is inserted along each n-GaN ridge, the emission uniformity is now greatly improved, as shown in (b)



Emission characteristics of (a) the old device , and (b) the new device

By adopting a new p-type ohmic-contact formation scheme, the output power of the new device is substantially enhanced. In the new device, Ni/Au thin spreading layer is directly deposited onto the exposed p-GaN area defined by a photoresist pattern prior to the SiO2 deposition. This guarantees the formation of a high-quality transparent electrode, permitting much more uniform current injection and high light output



Reference

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

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