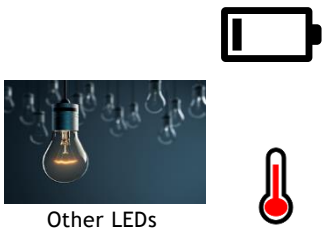
KubosLED Preliminary Product Brief

Kubos Semiconductors has developed technology to produce efficient, high brightness, **full-colour** microLED displays. As a result, the patented process technology for this single material system overcomes one of the main roadblocks in the AR/VR headset and the displays market.
To achieve world-leading efficiency, Kubos produces device-quality, epitaxial layers of gallium, indium, and aluminium nitride (Group III nitrides) and their alloys in the cubic phase.

Improved Efficiency


Other LEDs

- Improved battery life
- Better wall-plug efficiency
- Increased brightness
- Less self-heating
- Reduced droop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Better Colour with Increased Brightness


Other LEDs


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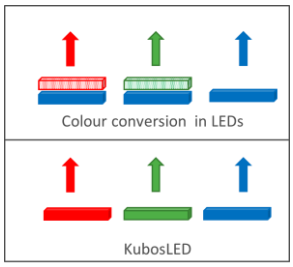
- Better colour rendering
- Colour shift reduction
- Faster switching speeds
- Improved colour gamut

Reduced Manufacturing Steps

- Same manufacturing equipment
  - Standard and scalable (standard silicon wafers from 150mm)
  - High volume processes compatible with existing microLED manufacturing of blue microLEDs
- Reduction in overall manufacturing costs
- No colour conversion (eg no Quantum Dots)
  - Improved efficiency



The Problem

Over the last 30 years the Group III nitrides, which usually crystallise in a hexagonal structure, have become an increasingly important group of semiconductors primarily due to their almost unrivalled suitability for the production of high efficiency, short wavelength (primarily blue and ultraviolet) light emitting devices. While in principle the Group III nitrides can be alloyed to enable devices fabricated in them to address the full colour gamut required for a display, in practice, well-understood physical limitations mean that to date it has been impossible to produce amber and red devices with suitable efficiency for a viable near-eye display.

These limitations stem from internal electric fields that result from the asymmetry of the hexagonal crystal structure and the need to employ a significant indium fraction in the nitride alloy used for the active region of longer wavelength LEDs. While in larger format devices an alternative material system can be employed to provide the required red and amber devices, this solution also fails when the device size shrinks. Indeed, despite more than a decade of effort and many millions of dollars of investment targeted on resolving these issues, the efficiency of amber and red microLEDs has remained stubbornly below the levels required for viable use in full-colour, high brightness displays.

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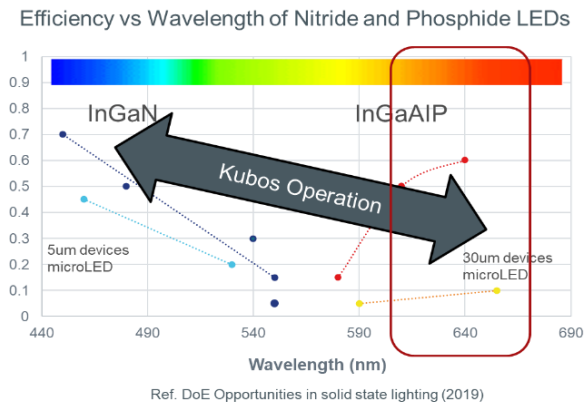
The Solution



Ref. DoE Opportunities in solid state lighting (2019)

It has long been known that it is also possible to crystallise the Group III nitrides in a metastable cubic form which has superior symmetry to the more usual hexagonal structure and that in this material the electric fields that inhibit the efficiency of the longer wavelength nitride-based LEDs are absent.

Furthermore, and fortuitously, the cubic nitrides have a narrower bandgap than their hexagonal equivalents which results in a requirement for less indium content in the alloy to achieve the same target wavelength.

For these reasons cubic nitrides have attracted considerable research interest but establishing a suitable epitaxial process to produce device quality material has proved elusive until now. Kubos Semiconductors has developed and patented a scalable and manufacturable method of producing cubic Group III nitride, device-quality epitaxy using standard materials and growth equipment which offers a solution to the problem of low efficiency red and amber microLEDs and the prospect of producing full-colour, high efficiency displays in a single material system.

Features and benefits of the Kubos technology include:

- Growth on silicon substrates ensures that it is readily manufacturable and scalable (already demonstrated at 150mm diameter), cost competitive and CMOS compatible.
- Growth on industry-standard, multi-wafer epitaxy tools using conventional III nitride MOCVD precursors.
- KubosLED wafers are fully compatible with existing hexagonal III nitride device processing lines.
- KubosLED eliminates the internal electric fields which give rise to the Quantum Confined Stark Effect which prohibits longer wavelength hexagonal III nitride devices. This also enables device designers to use quantum well width as another tool for tuning the emission wavelength of LEDs made in it.
- The narrower bandgap of KubosLED reduces quantum well indium fraction required to access efficient emission in the green, amber and red regions simplifying growth.
- Reduced carrier lifetimes in KubosLED results in lower carrier densities for reduced “droop” in LEDs and enables faster switching/refresh rates for displays and communications applications.
- Absence of internal electric fields in KubosLED eliminates screening as current density increases resulting in reduced spectral drift with LED drive current producing more consistent colour rendering.
- Improved p-type doping in KubosLED due to lower magnesium activation energy and higher hole mobility. This is beneficial in both LEDs and p-channel transistors.
- The ability to produce the full colour gamut with KubosLED paves the way to a monolithic solution for RGB pixels.

How to Get Involved

Given these advantages over hexagonal III nitrides, Kubos Semiconductors is offering:

- Initial evaluation samples of KubosLED structure epilayers at red wavelengths.
- Collaborative development projects.
- Manufacturing licenses to use this proprietary technology.

Further Information

1) Video of our green LED Demonstrator from Display Week 2023.
   LinkedIn Video
2) LED Magazine Article.
   Micro-led-manufacturing-are-cubic-ingan-red-micro-leds-on-your-roadmap

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