III-Nitrides NWs based µLEDs: a solution for AR display technology

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ABSTRACT

The major challenges of micro-displays for augmented reality (AR) are to find ways of drastically increasing the amount of lumens provided to the user eyes via an optical system. The projector form factor has to be as small as possible while keeping the power consumption as low as possible.

Micro-LED micro-displays can potentially meet those requirements because the brightness of micro-LEDs can be several orders of magnitude higher than the competitive technologies such as OLED or LCOS, and with an excellent contrast ratio. However, most of the micro-LED technologies experience efficiency loss when reducing the size of the micro-LEDs, provide a lambertian emission, which limits the coupling efficiency with an optical waveguide and need complex processes such as junction stacking or color conversion for RGB array manufacturing. Those issues limit the capability of those micro-LED technologies to produce efficient and cost competitive RGB micro-displays.

Aledia has developed a technology based on the epitaxy of GaN NanoWires (NWs), allowing the growth on 200mm to 300mm Si substrates. By its know-how in epitaxy, Aledia has succeeded in combining two epitaxy worlds, Metal Organic Chemical Vapor Deposition (MOCVD) and Plasma Assisted-Molecular Beam Epitaxy (PA-MBE) to develop this specific technology. Thanks to the unique combination of NWs and PA-MBE characteristics, Aledia is able to grow in the same epitaxy run, Red, Green and Blue active regions of a RGB array. The pixels and subpixels are constituted of array of NWs (Figure 1), which prevents EQE reduction with size, enabling to target subpixels down to 1.25µm. This allows to drastically reduce the size of a micro-LED micro display and the RGB light engine.

Moreover, the periodic arrangement of the NWs in the subpixels allow to obtain a photonic crystal effect that greatly increases the directivity of the emission of the subpixels. The amount of lumens emitted in +/- 20° around the normal of the microdisplay can be increased up to a maximum theoretical factor of 8 compared to a Lambertian emission, without the use of micro-lenses.

In this paper we will present RGB devices obtained in a single epitaxy run and show the directional emission of our GaN NWs based LEDs grown on Si wafers. We will emphasize how PA-MBE can revolutionize the RGB Augmented Reality world.

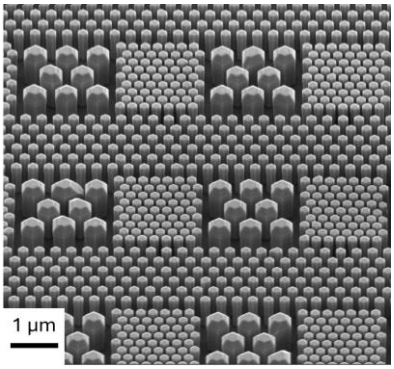

Figure 1: Bird view SEM image of Aledia 2 µm subpixel pitch Native Color NWs grown on Si