Recent Advances in Optoelectronic Technologies in ASTRI

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Abstract

A brief introduction to ASTRI's work on optoelectronics is given. Some research results on power GaN LED chips, LED packaging, LED general lighting, LED backlight units for LCD TVs and projectors, and anti-shaking camera modules are presented.

Introduction

Hong Kong Applied Science and Technology Research Institute (ASTRI) has been working on optoelectronics in the areas of light emitting diodes (LEDs) and photonics components. The LED program includes power GaN LED chip design and fabrication, LED packaging, and applications to solid-state lighting (general lighting) and display. Photonic components program focuses on advanced camera module development.

Power GaN LED Chip Design and Fabrication

A technology platform for power GaN vertical LED chips using a novel approach, i.e removing and replacing the sapphire substrate by a new material via a modified chemical mechanical polishing (CMP) process. Compared to the mainstream method of laser liftoff which poses technological challenges due to damages to epitaxial layers from the explosive nitrogen gas generated by pulse laser beam, the CMP method uses conventional tools and polishing processes, thus causing less damage to the epitaxial layers and improving process yield. It is suitable for mass production using batch processes. Fig. 1 shows a typical wafer on copper with sapphire removed and light emission images of LED mesas with different sizes (0.35 mm x 0.35 mm, 1mm x 1mm, and 2mm x 2mm).

Solid-State Lighting

ASTRI has successfully developed high performance and highly functional integrated lighting solutions using LEDs, covering components, fixtures and system aspects. We have promoted some of the research results to the industry for mass production, such as 5-Watt LED MR16, high brightness street lamps, uniform illumination light strip, wireless lighting network and control systems, as shown in Fig. 2.

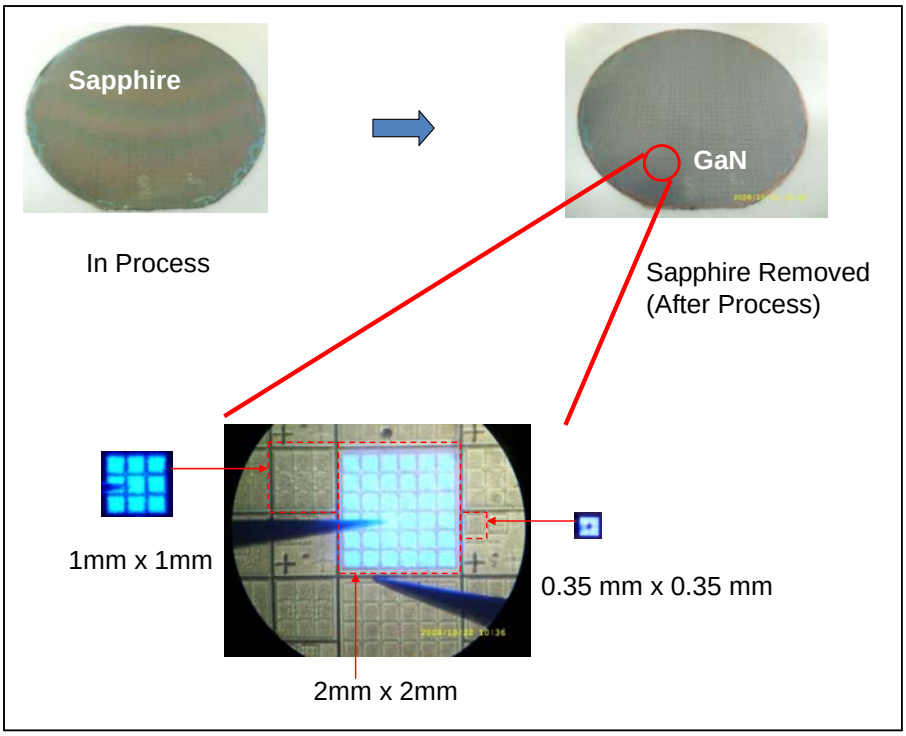

Fig. 1. Upper Panel: a 2-inch InGaN/GaN LED wafer on copper, during and after sapphire is removed by chemical mechanical polishing. Lower Panel: light emission from LED mesas with different sizes when current is applied, images taken from the eye piece of an optical microscope.

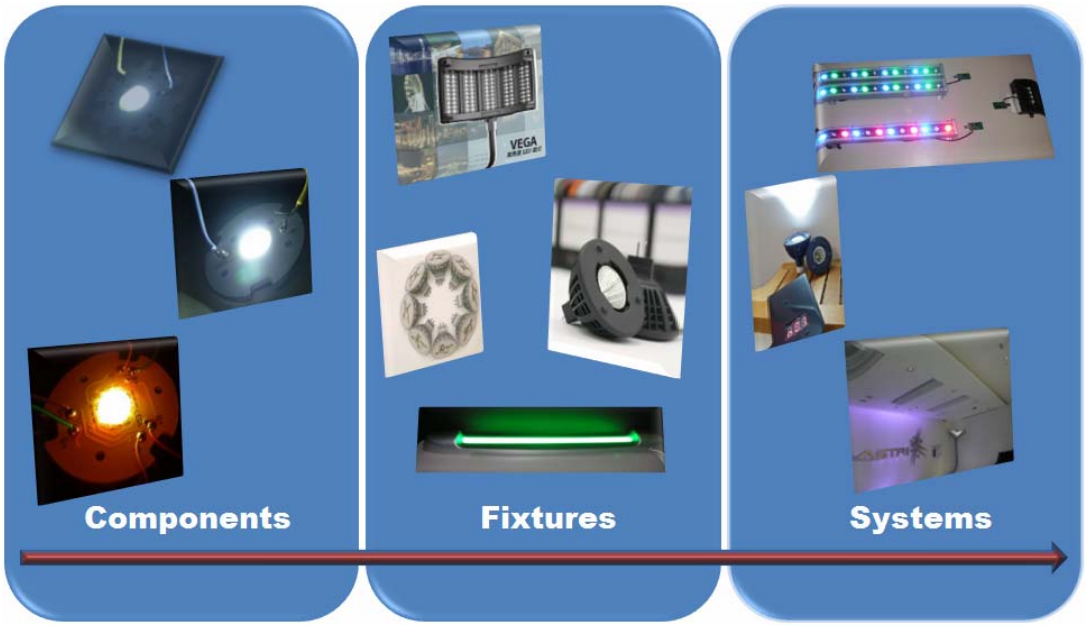

Fig. 2. Examples of the LED products for solid-state lighting developed at ASTRI.

LED Display Systems

Various technologies for LED backlight units have been developed, such as large-size ultra-thin LED backlight, high dynamic range (HDR) LCD display, pico-projectors, microdisplay (LCoS/DLP) miniature projector, MOEMS scanning mirror and laser scanning image projection system, novel large-size touch sensing technology and interactive display system. The HDR technology is particularly useful for better image quality and saving of electrical power. Fig. 3 shows the world's smallest pico-projector using LED as the light source developed at ASTRI.

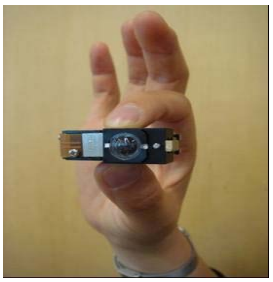

Fig. 3. World's smallest pico-projector developed at ASTRI

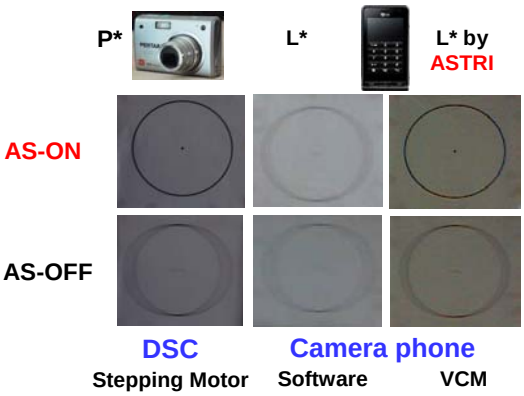

Fig.4. Improved image quality by ASTRI's anti-shaking camera technology.

Anti-Shaking Camera Modules

Digital camera and mobile phone camera both suffer from blur images due to movement of the device when photos are taken. A technology has been developed at ASTRI to incorporate anti-shaking function into the camera module, and yields much higher image quality as shown in Fig. 4. Prototypes with the world's smallest anti-shaking module have been demonstrated.

Summary

In conclusion, ASTRI has optoelectronic research programs in LED material processes and packaging, chip design and fabrication, solid-state lighting, backlight unit for display systems (LCD TVs and projectors), and advanced camera modules.