Characterization of InGaN LEDs for Higher Efficiency Optical Devices

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Indium Gallium Nitride (InGaN) is a promising candidate to make effective and environmentally friendly light emitting diodes (LEDs), used for electronics display, indoor lighting, and wireless communication. A long-standing problem has been the low efficiency of orange InGaN LEDs. The purpose of this project is to investigate the uniformity, electronic behavior, crystal quality, and structure of InGaN in the light-emitting layers of green, blue and orange InGaN LEDs by photoluminescence and electroluminescence. The electroluminescence method was used to test the structure and behavior of the LED, by placing an optical fiber above it, measuring the light's intensity and wavelength. The photoluminescence method was used to examine the crystal quality and indium content, by directing a laser beam to different points in the crystal to build a 2D map of the radiation spectrum. Through the results, the problems of orange LEDs were revealed: the rapid decrease of light intensity under high temperatures, 350-400K, the crystal defects that give fluctuating light wavelengths from 600-640 nm, and the high stress of 14.2Gpa on the crystal. By analyzing these results, it was proved that by decreasing the strain on the crystal and installing an AlGaN block layer, an increase in efficiency would be delivered. With this improvement, it is easier to combine all the colors of InGaN LED to produce high quality and efficient white lighting, eventually replacing fluorescent and incandescent lighting, and contributing to the Li-Fi technology, the wireless communication method between devices using light to transmit data.