Deep UV LEDs for Water and Air Purification

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We describe deep AlGaInN/GaN and AlGaN/GaN UV LEDs with peak emission wavelengths ranging from 250 nm to 340 nm operated at CW current levels up to 100 mA, with the external output power being nearly proportional to the drive current (see Fig. 1) and exceeding 10 mW/cm^2 in CW mode for a single LED.

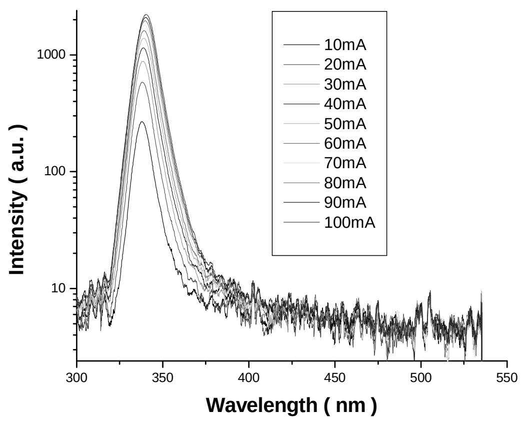

Figure 1. Emission spectra of 340 nm LEDs.

Typical device cross-section is 200 μm x 200 μm. The epitaxial layer design of these devices (see Fig.2) relied on strain energy engineering (SEBE) approach to control defects and improve light generation and extraction efficiency. The SEBE approach relies on using ternary compounds and/or strain compensating superlattice structures for controlling strain and increasing the Al molar fraction for obtaining a shorter wavelength emission. We have also explored using non-polar sapphire substrates. Migration Enhanced MOCVD (MEMOVD) technique was used to grow deep UV LED structures. This technique uses overlapping precursor pulses of optimized shape allowing for an effective migration of species on the growth surface and for a reduced growth temperature.

For 340 nm devices, the series resistance was on the order of 15-20 ohms. The leakage current at – 1 V was below 1 nA. The devices exhibited good stability after an initial drop in output power (see Fig. 4). No significant change in spectrum was observed after 170 hours stress at 90 mA drive current. The stability was virtually perfect at 50 mA drive current.

For very short wavelength LEDs, bulk AlN substrates were used for controlling lattice mismatch and growing improved quality LED structures emitting down to 240 nm (see Fig. 3.)

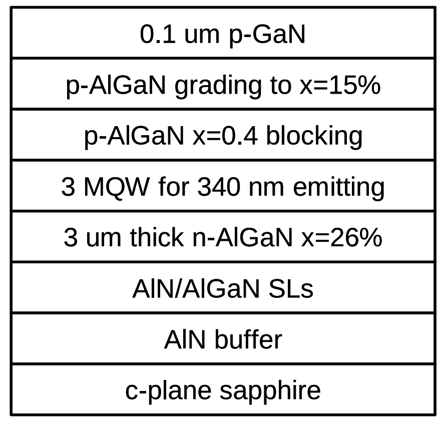

Figure 2. Device structure of 340 nm LED.

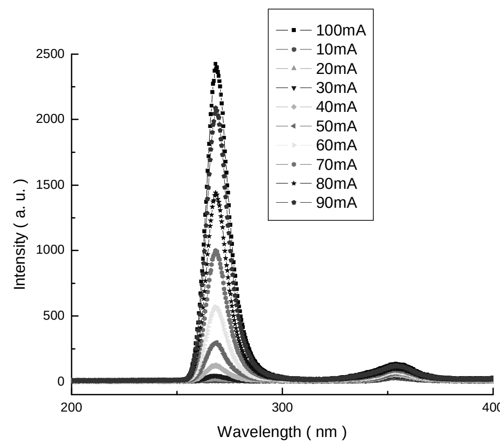

Fig. 3. Spectrum of 265 nm UV LED

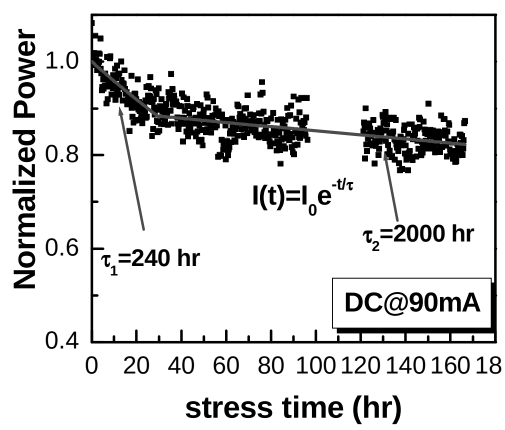

Figure 4. Stability testing of 340 nm LED

The availability of a variety of UV LEDs with different wavelengths allows us to place 340 nm and 260 nm UV LEDs in the same hermetically sealed package. We will report on using combinations of UV pulses at 260 and 340 nm for water and air purification.