Investigation of energy transfer between europium centers in GaN:Eu using combined excitation emission spectroscopy

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Establishing an all GaN based red LED is an important step toward micro-LED displays, which are the next step in a rapidly growing "smart society". Since commercially available red LEDs are achieved using AlGaNInP/GaAs, we have been working on a GaN:Eu based LED. Europium is a rare-earth, characterized by intrinsic 4*f* transitions, allowing for a temperature and host independent emission at ~620 nm. However, due to its size, Eu can create different defect environment in the GaN host. Using combined excitation emission spectroscopy (CEES), we have established the existence of 8 different emission centers in our organometallic vapor phase epitaxy (OMVPE) grown samples. We have also determined the proportion of each centers and their efficiency. The two main centers are called OMVPE4 (most abundant) and OMVPE7 (most efficient). CEES is the record of the photoluminescence (PL) as the excitation energy is changed by using a dye laser, while the PL is recorded with a CCD-equipped monochromator. To gain a more fundamental understanding of the energy transfer between the defect levels in the host and the OMVPE4 and OMVPE7 Eu centers, a two laser experimental setup was designed. In this set-up, one laser is used to directly excite each Eu center individually, and another is used to excite other defect levels within the GaN host, which can in turn transfer energy to the Eu centers. Preliminary results indicate that a direct excitation of OMVPE4 can lead to the emission from OMVPE7 via a transfer of energy through the host. In this contribution, we will further explore the nature of this energy transfer using our two laser excitation experiment, and discuss its possible influence on the operation of GaN:Eu based red LEDs.

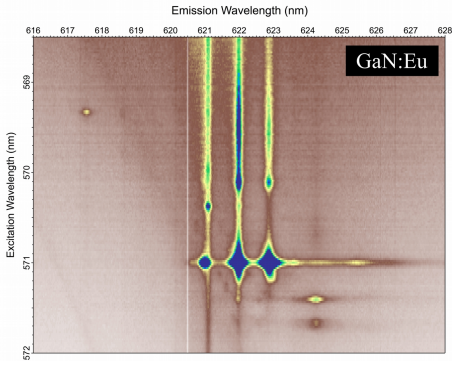

Figure 1. CEES map of a GaN:Eu sample: different excitation energies are used (y-axis), while the PL of the sample is recorded (x-axis).
Color code: the more intense, the more blue.