Understanding the Growth of Gallium Nitride Nanorods using Cathodoluminescence Spectroscopy

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Group-III nitride nanorods have gained considerable interest in recent times due to their direct bandgaps, full solar spectrum coverage and wide device applications. Self-assembled nanorod growth has gained special attention for applications in flexible electronics and single wire LEDs due to the low sample preparation and catalyst free growth.

Understanding the nucleation process of GaN nanorods during self-assembled growth is important if these wires are to be used for device fabrication. The nucleation process can affect the quality of the whole nanorod. Here we will demonstrate how cathodoluminescence (CL) can be used to investigate the early stages of nanorod growth and how this can influence the nanorod growth process.

The samples used in these experiments were hexagonal GaN nanorods grown on (0001) sapphire substrates in an Aixtron metal organic chemical vapour deposition (MOCVD) system. CL measurements were performed using an FEI Verios 460 field emission gun scanning electron microscope (FEG-SEM) equipped with a Gatan MonoCL4 system for the detection of CL emission. CL signal was detected using a high-speed photo-multiplier tube (HSPMT) for the collection of CL images or a UV-enhanced CCD array for the collection of full CL spectra.

Low-voltage CL imaging and full-spectral mapping have been used to characterise the GaN nanorods. Figure 1 shows scanning electron microscopy (SEM) (left) and panchromatic CL (right) images from a typical hexagonal nanorod, that has been transferred from the native substrate. From the CL image we are able to identify optically defective regions around the corners formed during the initial stages of growth.

By utilizing CL spectroscopy, we can investigate directly the optical properties of all stages of nanorod formation. This allows us to determine how these nanorods form, allowing for the growth process and parameters to be improved.
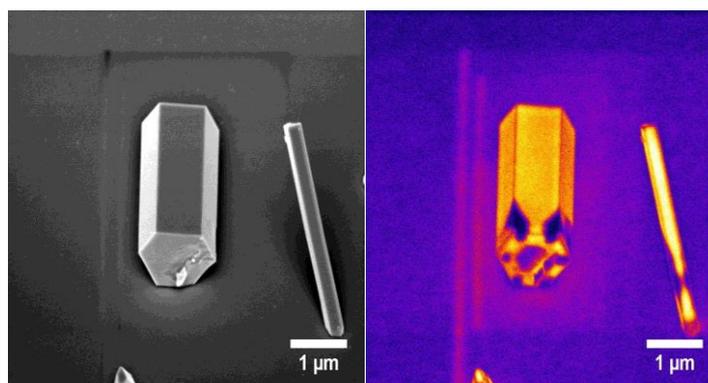

Figure 1. SEM (left) and Panchromatic CL (right) image from a typical nanorod.], collected with a beam current of 25 pA and voltage of 3 kV.