Engineering of InGaN/GaN in-plane quantum wires grown along surface atomic steps

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Less than one monolayer InGaN epitaxial layers have been grown on vicinal GaN (0001) surfaces in the step-flow mode. The chosen vertical growth rate is low and constant and determined by the supply of gallium precursor. One atomic terrace is covered by advancing steps in several seconds. Indium supply is switched on for even smaller time and thus In-rich regions (quantum wires) parallel to the growing atomic steps can form. Wide-area cathodoluminescence (CL) spectrum shows two peaks: one connected with GaN band-to-band emission and the other with InGaN emission, see Fig. 1a. Next, Atomic Force Microscopy (AFM) and CL have been applied to verify that indeed there are indium-rich regions correlated with arrangement of surface atomic steps, see Figs 1b-1d. We show that only InGaN-related monochromatic CL image shows some spatial correlation with atomic steps. In the present work we will show luminescence wavelength, intensity, peakwidth as a function of temperature and excitation power, for two different atomic terrace widths: 200 nm and 40 nm, thus defining the maximum width of the grown quantum wires. This kind of optical study should give basic information on carrier confinement inside the wires, their localization by the fluctuating potential minima at low temperature and luminescence efficiency. The described growth technique is promising for applications, because this kind of quantum wires could eventually be shaped by proper surface patterning.

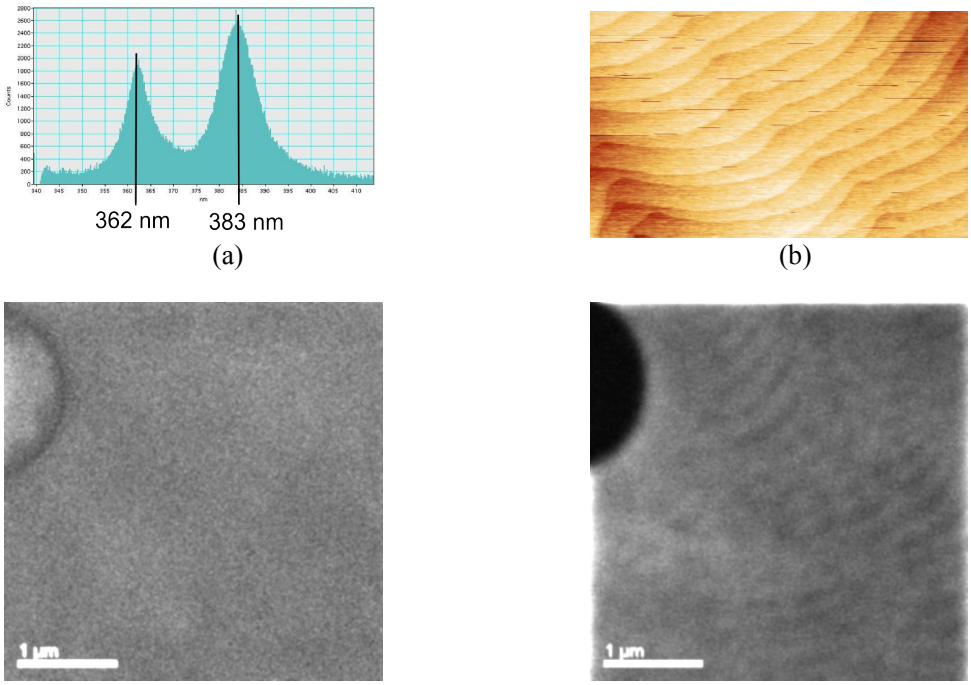

Fig. 1. (a) Wide range CL spectrum showing the 362 nm GaN peak and 383 nm InGaN peak, (b) AFM image with atomic steps, image size 5x3 micrometers, (c) monocgromatic CL image acquired at 362 nm and (d) monochromatic CL image acquired at 383 nm. Size of (c) and (d) is 5x5 micrometers.