Efficient green emission and phosphor-free white lighting based on nano-LED ordered arrays grown by selective area MBE

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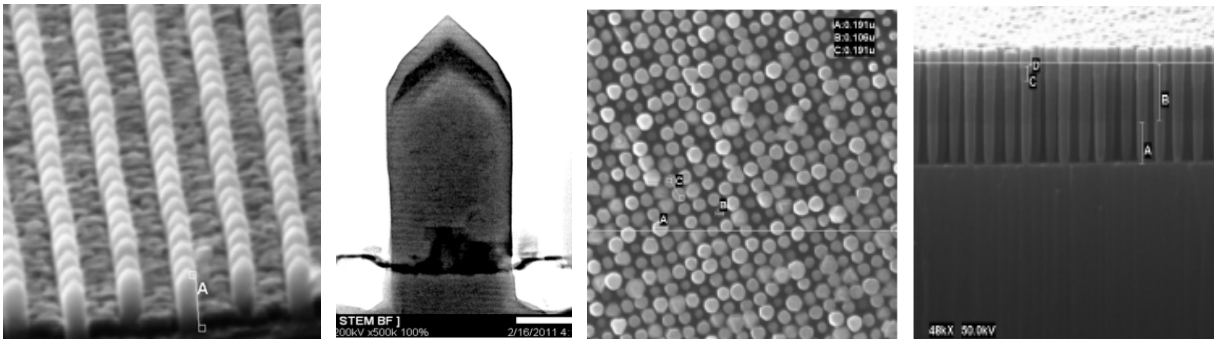
An analysis of the selective area growth (SAG) by plasma-assisted molecular beam epitaxy (MBE) is presented. Details will be given on the use of thin Ti mask with nanoholes of different diameter and pitch and on the specific conditions for localized, selective growth of nitride heterostructure materials. These conditions are quite different from those for optimized self-assembled growth. Successful localized growth on patterned or masked substrates depends critically on a balance between metal atom diffusion and desorption, both strongly influenced by the growth temperature, surface roughness, and III/V ratio. From the nucleation stage, conditions to avoid growth inhibition on r-facets are studied, leading to control the nanostructure topmost geometry (pyramidal or flat).

Different approaches will be discussed concerning the structure of the ordered nanorod arrays, where the active region (emitting region) can be either InGaN Q-disks with different In content or "thick" InGaN portions with constant or graded In compositions.

Efficient red, green and blue (RGB) emission is achieved by optimizing the InGaN active layer in GaN/InGaN nanorod arrays. Green emission seems not to suffer from an efficiency droop with injected current. In addition, very efficient white emission is obtained at room temperature from ordered arrays of nano-LEDs having a more complex active region.



(a) (b) (c) (d)

Fig. 1. Array (a) and close-up (b) of GaN nanorods with an embedded InGaN Q-disk (upper dark area); top (c) and cross-sectional (d) views of an ordered array of GaN/InGaN *p-i-n* nano-LEDs.