# Red emission thin nanocolumns with diameters less than 200 nm prepared by nano-template selective area growth

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Nanocolumns have properties suitable for InGaN-based high efficiency emitters, such as strain relaxation effect, threading dislocation filtering effect, and increased critical thickness of InGaN active layer. These characteristics can be expected to be sufficiently effected, particularly for thin nanocolumns with the column diameter (*D*) less than 200 nm. In this study, InGaN/GaN nanocolumns were prepared by RF-MBE using the nano-template selective area growth (SAG) method [1], which method provides highly uniform nanocolumn arrays. Figure 1 shows the cross-sectional TEM image of the red emission InGaN/GaN ordered nanocolumn arrays with the column period (*L*) of 160 nm; a bulk InGaN active layer with the thickness of 48 nm was prepared at the top of GaN nanocolumn, but no misfit dislocations were observed. The point EDX analysis was performed evincing the uniform distribution of In composition at $X_{In}$=31~33%. Figure 2 shows the photoluminescence (PL) spectra of InGaN ordered nanocolumn arrays with *L* = 160-350 nm. A monomodal red emission peak at 644 nm was observed for *L*=160 nm nanocolumn arrays, but with increasing *L* (with the increased *D*), the peak wavelength shifted toward the short wavelength side. In the previous work, as *D* increased, the wavelength became longer [2]. In this work, red emission nanocolumns were obtained for ordered nanocolumn arrays with the small *L* region less than 200 nm and then green emission was observed for *L* = 220-300 nm, as shown in Figure 3. We believe that these characteristics can contribute to the realization of highly efficient red emitting nanocolumn LEDs.

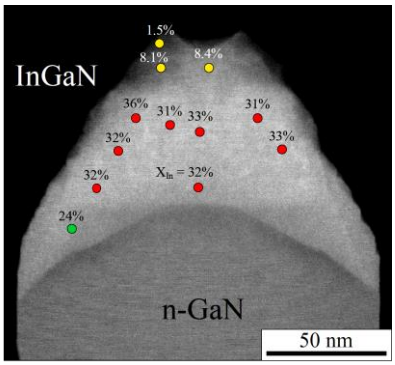


Fig.1 Cross-sectional TEM image and point EDX analysis of In compositions of red emission nanocolumn with *L*=160 nm

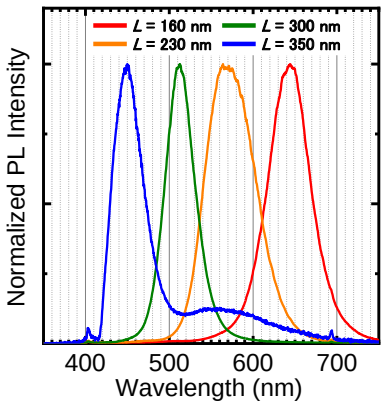


Fig.2 PL spectra of nanocolumn arrays with the different nanocolumn period (*L*) from 160 to 350nm

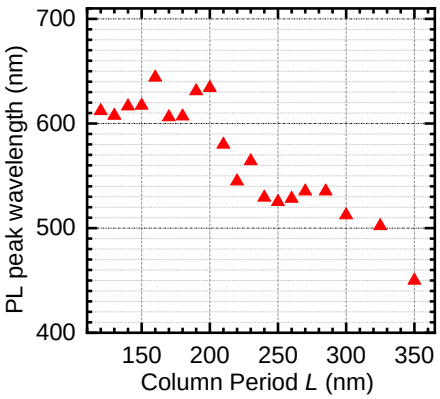


Fig.3 PL peak wavelength of nanocolumns arrays as a function *L*

**References**

[1] K. Yamano et al., Journal of Crystal Growth 425 (2015).
[2] H. Sekiguchi et al., Appl. Phys. Lett. 96 231104 (2010).