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GaInN-based LED structures on semi-polar crystal facets

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In order to overcome the problems of reduced recombination probability due to internal piezoelectric fields in strained GaInN quantum wells, we have developed a method to grow semipolar GaInN-based LED structures on {1-101} side facets of selectively grown GaN. This talk will describe our recent work concerning the epitaxial growth by metalorganic vapor phase epitaxy along with some sophisticated characterization studies. For the selective growth, we have studied stripe and hexagonally shaped geometries. We found a strongly facet dependent growth mechanism leading to very flat surfaces on {1-101} facets as opposed to their {11-22} counterparts along with a different indium incorporation efficiency. An increased indium uptake on semi-polar {1-101} facets as compared to conventional c-plane layers helped to shift the LED emission to longer wavelengths beyond 500 nm in the green spectral range despite the significantly reduced field-dependent Stark shift. By photoluminescence (PL) investigations on pre-biased LED structures along with respective model calculations, we could directly determine the value of the reduced internal electric field. The significant reduction was further confirmed by time-resolved PL studies. The symmetry of hexagonally shaped mask geometries is more favourable for large area device applications. Moreover, the reduction of dislocations resulting from the heteroepitaxial process on sapphire may be more pronounced. However, we found a quite strong local variation of the emission wavelength over the formed inverted pyramid facets which is also visible in locally resolved measurements of the carrier recombination times.

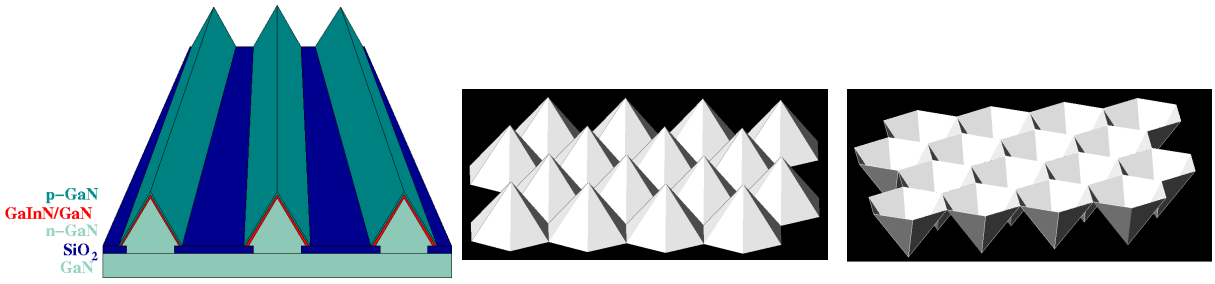

Fig. 1: Sketch of semipolar GaInN-GaN structures obtained by selective area epitaxy on masked GaN templates. Left: Stripe geometry; center: Mask openings with hexagonal shape leading to pyramidal growth; right: Hexagonally shaped mask areas leading to inverted pyramids.