# Comparison of InGaN Quantum Wells on Polar and (11-22) Semipolar Substrates of different defect density

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III-nitride based semiconductor light emitters still display reduced internal quantum efficiency in the green and yellow part of the optical spectrum. This is mostly due to the difficulties associated with the growth of InGaN quantum wells of sufficiently high Indium content needed to achieve an emission wavelength near the center of the visible spectrum. The resulting lattice mismatch to GaN favors defect formation and impedes efficient Indium incorporation, necessitating lower growth temperatures. Furthermore, the resulting polarization fields, of both spontaneous and piezoelectric origin, lead to a drop of the oscillator strength, especially when the growth is carried out along the conventional *c* direction.

The growth along nonpolar or semipolar orientations may help to overcome some of these difficulties. The polarization fields are reduced, enabling the use of wider quantum wells without degrading the electron-hole overlap. Furthermore, In incorporation seems to be favored for growth along certain semipolar orientations, permitting higher growth temperatures and improved crystal quality for a given indium concentration. Many recent publications report on QWs grown on semipolar orientations, despite the limited availability of semipolar substrates with defect densities comparable to conventional polar GaN substrates [1,2].

In this work we aim to compare InGaN quantum wells grown on polar (both, Ga-polar and N-polar) as well as semipolar (11-22) crystal orientations of varying defect densities. Indeed, to assess the role of the defect density and defect type, in the luminescence efficacy of semipolar growth, InGaN quantum wells were grown on semipolar (11-22) templates of high, intermediate as well as very low defect density, the latter thanks to a new and proprietary method developed at CRHEA and similar to the asymmetric ELOG previously reported [3,4]. The typical defects densities swept by the employed templates are: dislocation densities from $10^{10}cm^{-2}$ to values comparable with c-oriented substrates, and basal stacking faults densities from $10^{5}cm^{-1}$ to less than $10^{3}cm^{-1}$. Besides, free-standing Ga-polar and N-polar substrates, of comparable crystal quality (dislocation density $<10^{8}cm^{-2}$), were used as reference samples. Single quantum wells were prepared on all substrates using metal organic vapor phase epitaxy. Two series of samples with varying well widths and In concentrations were grown, and subsequently characterized by optical means (photoluminescence and cathodoluminescence) as well as by transmission electron microscopy, which enabled to determine the In content in each QW.

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