Carrier Recombination Mechanisms in Multicolor InGaN/GaN Light Emitting Diode

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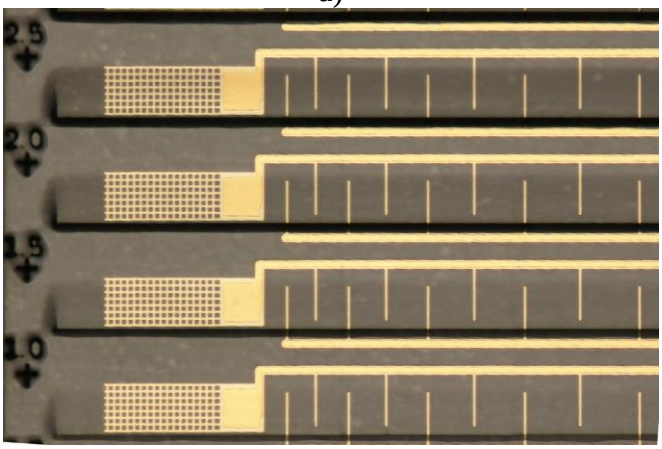
Miscut angle is one of the most important factors in epitaxial growth of every semiconductor structure. It governs kinetic processes on the growth front and influences structural, optical and electrical properties of quantum structures.

The ternary compound $In_xGa_{1-x}N$ bandgap and internal electric field are strongly dependent on indium composition, x. Wurtzite InGaN structures are usually grown along the polar c-direction. Although the main factor to determine indium composition is the growth temperature, it has been demonstrated that for c-plane substrate x significantly depends on the substrate miscut angle [1].

In our work, we developed a special patterning technique, which allowed us to locally tune the surface angle in relation to c-axis, and thus the indium content could be varied in different regions of one wafer.

We studied correlation of the wavelength of light emitted from quantum structures and devices prepared with this technique with the amount of indium and strength of the internal electric field. We measured temperature- and time- resolved photo-luminescence in MQW structure grown in substrate regions with different indium content. Based on these results we analyze radiative recombination mechanisms responsible for light emission in our structure. Finally, an electrically driven, multicolor LED device is demonstrated, with tuning range as large as 41 nm what means change from cyan to violet colors on one wafer. The recombination rate varies from 0.1 to 0.3 ns^{-1} decreasing with rising surface miscut angle.

a)



b)

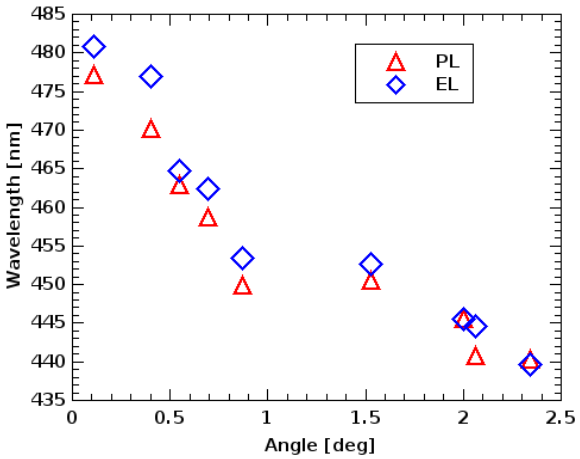


Fig. 1: a) Individual contacts made by photolithography. Regions tilted with respect to c wurzite plane can be seen. b) Electro – and photoluminescence wavelength dependences on miscut angle.

[1] M. Kryśko, G. Franssen, T. Suski, M. Albrecht, B. Łucznik, I. Grzegory, S. Krukowski, R. Czernecki, S. Grzanka, I. Makarowa, M. Leszczyński, and P. Perlin, *Appl. Phys. Lett.*, **91**, 21 (2007).