Wurtzite InGaN/GaN quantum wells form the active layers in the light emitters working in green-UV part of the spectrum. There are three effects which influence significantly efficiency of light emission: i) very high dislocation density (up to $10^8$-$10^9$ cm$^{-2}$), ii) high magnitude of the built-in electric fields (originating from spontaneous and piezoelectric polarizations), and iii) a high density of radiative recombination centers related to a local In-rich fluctuations in the In(Al)GaN quantum wells/layers. Role and interplay between these different mechanisms of radiative recombination in nitrides is not well understood. The consequence of i) and ii) is a strong reduction of the emission efficiency. The first factor (i), represents the nonradiative recombination centers, whereas the second one (ii), causes a spatial separation of electrons and holes and thus leads to a reduction of their wave functions overlap (Quantum Confined Stark Effect – QCSE). Concerning iii), the mentioned radiative recombination centers resulting from In-content-fluctuations, create regions in which the carriers can be trapped and isolated from the dislocations, i.e., nonradiative recombination centers. That increases the probability of radiative recombination. It is worth to point out that previous studies of light emission effects in quantum structures of nitrides clearly demonstrate a drastic reduction of the pressure coefficient of the emitted light energy with respect to the band gap shift. This effect was exploited in the studies of the built-in electric field in the studied quantum structures of nitrides.

The purpose of this work is to elucidate the influence of potential fluctuations caused by indium segregation onto radiative recombination mechanisms. Examination of the exciton/carrier localization by In-content fluctuations is carried out by means of hydrostatic pressure and temperature dependent measurements of the photoluminescence in multiquantum wells of InGaN/GaN.

First, we examined the temperature behavior of the emission peak, $E_E$. The sample used in the work shows very well pronounced S-shaped curve that is associated with localization effects. $E_E$ vs. T consists of an initial drop of $E_E$ with increasing temperature ($T \approx 4$-130 K) related to thermal emptying of energetically higher lying traps. It has been suggested that the lower energy states populated during the temperature increase by excitons/carriers have much more localized nature. Further rise of T ($T \approx 130$–220 K) is followed by reoccupation of higher lying traps of less localized character. It is accompanied by an increase of the emission energy with temperature. For higher T, excitons/carriers become entirely delocalized and $E_E$ vs. T resembles the band gap evolution. Analysis of such data can supply information about the localization properties of the structures. On the other hand, it is well known that increased localization of exciton/carriers may lead to a reduction of the observed shift of the emission peak energy with applying pressure ($dE_E/dP$). In this study, we determined pressure coefficients $dE_E/dP$ in these different temperature regions. We found a pronounced correspondence between decreasing $E_E$ in the region of about 130 K and achieving there a minimum value by $dE_E/dP$. It is suggestive to interpret that temporal evolution of $dE_E/dP$ as reflecting involvement in the light emission of the localized states of excitons/carriers, that is particularly visible in lower temperature range. This observation strongly supports role of In-fluctuations in the mechanisms of very efficient light emission from InGaN/GaN structures.