EFFECTS OF WEAK MAGNETIC FIELD TREATMENT ON THE INTERFACE OF EPITAXIAL GaN

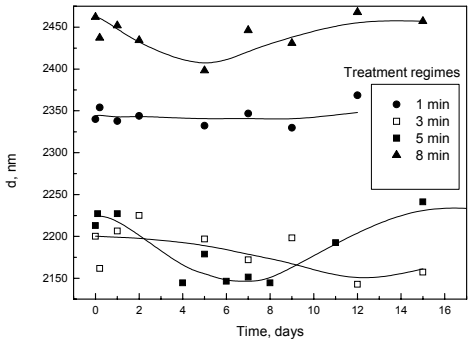
Red'ko R.A.
V. Lashkaryov Institute of Semiconductor Physics of the National Academy of Sciences of Ukraine, 41 Nauky Pr., 03028 Kyiv, Ukraine, e-mail: redko.rom@gmail.com

Objects of investigation were epitaxial films of GaN, Si-doped with concentration of $1.6 \cdot 10^{19}$ cm^{-3}, grown on Al_2O_3 substrates using MOCVD technique. Thickness of films was ranged from 2 to 2.5 microns.

The spectral dependencies of the optical density (OD) of epitaxial structures were measured at 300 K with a spectrophotometer Specord 210 in the 350–1100 nm wavelength range with an error below 0.1 nm. The treatment in pulse weak magnetic field (WMF) was at regime with $B = 60$ mT, $\tau = 1.2$ ms, t=1(№1), 3(№2), 5(№3) and 8(№4) min. For long-term processes researching all measurements were repeated during the time that was needed to reaching some equilibrium state with non-changed OD spectra. Usually, it was near the month.

The wavelength OD dependence of the initial sample in the studied spectral range has two characteristic regions: a typical straight-line in the band-edge range and oscillation at wavelengths of 400-1100 nm, related with interference on top GaN layer. WMF treatment with different duration leads to different features in OD spectra. In spectral dependence of the sample №1, which treatment time was the least, no changes was detected. Obviously, such regime of treatment was not able to result any modification of the interface film-substrate or it was negligible. In OD spectra corresponding to samples №2, 3 and 4 changes both amplitudes and frequency position of oscillation features were observed. The detected changes of curves could be caused by variation of optical constants (that seems unlikely under our experimental conditions) and width of layer that formed interference Using the well-known method, we estimated effective width d for film, which forms interference, and obtained term-dependence $d(t)$, that shown on Figure.

There was characteristic minima of $d(t)$ dependences. Obliviously, it related with essential transformation of impurity-defect structure of inner boundary structure under investigation. Treatment duration with 3 min result in minimum $d(t)$ appearing on 13 day, 5 min and 8 min – on 7 and 4-5 day, respectively.



The dependence of observing moment of the maximum of WMF-induced effect via the treatment duration well fitted by exponential two-parameter expression $t_{resp} = \alpha e^{\beta t_{treat}^{-1}}$, where α and β – empirical constants, which for device structure under investigation is 2.8 and 4.5, respectively; t_{resp} - time from the ending of treatment to the observing of the maximum of WMF-induced effect; t_{treat} - duration of the treatment in WMF.

Thus, the influence of WMF on GaN/Al_2O_3 device structures leads to the reduction of defects, which exist at the interface film-substrate due to destruction of the metastable complexes. The study of the evolutionary features of GaN/Al_2O_3 structures OD spectra have shown the sensitivity threshold of defect subsystem of the material under investigation to the duration of magnetic-field treatment, which was t_{treat}> 1 min. As well as the exponential dependence of the maximum of WMF-induced effect on the duration of magnetic-field treatment. Such WMF action can be used as a cost-effective method for modification of the structural parameters and decrease of non-equilibrium centers in semiconductor materials and devices. Compared researches of photoluminescence and OD for structures under investigation allow developing contactless method for estimating the diffusion factors of magneto-sensitive defects existing at the interface of GaN-Al_2O_3.