Microplasma Characteristics of the Light-Emitting InGaN/GaN Thin-Film Structures on Various Substrates at Reverse Bias

Veleschuk V.P., Vlasenko O.I., Kisselyuk M.P., Vlasenko Z.K.

V. Lashkaryov Institute of Semiconductor Physics, NASU, Kyiv; Ukraine

At increasing the area for the epitaxial thin-film InGaN/GaN heterostructures arises the urgent problem of express detection and non-destructive control of electrically active extended defects (imperfect regions) in such heterostructures of power light-emitting diodes (LEDs).

Except for various methods of diagnostics and reliability prognostication based on diversity of elemental and structural analysis techniques, different electro-physics methods effective in non-destructive characterization and control of quality of GaN (InGaN, AlGaN) structures are local photo-, electro-, cathode-luminescence (PL, EL, CL). But it is not always possible to detect critical electrically active extended defects (defects regions) influence of which is dominant on electric and luminescent functional parameters of InGaN/GaN structures.

At the same time, application of a reverse voltage to GaN structure produces controlled microplasma (MP) breakdown that takes place mainly in the regions of extended defects, and is accompanied by luminescence [1].

Studied in this work is the microplasma controlled breakdown of InGaN/GaN heterostructures in power LEDs (P_{el} = 1 W, I_{nom} = 350 mA, λ_{peak} = 460…470 nm), prepared on various substrates - SiC, AuSn/Si, Al_2O_3. It has been ascertained that the luminescent and electric parameters of the microplasmas for InGaN/GaN power LEDs are related with the InGaN/GaN functional parameters. It is ascertained that among these three investigated heterostructures on the different substrates (SiC, AuSn/Si, Al_2O_3) the heterostructure on the SiC substrate has the best quality and, respectively, the best functional parameters, in contrast to the heterostructure on the sapphire substrate that has the highest amount of critical defects.

It is established that the sources of microplasmas in the InGaN/GaN heterostructures of power LEDs in the most cases are corresponding to them extended defects at the grain boundaries of GaN crystallites.

1. V.P. Veleschuk, O.I. Vlasenko, M.P. Kisselyuk, and O.V. Lyashenko. Microplasma breakdown of InGaN/GaN heterostructures in high-power light-emitting diodes // *Journal of Applied Spectroscopy*. – 2013. - Vol. 80, N 1. – P 121 - 127.