Study Of Long Time-Scale Photoluminescence Dynamics Of Gan/Ingan Quantum Wells And Comparison With Samples Grown On ELOG-Gan

R. Micheletto[1], M. Abiko[1], A. Kaneta[1], Y. Narukawa[2], T. Mukai[2] and Y. Kawakami[1]

[1] Graduate School of Engineering, Department of Electronic Science, Kyoto University, Nishigyo-ku, Katsura, 615-8510, KYOTO JAPAN

[2] Nichia corporation, 491 Oka, Kaminaka, Anan, 774-8601, TOKUSHIMA JAPAN

InGaN/GaN system has been investigated extensively lately because of their importance in the development of new light emitting diodes (LEDs) and other optical devices like diode lasers. Many research on these materials are focused on their optical characteristics, and in particular on their behaviour in very small time scale range. Conversely, in this report we studied optical phenomena that have long-range time constants. In particular, we studied samples where a thin InGaN/GaN interface defines a single quantum well (SQW) structure in the crystal. Tiny fluctuation of the Indium concentration in the SQW induces localized regions of high Photoluminescence (PL) emission. The disuniform pattern of sharp or blunt emission peaks are spatially ranging from few hundreds of nanometer extension to the micrometer scale range. Investigating these samples we established conditions by which instabilities in the PL optical signal were detected. These are characterized by significant blinking phenomena on the Photoluminescence map. Also we noticed an interesting slow drift of the bulk PL signal, a phenomenon that suggests the presence of a mechanism of optical memory involved in the process of Photoluminescence.

In this study we will present details on these measurements, in particular we will show how locally indium-rich centers seem to be directly involved in the blinking phenomena. Also, we will report on the dependence of the temporal behaviour with the large-scale (bulk) Indium concentration, and we will show how an epitaxially laterally overgrown GaN (ELOG) substrate influence the PL temporal instabilities.

We believe that these new intriguing long time scale dynamical phenomena are of crucial importance to shed light on the photoluminescence mechanisms occurring in these samples; their study is vital to pave the way to realize new and more efficient light emitting devices.

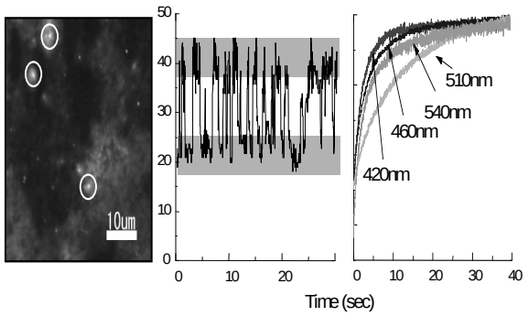

Fig. 1: The picture on the left is an example of PL map of InGaN/GaN device (excitation 365 nm). The circled area are blinking in a fashion shown in the central inset (vertical axis is PL intensity). The right plots represent a slow drift of PL signal observed in samples emitting at different wavelenghts as indicated by the arrows.