Home-made Cathodoluminescence, Electron Beam Induced Current and Transmission Electron technique in conventional SEM

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The development of novel technology is joined to the sophisticated, but also suitable characterization technique. The Scanning Electron Microscopy (SEM) has showed that it is a powerful non-destructive characterization tool [1]. Typically, energy dispersive spectrometer (EDS), secondary and back scattered electron detectors are installed in any SEM. Morphologic images and chemical composition can be obtained with these detectors. Nevertheless, characterization of optical and electrical properties is unavoidable for opto-electronic materials. In particular, semiconductors samples for luminescent applications need a study of their optical spectrum and electrical behavior. In these cases, sophisticated detectors can be installed into the SEM from the manufacturer, but the price could be as high as new standard SEM. Cathodoluminescence (CL) technique uses an electron beam as excitation source [2]. The high energy that is transferred to the sample can also be focused in a tiny volume. Thus, spectra (Fig. 1a) and monochromatic images (Fig. 1b) can be acquired during the same SEM session. Electron Beam Induced Current (EBIC) is another technique that also uses an electron beam as excitation source [3]. Images of electrical response can also be observed. Moreover, under special configuration the diffusion length of electron-hole pairs is estimated (Fig. 1c). Finally, with thin sectional samples, transmitted electrons give different contrast to the usual secondary and back scattered electrons (Fig. 1d). To get images by transmission electron in convention SEM (T-SEM), the sample has to be transparent to electron [4].

In this work we present results from our home-made CL, EBIC and T-SEM system installed inside a JEOL JSM-

5300 SEM having a tungsten filament as electron source. The SEM is able to change the accelerating voltage from 5 to 30kV. The measurements were carried out at room temperature. In order to get micrographs in CL, EBIC or T-SEM, voltage-signal coming out from respective detector is introduced to the internal electronic system of the SEM. Thus, SEM does itself the synchronization signal-intensity over each pixel. In CL imaging, the spectrometer was manipulated by our home-made Visual Basic program.

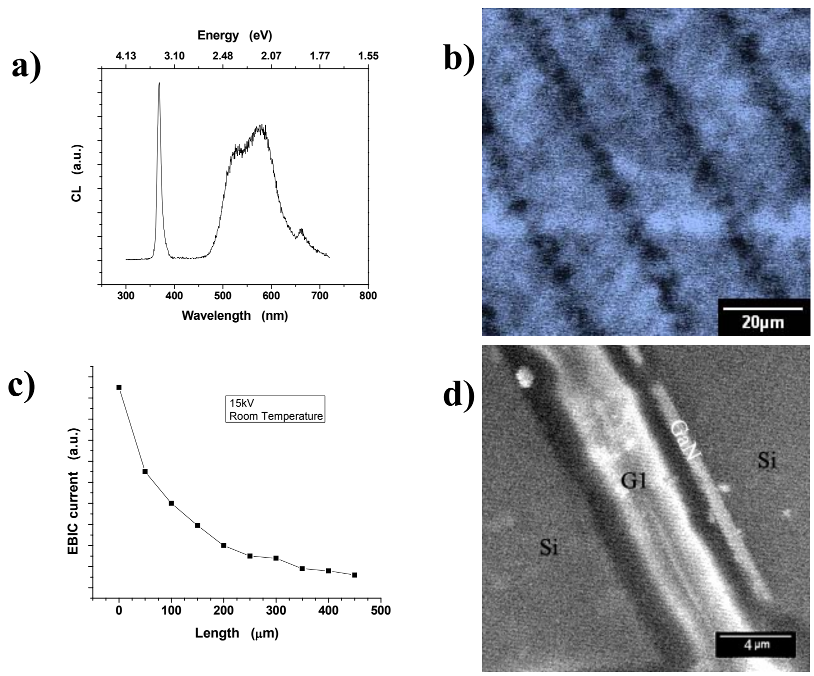

Fig 1. (a) Cathodoluminescence spectrum from a GaN sample. The GaN was grown by ELOG mode and its effect is observed on the monochromatic (364 nm) image in the Fig. (b). EBIC current response is illustrated in the Fig(c). Finally, the contrast in the Fig. (d) is created by transmitted electrons in GaN thin film in cross-section mode, where the secondary electron detector was used.

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[1] Joseph Goldstein, Dale E. Newbury, David C. Joy, Scanning Electron Microscopy and X-ray Micro-analysis. Editorial New York: plenum (1981)

[2] D. R. Vij, Luminiscence of Solids, Editorial New York: plenum (1998)

[3] H. J. Leamy, J. Appl. Phys., 53 (1982) R51-R80

[4] James M. Ehrman and Irena Kaczmarska, Microscopy Today, 9 (2001) 12-14