Characteristics of in-situ Photoluminescence from GaN Electrodes

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Traditionally the characterization of schottky diodes is based on electrical measurements. Alternative techniques of interface analysis which exploit the properties of compound semiconductors are of interest. The optical sensitivity of these materials affords us a method of probing the in-situ luminescent properties when schottky contacts are made to these semiconductors. While there have been several reports of in-situ photoluminescence (PL) studies such as GaAs and GaP/electrolyte (1,2) and InP/metal systems (3), the in-situ luminescent properties of GaN electrodes have been examined to a lesser extent. In this paper we report the characteristics of the in-situ photoluminescence intensity (PLI) from GaN/electrolyte and GaN/Au systems under the application of a potential. Experiments were carried out on n-GaN electrodes consisting of epitaxial GaN deposited on a sapphire substrate by MOCVD. The GaN surface was investigated using two distinctly different types of contacts. Sulphate solutions with values of pH ranging from 0 to 14 were used to form a GaN-liquid contact. For metal schottky contacts, a semitransparent gold film was thermally evaporated onto the GaN. For PL experiments, electrodes were illuminated by a He-Cd laser and the PLI at 365 nm was monitored as the electrode potential was varied. Estimates of the flatband potential for the liquid and metal GaN contacts were made from the corresponding Mott-Schottky plots. Fig. 1 shows the variation of PLI with electrode potential in an electrolyte of pH 3. The potential was scanned from 0.0 V to a lower limit of -1.5 V and back to 0.0 V. At more positive potentials the PLI was independent of potential. Data was normalized relative to this baseline value. On the forward scan the PLI can be seen to increase dramatically as the electrode potential is made more negative. The PLI reaches a plateau value at -1.05 V which was determined to be close to the flatband value of -1.075 V. This constant PLI value is maintained over a range of more than 0.5 V. On the reverse scan it can be seen that the PLI maintains the same values at a given potential as on the forward scan. However, as shown in Fig. 2, when the lower potential limit is decreased to -1.8 V, the PLI on the reverse scan at any given potential is reduced relative to the forward scan. Hence, it becomes apparent that the observation of hysteresis in the PLI-potential curves is dependent on the value of the lower potential limit. Such dependence of the extent of the hysteresis on the value of the lower potential limit was found to be consistent at each pH value. However in more basic solutions the potential range over which the PLI retains a constant maximum value is much smaller than in the case of the acidic solutions and so the observation of significant hysteresis is more sensitive to the value of the lower potential limit.

Similar PLI-potential characteristics were measured at the other pH values and such variation of the PLI with electrode potential indicates that GaN surfaces are not pinned in the indifferent electrolytes used.

REFERENCES