(Photo-)electrochemistry at n-GaN grown on sapphire and on Si : a comparitive study.

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In recent years, the importance of GaN and related III-nitride compounds for (opto-)electronic devices has been fully recognized. However, until today, GaN is grown on substrates to which it is lattice and thermally mismatched, resulting in structural defects and non-ideal surfaces. These non-idealities may have a negative influence on the efficiency of the devices. To date, the most commonly used substrate for the growth of n-GaN layers is sapphire. Recently, growth of n-GaN on Si substrates was achieved. [1]. To circumvent the problem of the high lattice mismatch between GaN and Si, a series of buffer layers was used. In contrast to sapphire, Si is not an insulator, which makes it possible to fabricate n-GaN/Si electrodes with ohmic contacts on the backside of the sample.

In this paper, a comparitive study between the (photo-) electrochemical behavior of n-GaN grown by MOCVD on sapphire and on Si(111) is made. It has been shown that (photo-)electrochemistry is a very useful tool to investigate the electronic structure of the semiconductor and the properties of the semiconductor surface. Because of the difference in substrate for epitaxial growth, it may be expected that the electronic structure of the n-GaN/Si and the n-GaN/sapphire layers is not the same.

Subbandgap photoluminescence measurements in 1M H_2SO_4 and electroluminescence measurements in persulfate-containing solutions at pH=4 were performed. For both n-GaN/sapphire and n-GaN/Si , the well-known yellow emission band is observed under photo-excitation. The spectral distribution of the observed electroluminescence band, however, is not the same for n-GaN/Si and n-GaN/sapphire. The possible origin of this effect is discussed.
Impedance measurements were carried out at n-GaN/Si and n-GaN/sapphire in aqueous solutions. It was established that the value of the flatband-potential in aqueous solutions is considerably more negative for n-GaN/Si than for n-GaN/sapphire. The impedance measurements were also performed to investigate the effect of frontside or backside ohmic contacts on the impedance spectrum.

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References :

[1] A.Dadgar, M. Poschenrieder, J. Bläsing et al., Appl.Phys.Lett.80, 3670 (2002).