Monitoring of Biochemical Processes with Group III-Nitride Devices

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Due to their excellent electronics characteristics and their long term stability in electrolyte solutions AlGaN/GaN electrolyte gate field effect transistors bear a great potential as sensor devices for electronic detection of biochemical processes. In addition, their high pH-sensitivity allows the electronic detection of enzymatic biocatalytical reactions accompanied by local pH changes.

Besides the basic properties of AlGaN/GaN electrolyte gate field effect transistors for operation in liquid electrolytes we report on the biochemical functionalization of AlGaN surfaces by deposition of self assembled silane monolayers. This allows the immobilization of biomolecules such as DNA or enzymes on GaN-based devices.

As one application we have analyzed the influence of the immobilization process on the characteristics of enzymes immobilized on GaN surfaces. For this purpose we have prepared enzyme-modified field effect transistors (EnFETs) by physisorption of penicillinase multilayers as well as by covalent immobilization of penicillinase monolayers. The response characteristics of both kinds of EnFETs to penicillin was compared. Both the calibration curve and the stability of the devices are shown to be strongly affected by the applied immobilization technique. It is shown that covalent immobilization results in the formation of an enzyme (sub-)monolayer and allows the preparation of EnFETs with highly reproducible characteristics, which can serve as a well defined bioelectronic model system, allowing electronic analysis of biochemical processes.