Topic **Sensors & Bio-electronics**

GaN HEMT based Biosensor for Low-Level Detection of Interferon-Gamma (IFN-γ)

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Abstract

This paper reports on the detection of a very small quantity (ng/ml) of circulatory biomarker Interferon-gamma (IFN-γ) using highly sensitive Gallium Nitride (GaN) High Electron Mobility Transistor (HEMT) based biosensor. To the best of our knowledge, no prior work reports on the detection of this much low concentration of IFN-γ using HEMT. Interferon-gamma (IFN-γ) is a cytokine which is involved in the generation of immunological responses. A response to IFN-γ is mediated by IFN-γ Receptor (IFN-γR), a cell surface receptor that activates downstream signals to regulate gene expression. It is a predictive circulatory biomarker in ovarian carcinoma [1], mycobacterial infection, rheumatoid arthritis [2] and traumatic brain injury. Low-level detection of this biomarker is important to detect the early stage of the disease. The early detection of the rise in biomarkers could help physicians prevent, or at least reduce, the extent of potential damage. Therefore, in the context of current status, this work is of great importance for early stage detection and management of the disease by detecting the low quantity of this biomarker using an efficient GaN-based HEMT biosensor. A GaN HEMT based Biosensor is designed and fabricated on a Sapphire substrate with a gate length of 5 μm and a gate width of 100 μm. The sensor is passivated using silicon Nitride-based dielectric film except an opening over the gate for biosensing application. Figure 1 shows the designed and fabricated HEMT biosensor. The bio-active GaN HEMT has been developed by incubating various concentrations (Sample A; 1:100 and B; 1:200) of IFN-γ antibody over the surface functionalized GaN HEMT device for 24 hours. The non-specific binding site on the device has been blocked with blocking reagent after the device gets coated with antibody. The developed device is further stored at 4°C until it proceeds for detection of IFN-γ antigen in the ng/ml range. Change in the drain current (I_{ds}) is measured with respect to the drain voltage (V_{ds}) for each test related to antibody dilution and antigen. Sample A (1:100) delivered the best results and showed a 74 % reduction in the I_{ds}. Figure 2 shows the change in the I_{ds} after drop casting antigen in a very low concentration of 1 ng/ml on the sensor surface.

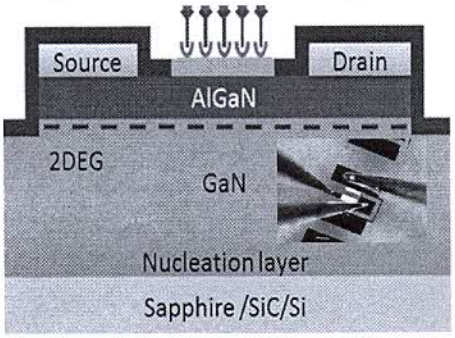

Figure 1. Designed and Fabricated sensor

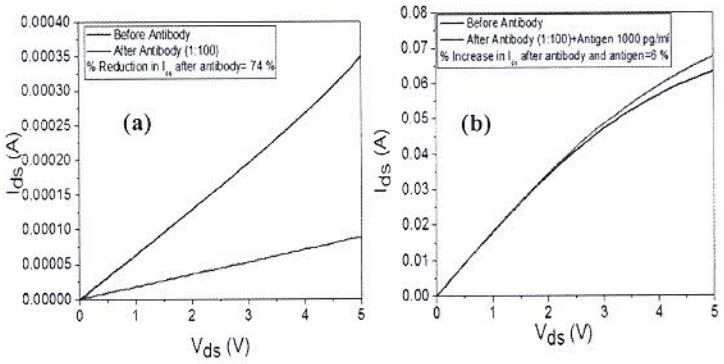

Figure 2. Effect of antibody and antigen (IFN-γ) on I_{ds}

A reasonably good change of 6 % in the I_{ds} value shows the high sensitivity of the sensor for a very low concentration of IFN-γ. LOD of the sensor is in ng/ml range and the detection time is less than 5 sec. Conclusively, the developed biosensor is capable to detect ng/ml of circulatory biomarker Interferon-gamma (IFN-γ) in less than 5 sec.

References

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