AlGaN/GaN HEMT-type transducers for gas- and chem-sensing applications

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In recent years an increase is observed in application of nitrides for gas and bio-chemical sensors. In this sensor two essential elements could be distinguished: transducer part and receptor part. In a result of interaction of analyte with receptor part specific physic-chemical reactions occur in it that cause changes in the properties of the transducer part. Depending on the type of applied transducer the chemical information is changed on other type of energy in form of electrical, optical or acoustic signal. Typically the semiconductor transducers utilize the field effect. The operation of MISFET (MOSFET), MESFET and HEMT transistors are based on this effect. In the general case, the transistors could be used as a transducer in which the metallic gate was replaced by receptor part. From many years the silicon ISFET transistors were used as a transducer. In recent years, because of higher electrons mobility, the ISFET transistors are replaced by HEMT transistors. Two dimensional gas electrons in the channel of HEMT transistors, fabricated in classical AIIIBV semiconductors, have very high mobility but in this case the semiconductor surfaces are chemically and electrically unstable and could be biologically incompatible (or even toxic for cells cultures). Because of it the nitrides were proposed for HEMT transistors fabrication process [1]. AlGaN/GaN heterostructure with AlGaN or AlN or GaN cap layer could be applied for this purpose [2]. The operation of AlGaN/GaN HEMT transistors is based on the modulation of the sheet carrier concentration of 2DEG, in triangular potential well, that is formed in the GaN layer near the AlGaN/GaN interface. The electrical response of AlGaN/GaN HEMT-type transducer could be the change of the channel resistance, alteration of the drain saturation current or the change of pinch-off voltage of the channel. Depending on the type of applied receptor layer the HEMT type AlGaN/GaN transducers could be used as a gas sensors or for sensing of various types of biological and chemical substances. There was also found that exposed surface of transducers reacts on changes of electrolyte pH [3] that should enable elaboration of semiconductor pH sensor. However, in hydrogen sensor as a receptor part the thin metal layer of palladium or platinum are applied that catalyse the dissociation of gas molecules.

References

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