

## GALLIUM NITRIDE ELECTRONICS

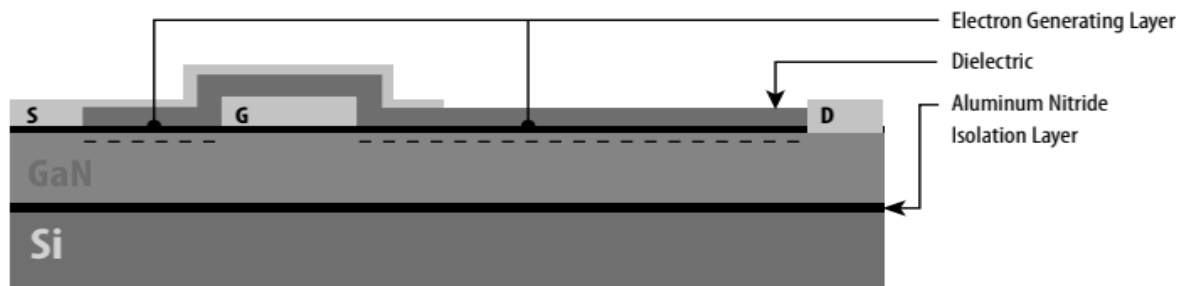
*Yaroslav Burkovskiy*

*Faculty of Radio Engineering, National Technical University of Ukraine*

*“Igor Sikorsky Kyiv Polytechnic Institute”*

Gallium nitride is not new material; it is studied from the 1970s. The first GaN devices were light-emitting diodes, which over the past 20 years have found wide application. Today, when the requirements of reducing consumption and size of industrial electronic or modern gadgets are very high, GaN-transistor are the most perspective electronic switching elements, capable to replace powerful MOSFETs and IGBT transistors based on silicon or SiC in compact power supplies, DC/DC-converters, motor drivers, etc.

Let's consider the advantages and disadvantages of GaN, as a semiconductor that has wide bandgap, which determines a number of properties that allow to create powerful devices with excellent characteristics on their basis. High movability of the charge carriers causes small  $R_{ds(on)}$  of GaN transistors in the open state. GaN FETs have higher breakdown voltage than silicon due to the higher critical strength of the electric field. And since the concentration of charge carriers of GaN is less than in silicon, devices based on GaN can operate at very high temperatures. The scientists of the Glenn Research Center of NASA demonstrated the work of GaN FETs at a temperature of 300 °C [1], and the scientists of the Institute of Quantum Physics and Photonics(Switzerland) – at 1000°C in vacuum [2] (maximum operating temperature of silicon transistors is 140 -150 °C). And, finally, the thermal conductivity of gallium nitride is also higher (Table 2) [3].



*Fig (1) GaN Power Transistor Structure*

One of the most promising properties of gallium nitride from the point of view of creating powerful devices for power electronics is the possibility of forming AlGaN/GaN heterostructural FETs with low  $R_{ds(on)}$ . Owing to the high values of the mobility and concentration of charge carriers of a 2D electron gas (2DEG) formed at the interface of the heterostructure, the saturation current of such a structure is large, and the output power of devices based on AlGaN/GaN devices is large due to the large width of the forbidden band of the material. In this case, the total gate charge and gate charge relative to the drain ( $Q_g$  and  $Q_{gd}$ , respectively), required for switching the transistor, is less than for silicon devices of the same power. Smaller  $Q_{gd}$  allows us to rise the switching speed and minimize switching power loss in the transistor.

Nowadays, GaN – based system has wide application in high-end, state-of-art critical electronics systems and its vital to understand advantages and disadvantages of this technology.

#### **References:**

1. Neudeck P., Okojie R.S., Chen L.Y (2002). High-temperature electronics – a role for wide bandgap semiconductors? Washington, D.C: Proceedings of the IEEE. p.1065–1076.
2. Medjdoub F. Carlin J.-F., Gonschorek M., et al. (2006). Can AlN/GaN be an alternative to high power / high temperature AlGaIn/GaN devices? IEDM: IEEE. p.1-4.
3. Everts J., Dasz J., Van den Keybusx J. et al. (2010). GaN-Based Power Transistors for Future Power Electronic Converters. Belgium: IEEE Benelux Young Researchers Symposium. 1-6.

### **ELECTROMYOGRAPHY INTEGRATOR**

*Dmytro Danilian, Dmytro Levinskyi*

*Faculty of Biomedical Engineering, National Technical University of Ukraine  
“Igor Sikorsky Kyiv Polytechnic Institute”*

Development of an integrator of electrophysiological signals is needed to facilitate quantitative analysis and to give an overview of results of the study of electromyography (EMG). Using of these methods is important in modern medicine, in conditions of low level financing of medical institutions in Ukraine.

Integration is one of main mathematical operations, and its electrical implementation means the construction of a circuit [1] in which the rate of change in the output voltage is proportional to the input signal.

The analyzers of biopotential is a device with specialized computing devices designed to automatically analyze changes in bioelectric potentials in time [2]. One of the varieties of analyzers – the integrator is used to evaluate the process power.

Evaluation of results of these research parameters is mainly made visually. However, received information in this case is insufficient both to some extent subjective, and the process of visual analysis is long and requires high qualification.

The tasks of projectwere:

- to develop structural-functional and electric circuits of device for definition of integral indicators of electrophysiological signals;
- to perform model research by means of the circuit design;
- to develop breadboard model with CAD;
- to construct, make and adjust the layout board of electronic device;
- to perform experimental prototype research and to compare results with the circuit;
- to design the case of the device, its functional elements with modern design tools;
- to carry out complete process of manufacturing device, to check its work.

The developed structural-functional diagram of adevice, which consists of a precision rectifier of the input signal, an integrator, monovibrator and a comparator.

The EMG signal from amplifier output is fed to an exact two-phase rectifier.