Current development of electronics relies on the continued miniaturization of semiconductor chips based on nanostructures, which can effect on the unique parameters of the device/component. Nanostructures, in combination with sophisticated processing, allow getting better and better parameters of devices and increasing the speed of operating frequency of modern electronics. A very important parameter here is cut-off frequency *fc*, which mainly results from the physical parameters of semiconductor structures and from the processing techniques/technologies. Normally, to achieve high operating frequency of the device is required to perform a very small structures based on high-quality semiconductor nanostructures. We aim to obtain as small as possible resistance value R and the capacitance C in the active part of the structure. This is the way to significantly reduction of RC product, which is inversely proportional to the frequency limit. To follow tendency of increasing *fc*, the attractive structures for such scientific tasks are epitaxial layers with two-dimensional electron gas (called 2-Dimensional Electron Gas 2DEG), which contains the channel of high conductivity and well insulated adjacent layers. Electrons in this system are “high mobility” it means electrons are located in the area of high quality semiconductor, in which there is no scattering, so they can move with very high saturation velocity. This makes possible to obtain high switching and operating frequency of devices.

This project aims to investigate high frequency of nitride structures and to establish a new scientific team in the Institute of High Pressure Physics of the Polish Academy of Sciences (IHPP PAS) in Laboratory of Terahertz Radiation (TeraGaN) leaded by prof. dr. hab. Wojciech Knap, a world expert in the field of fundamental semiconductor research at the field of microwaves and terahertzes. A task for the newly formed scientific team will be investigation and testing high-frequency components based on high-quality nitride structures and to create an effective feedback loop between the technology of high-quality two-dimensional structures, design, processing and microwave investigations of test structures. In this task, in particular, they will be studying the mechanisms of propagation sub-THz electromagnetic waves in lateral nitride structures with 2DEG. Using well-developed in the IHPP PAS nitride technology, epitaxy and processing structures are going to reduce the capacitance of the Schottky contact using lateral contact to the 2DEG and reduce the access resistance by using regrown contact technology. We expect that in this way we will be able to fabricate high quality lateral structures, which can operating frequency is above 100 GHz. Significance of using nitrides is from the point of view of physical parameters, e.g. high breakdown voltage, potential to work in the harsh environment and/or high temperatures. We expect that in high frequency investigations, we will be able to resolve many materials issues, which can effectively optimize the nitride technology. The main task of this project is explore the potential of lateral structures (lateral Schottky diodes) with high quality and low resistance ohmic contact. The proposed in the project structures are components, which can be the innovative building-blocks for future research and development projects for detectors, mixers and multipliers in range of microwave and sub-terahertz frequencies.

Unipolar electronics can reduce the energy dissipation and a significantly increase cut-off frequency. This is extremely important in progress of nitride technology, which recently is significantly improved. This leads to obtained good nitride nanostructures and new record values of physical parameters, which allow to study very sophisticated physical effects. We believe, that the basic knowledge about high-frequency physical parameters of nitrides in lateral structures will be very important in future projects of optimization of devices based on gallium nitride, which started to play a significant role in the development of civilization and this role was recognized by attribution of **2014 Nobel Prize in physics** to physicists and engineers that pioneered nitrides science and technology.