The development of bulk $A^{III}B^{V}$ materials (InAs, GaSb, AlSb, InAsSb, AlAsSb) technology enables a design of infrared (IR) structures achieving nearly background limited phtodetectors (BLIP) condition at temperatures reached by thermoelectrical cooling and room temperature condition (300 K). In terms of the covalent bonding $A^{III}B^{V}$ compounds may theoretically operate at higher temperatures in comparison with HgCdTe (MCT - mercury cadmium telluride), where ionic bonding is dominating. This gives a potential for $A^{III}B^{V}$ materials to be implemented in many higher operation temperature applications. Presented subject is one of the main research challenges of today's semiconductor physics particularly applied to IR detectors optimized for the 3−5 µm (MWIR - *medium wavelength infrared radiation*) and 8−14 µm (LWIR - l*ong wavelength infrared radiation) spectral range*).
The theoretical analysis shows that physical properties of $A^{III}B^{V}$ compounds predisposition these materials in comparison with HgCdTe dominating for 40 years in IR technology. In addition, numerical analysis shows that the inherent physical parameters of $A^{III}B_{V}$ detectors might be considerably improved by introducing appropriate design changes in the photosensitive elements. This possibility is offered by structures with unipolar barriers, limiting the flow of charge carriers of one type, or complementary barriers, limiting both: the flow of majority and minority charge carriers. What is more, barrier's implementation restricts Shockley-Read-Hall (SRH) generation recombination (GR) mechanisms being especially dominated in $A^{III}B^{V}$ materials. Taking this into consideration we will focus on research on physics related to IR detection in barrier bulk $A^{III}B^{V}$ (InAsSb/B-AlAsSb, where B stands for barrier) detectors. This means that the main goal of the proposed project is research on InAsSb/B-AlAsSb growth by molecular beam epitaxy (MBE), fundamental photoelectrical effects related to the time response, detectivity, designing, numerical modeling barrier IR detectors operating without cryogenic cooling (200−300 K). Moreover, proposed project is also focused on research on determination of the structure and development of the technology of barrier InAsSb/B-AlAsSb detectors operating at temperatures 200−300 K, in MWIR spectrum exhibiting high frequency response without impeding detectivity. The barrier structures will be grown on GaAs substrates in order to increase optical area of the detector which in turn should give rise to the detectivity by one order of magnitude (GaAs immersion lens' forming is commonly used in HgCdTe technology).
The detector's optimization in terms of time response and detectivity is extremely difficult because the parameters responsible for increasing of frequency response lower detectivity and opposite. There is a contradiction which could be solved only by numerical modeling. This observation and our preliminary simulation results indicating that simple nBn structures with InAsSb (x_{Sb} = 0.09) and AlAsSb (x_{As} = 0.09) active layer reach time response, = 1−2 ns for V > 600 mV and detectivity, $D^{*} > 10^{9}$ cmHz$^{1/2}$/W for wavelength = 3.3 µm, and T = 200−300 K fully confirms an idea related to the legitimacy of the project.
As it was mentioned above we are planning to grow InAsSb/B-AlAsSb on GaAs substrates. The MBE InAsSb/B-AlAsSb growth on GaAs is challenging due to lattice mismatch between InAsSb and GaAs. The strains will be compensated by buffer layer (e.g. GaSb) implementation. It is expected that in barrier InAsSb/B-AlAsSb structures on GaAs substrates we will reach time response < 1ns for turn on voltage biases and detectivity ~ 10^{10}−10^{11} cmHz$^{1/2}$/W for T = 200−300 K.

The proposed project will include research on growth of InAsSb/B-AlAsSb BIRD detectors grown on GaAs substrates and research on photoelectric effects (theoretical and experimental work):

1) growth of BIRD InAsSb/B-AlAsSb structures by MBE technique;
2) advanced numerical analysis of the charge carrier transport and time response in the InAsSb/B-AlAsSb barrier structures;
3) development of an optimal BIRD InAsSb/B-AlAsSb structure;
4) development of the *processing* of the barrier detectors.

The following stages of the project could be enumerated:

1) numerical modeling of the InAsSb/B-AlAsSb barrier structures (the numerical analysis allows to extract the mechanism directly responsible for time response and optimal detectors structure characterized by the highest frequency response);
2) growth of the simple BIRD InAsSb/B-AlAsSb structures by MBE technique (the barrier $A^{III}B^{V}$ structures will be grown in joint VIGO S.A./MUT laboratory. MUT will perform characterization and numerical modeling of the devices in particular time response and detectivity);
3) experimental verification and characterization of the layers;
4) detector's *processing*;
5) characterization of the fabricated detectors (*I-V*, *C-V*, spectral, time response characteristics).

The project will be closely focused on the study of physics behind processes and effects leading to fabrication of optimal MWIR detectors operating at T = 200−300 K. The results of our simulations show the significance and practicality of the chosen topic. The experimental results will verify preceded theoretical analysis and will consolidate our knowledge on the charge carrier transport being responsible for time response and detectivity of InAsSb/B-AlAsSb barrier detectors.
The main goal of proposed project is to maintain or strengthen of the Polish specialty in global scale (what we have been doing for nearly 20 years with HgCdTe) in terms of designing and fabrication of HOT IR detectors. This goal could be met only by introduction and implementation of the new material with better physical parameters in comparison to the MCT being the most explored compound in IR detetcors' technology. The proposed project fully uses internal research potential and what is most important it offers further step ahead in terms of development of the new type of IR detector.
The proposed project takes up the subject of the growth of the barrier detectors consisting of InAsSb active layers and AlAsSb barriers due to potential reduction of the fabrication costs (GaAs substrates are less expensive than GaSb) but also thanks to ability of the immersion lens forming which in turn increases detectivity. What is more the project deals with HOT detectors with completely unique energy band structure. The successful realization of the proposed project will have a significant influence on the level of the knowledge in proposed subject. Our main effort will be to increase operating temperature and increasing the time response and/or detectivity at the same time. It requires high technology and numerical modeling capability of the effects related to detection of IR. Advanced simulation of the barrier detectors should lead to optimal architectures and should reduce the cost of fabrication. This allows to increase the range of potential applications in science medicine, environment protection, in particular

where cooling is difficult to realize. Proposed detectors structures could be used for detection of explosives, which gets further attention due to increase of the possible terrorist attacks.

Tasks planned to be undertaken in this research project are new in comparison to the present state of the art. The lack of the detailed theoretical analysis of InAsSb/B-AlAsSb on GaAs substrates (problems with the growth on GaAs) based barrier detector in terms of time response, no available comparison with conventional detectors, and novel implementation of optimal design solutions underline the innovative character of the project. The proposed subject of research will be of great importance in development of both, the theory and technology of new type of IR detectors exhibiting high frequency response without influencing detectivity. The progress in this project will enable a better understanding of the charge carriers transport effects as well as the sources and mechanisms responsible for detector's time response. Also, it will significantly contribute to a development of the optimal design and technology of MWIR InAsSb/B-AlAsSb barrier detectors.