For decades, electronic components such as transistors and diodes are manufactured on the basis of silicon (Si). The same situation can be observed in power semiconductor devices used in modern power electronic converters, which can be found in supply systems, household appliances, transport and power delivery systems. However, looking at physical properties, which are important from the point of the transistors and power diodes, silicon is not the most optimal material. It turns out that it is possible to find other solutions, such as silicon carbide (SiC), which have a significantly higher value of the critical electric field which determines the breakdown voltage of the power device.

Last years, thanks to mastering the technology of SiC power devices appear in more and more low-voltage power electronic systems causing efficiency increase and reduction of the weight and size. Particularly, high expectations are associated with the new technology in the area of medium voltage (above 1 kV) power conversion, that is why research works are conducted in three main directions. First of all, high-voltage transistors are investigated, examples of the transistor with the breakdown voltage up to 27.5kV can be found today. At this stage, it turns out that they are extremely expenisve and their rated currents are limited. Therefore, the medium voltage power switch based on the low-voltage transistors connected in series is also subject of the research. Price of such transistors significantly declined in recent years, there is also evidence of the stability parameters over time. Finally, the third concept of the use of new SiC power transistors in medium voltage range is possible on the base of low-voltage power devices and multilevel topologies. First research works have been also conducted in this field. All published results show that SiC transistors offer better performance than Si counterparts. Still, there is no research trying to compare three mentioned concepts of SiC devices application in medium voltage power converters. This comparison is the main research objective of the proposed project.

Obviously, in the medium voltage range it is possible to find number of different power electronics converters, therefore, the comparison is focused on a basic structure – the switching pole (power electronics building block). Majority of DC/DC, DC/AC ora AC/DC converters may be developed with the use of such switching poles. That is why, the plan is to develop and test three switching poles based on three different concepts and perform a comparison with the use of analysis, simulation and experiments. Due to limited availability and high cost of the devices the planned parameters of the switching poles are : voltage up to 1,8kV and currents up to 200 A (RMS). All switching poles will be tested in the laboratory with special attention on power losses measurements using advance power analyser and precise double-jacket calorimetric chamber.

As a result of the project knowledge in the field of power semiconductor devices operating at medium voltages will be considerably increased, in particular considering design of power circuits and gate drivers operating with fast-switching SiC power transistors. Comparison and determination of the most beneficial concept of the new SiC technology application, including development of three switching poles, will speed up an introduction to the industrial applications. New technology will be applied in power electronics systems in electric traction, electric drives and those cooperating with the power system. In consequence, new systems will be characterized by higher efficiency, which will reduce electricity consumption and thus, indirectly, reduce greenhouse gas emissions. In addition, silicon carbide devices will increase the switching frequency of the system and the size of passive components (inductors, transformers) will be also reduced. This will decrease consumption of natural resources (copper, aluminum). All mentioned results of the project will have positive impact on the science, civilization and society.