The importance of infrared (IR) technology results from the prevalence of infrared radiation. This invisible to the human eye radiation provides the comprehensive information about their position in space, temperature, surface properties, as well as information about the chemical composition of the atmosphere through which the radiation is transmitted. All information carried by the infrared radiation can be red and processed by suitable sensors (detectors) which transform infrared energy into other forms of energy, easy to direct measurement. Among many types of IR detectors, some of them enable (for example) individual photons to be detected when the incident flux of light is very low.

For many years, photomultiplier tubes (PMTs) have been used to detect very weak signals. Despite the high sensitivity and high gain amounting of at several million, they have a significant deficiency, such as a low quantum efficiency, incorrect operation in the presence of magnetic fields, have a large size and not persistent design.

Semiconductor devices, particularly avalanche photodiodes (APDs), are alternatives to photomultipliers. Avalanche photodiodes can detect electromagnetic radiation of extremely low intensity. By applying a high reverse bias voltage, APDs show an internal current gain effect due to impact ionization (avalanche effect). Under the influence of a high electric field, the electrons/holes in the depletion region of an APD are accelerated and gradually acquire sufficient kinetic energy to impact ionize other electrons/holes leading to the junction break- down. It results in current gain of even several million times (depending on the applied voltage – the higher the reverse voltage, the higher the gain). Avalanche photodiodes with the highest operating gain allow detection of single photons. Such photodiodes are called single-photon avalanche diodes (SPADs). In typical APDs, the operating gain is around 1000.

Present APDs are as sensitive as photomultipliers, and at the same time are much smaller and more convenient to use. Due to the ability of very weak signals detection in a short time intervals, APDs are widely used in laser rangefinders, optical radars, long-range free space or fiber-optic telecommunication and ultrasensitive spectroscopy. New applications include positron emission tomography.

Commonly used APDs operate mainly from the ultraviolet throughout the visible spectrum and the near infrared. In principle, any semiconductor material can be used as a multiplication region: silicon, germanium and semiconductor compounds of group III-V, the most popular is the indium gallium arsenide (InGaAs). The mercury cadmium telluride (HgCdTe) diodes operate in the infrared, typically at wavelengths up to about 14 μm, but require cooling to reduce thermal processes of generation of charge carriers. Cryogenic cooling creates costly and inconvenience limitations. For these reasons, it is reasonable to launch a work on APD infrared detectors operated without cryogenic cooling – so called High-Operating Temperature (HOT) detectors. The key to success is a through identification of the photoelectric phenomena in such device architectures, their analysis by using of computer programs and development of the architecture of HgCdTe avalanche photodiodes. Continuous research allows to increase the competitiveness of existing production of infrared detectors in Poland, which will facilitate the maintenance of existing work positions in the field of advanced technology, as well as enable the creation of the new ones.