New concepts in infrared photodetector designs

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ABSTRACT

In 1959, Lawson and co-workers publication triggered development of variable band gap $Hg_{1-x}Cd_xTe$ (HgCdTe) alloys providing an unprecedented degree of freedom in infrared detector design. HgCdTe ternary alloy has been used for detectors operated at various modes such as: photoconductor, photodiode and metal-insulator-semiconductor (MIS) detector. Over the five decades, this material system has successfully fought off major challenges from different material systems, but despite that it has more competitors today than ever before. It is interesting however, that none of these competitors can compete in terms of fundamental properties. They may promise to be more manufacturable, but never to provide higher performance or, with the exception of thermal detectors, to operate at higher temperatures.

In the last two decades a several new concepts of photodetectors to improve their performance have been proposed. They are especially addressed to the group of so called high-operating-temperature (HOT) detectors. In this paper a new strategies in photodetector designs are presented including barrier detectors, unipolar barrier photodiodes, multistage detectors and trapping detectors. It seems to be clear that certain of these solutions have merged as a real competitions of HgCdTe photodetectors.

Keywords: surface plasmon detectors, photonic crystal detectors, HOT detectors, HgCdTe photodetectors, barrier detectors, type-II InAs/GaSb superlattice photodetectors, Sb-based III-V photodetectors, photon trapping detectors, cascade infrared detectors

Antoni Rogalski is a professor at the Institute of Applied Physics, Military University of Technology in Warsaw, Poland. During the course of his scientific career, he has made pioneering contributions in the areas of theory, design, and technology of different types of IR detectors. In 1997, he received an award from the Foundation for Polish Science (the most prestigious scientific award in Poland) for achievements in the study of ternary alloy systems for infrared detectors – mainly an alternative to HgCdTe new ternary alloy detectors such as lead salts, InAsSb, HgZnTe, and HgMnTe. He was elected as a corresponding member (2004) and next as an ordinary member (2013) of the Polish Academy of Sciences. In 2013 was also elected as a member of Central Commission for Academic Degrees and Titles.

Professor Rogalski's scientific achievements include determining the fundamental physical parameters of InAsSb, HgZnTe, HgMnTe, and lead salts; estimating the ultimate performance of ternary alloy detectors; elaborating on studies of high-quality PbSnTe, HgZnTe, and HgCdTe photodiodes operated in 3-5 µm and 8-12 µm spectral ranges; and conducting comparative studies of the performance limitation of HgCdTe photodiodes versus other types of photon detectors (especially QWIP and QDIP IR detectors).

Professor Rogalski has given about 60 invited plenary talks at international conferences. He is author and co-author of about 220 indexed scientific papers, 13 books, and 26 monographic papers (book chapters). He is a fellow of the International Society for Optical Engineering (SPIE), vice president of the Polish Optoelectronic Committee, vice president of the Electronic and Telecommunication Division at the Polish Academy of Sciences, editor-in-chief of the journal *Opto-Electronics Review*, deputy editor-in-chief of the *Bulletin of the Polish Academy of Sciences: Technical Sciences*, and a member of the editorial boards of *Journal of Infrared and Millimeter Waves, International Review of Physics* and *Photonics Letters of Poland*.

Professor Rogalski is an active member of the international technical community. He is a chair and co-chair, organizer and member of scientific committees of many national and international conferences on optoelectronic devices and material sciences.