

Potential profile engineered nanomaterials with charged quantum dots for advanced sensing applications

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The presentation focuses on design, fabrication, and characterization of novel quantum dot (QD) structures with potential profile engineering and manageable kinetics of photoelectrons. Our approach is based on engineering of photoelectron capture processes using various configurations of manageable potential barriers around separated QDs and collective barriers around QD clusters. Potential barriers around QDs are always created, when electrons from dopants outside QDs fill the dots. To effectively control photoelectron capture processes, the barrier height should be of the order of the thermal energy of electrons. Such barriers can be created by Quantum dots with Build In Charge (Q-BIC) that is controlled by the type and by the level of doping. By combining Q-BIC with various positions of dopants it is possible to create unique distribution of potential barriers, which forces photoelectrons to move in designated direction without capturing into the QDs. Besides manageable photoelectron lifetime, the novel structures provide also stronger coupling to radiation, high scalability, low generation-recombination noise in sensing applications and effective harvesting of infrared energy in Q-BIC solar cells. It was experimentally demonstrated that responsivity of QD infrared photodetectors at nitrogen temperatures can be increased by more than 30 times using Q-BIC structures.

The major part of the talk is based on the works made in collaboration with J. W. Little, S. Oktyabrsky, K. Sablon, A. Sergeev, G. Strasser, K. Reinhardt, N. Vagidov, and M. Yakimov.

Vladimir Mitin, SUNY Distinguished Professor at the Department of Electrical Engineering at the University at Buffalo, the State University of New York. He is a fellow of IEEE, SPIE, APS, AAAS, and IoP. He was the Chair of that Department for two terms: 2003-2006 and 2006-2009. During 1993-2003 he was a Professor in the Department of Electrical and Computer Engineering at Wayne State University in Detroit, Michigan. His fields of specialization are nanoelectronic, microelectronic and optoelectronic devices and materials. Currently he is working in the areas of design and characterization of electronic and optoelectronic devices with emphasis on light absorption and emission, energy conversion and heat dissipation. Special attention in his research is now placed on simulation, design, and characterization of nanosensors, and quantum dot infrared photodetectors and solar cells. He has more than 240 publications in refereed journals, twelve patents, four monographs and five textbooks.

He obtained his Doctor of Science degree in 1987 from the Institute of Semiconductors of Ukrainian Academy of Sciences in Kiev, Ukraine.

More information is available at http://www.ee.buffalo.edu/faculty/mitin/mitin_intro.html .