Reconfigurable nanomaterials for adaptive sensing: Electric and optical control of nanoscale potential profile

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Development of adaptable nanomaterials will qualitatively improve IR/THz sensing technologies. Adaptive sensing substantially enhances real-time detection, tracking, and identification capabilities and simultaneously provides optimal use of sensing resources. Two-dimensional (2D) and 3D nanomaterials, such as nanostructures with quantum wells and quantum dots, provide wide-ranging and reliable possibilities for effective control and management of photoelectron processes via charge redistribution between the matrix and the wells and/or dots.

In this presentation we review design, fabrication, and characterization of quantum dot and quantum well nanostructures with complex selective doping and various mechanisms of electron coupling between nanoblocks. The feasibility of effective control and management of all electron processes by voltage bias, optical bias, and gate voltage will be demonstrated. The charge redistribution between the matrix and the nanoblocks strongly changes photocarrier lifetime, concentration of thermally excited carriers, thermal noise, and coupling to IR radiation. These adaptable parameters provide effective ways for control and tuning of interrelated detector parameters: responsivity, sensitivity, acquisition time, and dynamic range.