III. Device Concepts & Sensor/System Functionality

(A2) Nano-Engineered Sources, Detectors & Components for Situational Awareness

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Total situational awareness of the local and global environment represents one of the greatest challenges facing sensor scientists and engineers today. For defense and security applications this includes sensing of vehicles, personnel, weapons, chemical and biological threats, projectiles, explosives, landmines, IEDs, motion, as well as health monitoring. Some sensors must operate in severe environmental conditions, during the day and night, and need to be extremely sensitive. Invariably, this means that some form of noise or "clutter" lowers the signal-to-noise ratio (SNR) or signal-to-clutter ratio (SCR), and degrades the probabilities of detection and false alarm. Nanoelectronics is providing advances in the "front-end" components that can improve the SNR and SCR and thereby mitigate clutter effects before signal processing is carried out. This session will focus on these advances starting with recent developments in widely tunable, single-frequency semiconductor lasers operating from the UV to the THz region. It will then examine the state-of-the-art in detector technology, particularly uncooled, photoconductive, and photovoltaic detectors that can be implemented in 2D focal-plane arrays. Most of these devices have utilized nanotechnology in just one dimension through improvements in the precision or materials used in molecular-beam or other type of epitaxial-growth technique. Good examples are quantum cascade lasers and semimetal-semiconductor Schottky rectifiers. But lateral nanotechnology is also playing a role, particularly through the techniques of ultrafine e-beam lithography and molecular self-assembly. Ultra-efficient quantum-dot lasers are a good example of the lithographic nanoscale devices, and surface (plasmon) polariton detectors based on metallic nanoparticles are a by-product of self-assembly. Papers addressing the general theme of coupling in wirelessly (from the microwave to optical) to, and processing information with (including both detection and computation) nanoscale devices will also be presented. The impact of reduced dimensionality on nanoscale devices will be a general theme. Reduced dimensionality can be in the quantum sense (one of the dimensions smaller than the electron de-Broglie wavelength), such as 2D (quantum well), 1D (nanowires and nanotubes), and 0D (quantum dot) devices, as well as in the classical sense (one of the dimensions smaller than the electromagnetic photon wavelength), such as 2D arrays (metamaterials), 1D systems (nanoscale dipole antennas), and 0D devices (e.g. plasmons in metallic nanoparticles).