Innovations Ecosystem in Nanotechnologies Supporting Safety, Security and Sustainability

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The geopolitical landscape of the 21st century has become relatively complex, dynamic, and unpredictable than that faced in the previous century. Implementation of effective tools to address such challenges demands an understanding of transformational emerging sciences, concepts and theories. Numerous technological advances arise from the potential of nanoscale materials to exhibit unique properties that are attributable to their small size. Furthermore, advances in material synthesis, device fabrication and characterization have provided the means to study, understand, control, or even manipulate the transitional characteristics between isolated atoms and molecules, and bulk materials. Consequently, various "designer" materials capable of producing devices and systems with remarkable, tunable, and desired properties have recently been fabricated. Such advances coupled with information technology, cognitive sciences, biotechnology, artificial intelligence, and genetics offer novelties and potential solution pathways in ways never imagined possible earlier, such as deployment of systems with enhanced capabilities, information gathering, and thwarting threat at point-of-origin (PO2).

This presentation provides many examples of such innovations using nanomaterials, such as in sensors/detectors, employing materials, phenomena, and effects including multilayer semiconductor structures, specially formulated interfaces, and exploiting different regions of electro-magnetic spectrum provide various functionalities. Mechanisms such as refractive and nonlinear effects, absorption of electromagnetic radiation, fluorescence, avalanche phenomena for the detection of small fluxes of optical radiation, remote detection of explosives by neutron radiation, etc., provide additional sensing capabilities, in conjunction with algorithms for complex processing of information, providing end-to-end strategic assessments and modeling of mixed and complex hazardous environments to delineated signal from background interactions. Specific examples relating to radiation sensors based on polymeric materials, sensors for toxic industrial chemicals (TICs), and/or toxic industrial materials (TIMs), e-tongue to identify rapidly several waterborne microbial pathogens, and bio-mimetic using siderophores will be illustrated. The overall scope encompasses abilities to sense, detect chemical-biological-radiological, nuclear, high yield explosive, and water borne contaminants – all from safety and security standpoint. Thus, in order to provide accurate intelligence, surveillance, preparedness and interdiction of such combative postures, advances in S&T offers prudent preparedness.