FOREWORD

In recent years, the field of Terahertz (THz) science and technology has entered a completely new phase of unprecedented expansion that is generating every growing levels of broad-based international attention. Indeed, the plethora of activities that have arisen recently in both the technology and scientific arenas associated with the THz frequency domain – i.e., usually defined as the portion of the submillimeter-wavelength electromagnetic (EM) spectrum between approximately 1 millimeter (300 GHz) and 100 micrometers (3 THz) – suggest that the field might be attempting to undergo a dramatic transition that could lead to long-awaited payoffs in a number of application areas. The inherent advantages and potential payoffs of the THz regime for military and security relevant applications have long stood as an important driver of interest in this science and technology area. For example, this extremely expansive and spectrally unique portion of the EM spectrum was initially of high interest for such applications as space-based communications, upper atmospheric sensing and communications, and potentially for short-range terrestrial communications and non-intrusive package screening. However, the very rapid growth in more recent years is arguably most closely linked to the potential payoffs of THz sensing and imaging (THz-S&I) for an array of military and security applications. These applications include the spectroscopic-based detection identification and characterization of chemical and biological (CB) agents and materials, remote and standoff early-warning for CB warfare threats, and video-rate imaging of concealed weapons and explosives, just to name a few. In addition, these same THz-S&I capabilities have a close synergy and dual-use potential for private-sector application areas as biological science, medical diagnostics, pharmaceutical characterization and security screening.

While recent developments in the THz field offers promise that a broad spectrum of commercial and scientific payoffs may be on the horizon, there still remain significant technological challenges that will need to be resolved. In particular, the refinement of THz systems is needed to enable very near-term payoffs such as security screening and the detailed characterization of materials such as explosives and pharmaceuticals; a significant advancement is needed in THz source and detector technology to enable medium-range applications such as remote/standoff detection and identification of biological and chemical agents; and, new breakthroughs in sensor architectures and probing techniques will be required for enabling far-future applications such as detailed spectroscopic characterizations of biological molecules and nanoscale systems. This special issue presents some of the leading fundamental research efforts that working towards the realization of practical THz-S&I capabilities for military and security applications. Specifically, the papers that follow span an array of pertinent THz Science

and Technology (THz-S&T) subjects that will have important ramifications to the future success of THz-S&I applications. Relevant subjects included the theoretical prediction and/or measurement of THz spectroscopic phenomenon in solid-state materials such as high explosives (e.g., HMX, PETN, RDX, TNT, etc.), carbon-fiber composites, biological agents (e.g., DNA, RNA, proteins, amino acids) and organic-semiconductor nanostructures. Individual papers in this special issue also address the effective utilization of state-of-the-art THz-frequency technology in military and security relevant scenarios such as standoff S&I, screening of packages and personnel, and perimeter defense. Technical papers included in this volume also introduce novel devices and/or concepts that enhance THz source and detector performance, that enable completely new types of sensor functionality at THz frequency (e.g., detection at nanoscale/molecular levels), and that define new and innovative sensing modalities (e.g., remote personnel identification) for defense and security. Therefore, the collective research presented in this special issue represents a valuable source of information on the evolving field of THz-S&I for Military and Security Applications.

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