Front. Optoelectron. 2021, 14(1): 1–3
https://doi.org/10.1007/s12200-021-1224-2

EDITORIAL

Preface to the special issue on “Terahertz Science and Applications”

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Terahertz (THz) waves, with the spectrum located between microwaves/millimeter-waves and infrared radiation, were historically difficult to be generated and detected and known as “terahertz gap” [1]. However, Since the 1980s, the rapid development of semiconductor optoelectronics, ultrafast optics and ultrafast electronics has greatly promoted the research on generation, detection and application of THz waves. Many breakthroughs were achieved in the past decades, including high performance sources, sensitive detectors and interaction of THz wave with matters. THz waves have low photon energy and are non-ionizing. They can penetrate through most non-conductive materials. Many complex molecules have intra-/inter-molecule rotational or vibrational modes in THz frequencies. Due to these unique features, THz waves have great scientific value and have found an increasingly wide variety of applications in molecular fingerprint detection [2], diagnostic imaging [3–5], security and anti-terrorism [6–8], broadband communication [9–11], astronomical research [12], etc.

More recently, the rapid development of nano-photonics opens up a new way for manipulation of THz radiation. The unique optoelectronic properties of two-dimensional (2D) materials have been explored to realize next generation THz photodetectors [13,14]. Metasurfaces provide a new platform for designing ultrasensitive terahertz sensors, allowing for more accurate detection than classical THz spectroscopy [15]. The recent discovery of the topological phase of light has suggested possible solutions for on-chip communication at terahertz frequencies [16].

This special issue on “Terahertz Science and Applications” includes five review articles and one research article, covering most of the topics mentioned. Zhang et al. [17] provide a comprehensive overview of progress in the generation, detection, and applications of intense THz radiation. New developments with emerging technologies, including topological insulators, spintronic materials, metasurfaces are also introduced. Jin et al. [18] review the pioneering work in Prof. Xi-Cheng Zhang’s group of using liquid water to generate THz radiation. Laser-induced plasma formation associated with a ponderomotive force-induced dipole model was proposed to explain the generation process. Both one-color and two-color excitation scheme are demonstrated and a higher THz electric field was obtained with water film than with air under identical experimental condition. Isgandarov et al. [19] provide an overview of the evolution and recent development of intense THz pulses generation using large-aperture photoconductive antenna (LAPCA), including those with large-aperture dipoles and those with interdigitated electrodes. By gathering the past and recent achievements in the development and characterization of these intense THz photoconductive emitters, they show LAPCAs are very attractive and compact THz sources capable of room-temperature operation with high efficiency and stability. Shao et al. [20] present single mode THz quantum cascade lasers (THz QCLs) with sampled lateral grating emitting approximately at 3.4 THz. They show a side-mode suppression ratio larger than 20 dB with the new grating design and 11.8% improvement of peak power compared to devices with uniform distributed feedback gratings. Zuber et al. [21] present a theoretical investigation of charge transport and nonlinear effects in the THz frequency region, such as high harmonic generation, in topological materials including Weyl semimetals (WSMs) and α-T_3 systems. Their results provide useful information on developing nonlinear THz devices based on topological materials. Baydin et al. [22] review recent developments of

Received March 23, 2021

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THz time-domain spectroscopy (THz-TDS) in high magnetic fields. Advantages and disadvantages of different types of magnets in performing THz-TDS experiments are discussed and new fascinating physical phenomena that have been revealed by THz-TDS in high magnetic fields are highlighted.

We hope that this special issue on “Terahertz Science and Applications” will attract researchers working in the related areas, and provide useful references that will inspire future research in this exciting field. We thank all authors for their contribution to this special issue, and the reviewers who have offered their valuable time to provide pertinent comments on these papers. At last, we would like to thank *Frontiers of Optoelectronics* for providing a valuable opportunity to organize this special issue.

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