Guest Editorial

TTA Special Section on Terahertz Devices

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Recent advances of artificial structured materials, including photonic crystals and metamaterials, have greatly broadened the functionalities of terahertz (THz) devices and provided more degree of freedom in manipulating THz waves beyond traditional constraints. These materials are usually constituted by periodic or aperiodic sub-wavelength elements, showing significant electromagnetic responses during the wave matter interaction, thus enabling the modulation of amplitude, phase, or propagation direction of incident waves as a result. So far, a variety of applications have been proposed and experimentally validated, such as the THz filters, polarizers, modulators, and biosensors with the advantages of ultrathin profile, easy integration, and simple geometry. By incorporating novel materials like graphene, vanadium dioxide, and liquid crystals in the element design, we are allowed to adjust the characteristics of the THz radiation dynamically, which brings additional flexibilities toward the construction of novel THz functional devices.

In this special section, two research achievements concerning the THz sensing and THz modulation via artificial materials are reported, which offers attractive prospects for related applications in the THz spectrum.

In the first paper, a novel ultrathin THz modulator is designed based on hybrid graphene-metal metamaterial. From the simulation results, the authors showed that when the graphene was layered on the metamaterial, the modulation depth of transmission was only 29.2%. However, it could be greatly enhanced by increasing the Fermi energy of graphene layer, which reached approximately 79.5% at 1.0 eV in a broad frequency range, indicating that this graphene-metal metamaterial structure can functionalize as a THz modulator.

In the second paper, the sensitivity of THz spectroscopy is usually relatively low due to the large wavelengths of THz radiation. Many approaches have been proposed to circumvent this problem. Resonance shifting due to refractive index changes is used quite often; however, it does not represent the advantages of substance identification of THz technology. Here by extending the recently proposed idea of using a THz cavity whose resonance is designed to match the absorption frequency of the sample, the authors used a photonic crystal cavity structure to enhance the sensitivity of THz sensing while retaining the original capability of substance identification. Due to the many times back-and-forth propagating of terahertz radiations inside the cavity and the resulted high dependence of the defect mode transmission on the material loss, the transmission sensitivity to the quantity of target was amplified significantly. The detection of α-lactose was used as an example, which demonstrates steady detection with its thickness of a few microns. The sensitivity can be further enhanced by using a cavity with a larger quality factor.

On the behalf of the editorial committee, I would like to express my gratitude to all the authors and reviewers for their contributions to this special section. Moreover, I am honored to be the guest editor of this special section. And I appreciate very much the excellent assistance and the great efforts from all the editorial staffs.

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Qiang Cheng received the B.S. and M.S. degrees from Nanjing University of Aeronautics and Astronautics, Nanjing in 2001 and 2004 respectively, and Ph.D. degree from Southeast University, Nanjing in 2008. He joined the State Key Laboratory of Millimeter Waves, Southeast University in 2008, where he was involved in the development of metamaterials and meta-devices. He is currently a full professor with the Radio Department, Southeast University. He has authored or coauthored more than one hundred publications, with all his work cited more than 2000 times. Now he leads a group in the area of metamaterials, tunable microwaves circuits, microwave imaging, and terahertz systems. Prof. Qiang Cheng served as the vice chair of the 2008 and 2010 International Workshop on Metamaterials, Nanjing. He was a recipient of the 2010 Best Paper Award from New Journal of Physics. He was awarded China’s Top Ten Scientific Advances in 2010 and won the Second Class National Natural Science Award in 2014.