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Editorial

Metamaterials, Plasmonics, and THz Frequency Photonic Components

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An emerging area of interest in application is the terahertz (THz) technology covering the frequency range from 0.1 to 30 THz. Potential applications of such THz technology are widespread, including military security, medical diagnosis, coherent imaging, material analysis, environmental protection, and space science. Development of new photonic components dynamically functioning over such THz frequencies is a subarea of major currently ongoing advanced research effort and is very crucially relying on the availability of new materials, new physical mechanisms, new device designs, and new fabrications/approaches. Effective and efficient integration of new metamaterials with unique surface plasmonic resonance behaviors, for example, could create a full basket of "new-conception" THz photonic components bearing new operation mechanisms including negative refraction, lossless transmission, dynamic tunability, and so forth. In this special issue focusing on both advanced metamaterial research and novel plasmonic study, we have invited a few papers that address such major issues, summarize some of those recent progresses, and discuss those emerging opportunities.

The first paper of this special issue "Plasmonics: manipulating light at the subwavelength scale" by C.-P. Huang and Y.-Y. Zhu summarizes recent progresses in studying surface plasmon-polariton waves, mainly relating to plasmonic waveguide and plasmonic transmission. The former is able to guide the light in a thin metallic surface layer with subwavelength lateral dimensions, and the later to support the enormous transmission when featuring a metal with a subwavelength hole array.

The discussion covers generally the broad photonic spectrum. More focusing, resonant excitation of surface plasmons and the extraordinary transmission specifically over the THz frequencies are reviewed in the second paper "Resonant excitation of terahertz surface plasmons in subwavelength metal holes" by W. Zhang et al. Effect of the hole shape, dimension, material selection, incident electromagnetic (EM) polarization, and metal film thickness on the resonant THz transmission is studied by the state-of-the-art THz time-domain spectroscopy, which reveals an extended potential over even using those poor metals such as lead.

In more details, the third paper "Effects of microstructure variations on macroscopic terahertz metafilm properties" by J. O'Hara et al. discusses the effect of slightly varying the split-ring microstructure design on macroscopic THz metallic film properties including transmission and reflection. This leads the research toward the more practical side on generating new THz photonic component designs as potential optical filters, modulators, and switches.

Moving forward to make THz photonic devices, the fourth paper "Extraordinary transmission and enhanced emission with metallic gratings having converging-diverging channels" by A. Battula et al. investigates the extraordinary transmission behavior when changing the hole from the direct through to a new converging-diverging channel (CDC) shape. By varying the gap size at the throat of the CDC, the spectral locations of the transmission resonance bands can be shifted close to each other and have the transmittance in a very narrow energy band. This indicates a great potential to make THz optical filters having the needed flat-top and narrow transmittance band.

Experimentally, the transmission behavior of THz wave in a one-dimensional metallic grating investigated by the unique time-domain THz spectroscopy is discussed in the fifth paper "Transmission properties of metallic grating with subwavelength slits in THz frequency region" by D. Liang et al. which opens up the potential of making highly polarization-discriminative photonic components.

The next two papers (the sixth and the seventh) "Compact optical waveguides based on hybrid index and surface-plasmon-polariton guidance mechanisms" by M. Yan and M. Qiu, and "Subwavelength-diameter silica wire and photonic crystal waveguide slow light coupling" by Z. Zhang et al. discuss the interesting optical propagation phenomena in two special waveguides: one is defined by a combination of the conventional index confinement and the surface-plasmon-plariton guiding mechanism, and the other is an integration of a subwavelength silica nanowire with a photonic crystal waveguide. The former expects a significant loss reduction when the light is beyond the diffraction limit (using those nanoscale guiding cores for visible wavelengths, e.g.) and the latter for slowing the light for potential applications including compact delay lines for photonic signal processing, dispersion management, and so forth.

The final paper of this special issue "The structural engineering strategy for photonic material research and device development" by Y. Lu actually touches both fabrication and material selection issues during making those THz photonic components, with the goal to enhance the efficiency in both structural and compositional optimizations by using a so-called structural and compositional combinatorial strategy. Details about the strategy are introduced, and its applications in making photonic sensors, dielectric tunable materials, and negative refraction superlattices are also discussed.

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