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EDITORIAL
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Editorial: Tunable and Reconfigurable Optical Metamaterials

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Editorial on the Research Topic

Tunable and Reconfigurable Optical Metamaterials

Metamaterials and 2D metasurfaces [1–8] show promising and novel methods for the manipulation of optical waves in the terahertz, infrared, and visible regimes. Their performance has been demonstrated in high-resolution imaging, nonlinear optics, radiation control, holography, and optical communications. However, their practical applications are limited by the narrow operation wavelength range resulting from the resonant nature of the constitutive microstructures.

Materials with changeable properties or reconfigurable structures are being incorporated to achieve tunable optical properties, i.e. to extend the operation bandwidth or parameter space of metamaterials [9–14]. For example, graphene and related 2D materials, semiconductors, phase changing materials like VO_2 and $Ge_2Sb_2Te_5$, liquid crystals, and MEMS-structured metamaterials are emerging for advanced optics and photonics spanning from terahertz to visible frequencies. These developments are important for both fundamental optical physics and possible applications in nonlinear nanophotonics and super-resolution imaging.

This research topic on **Tunable Metamaterial/Metasurface** includes some remarkable examples. From the theoretical side, Xu et al. reported a study on the tunable optical scattering properties of a kind of plasmonic nanoantenna which is composed of metal-dielectric-metal metamaterial embedded with PT-symmetric layers designed for unidirectional scattering functionality. Yang et al. exploited the radiation characteristics of an ultrathin Pt layer and impedance matching to design a wavelength-selective absorber based on planarized platinum/silicon (Pt/Si) multilayer film for infrared stealth. The absorber effectively suppresses thermal radiation in two atmospheric windows and enhances thermal radiation in the nonatmospheric window. Lu et al. proposed a magneto-controlled method to manipulate the transmittance properties of a graphene-based THz metasurface comprised of graphene cut-wire arrays. It is found that the introduced vertical electrostatic field deflects the carriers in graphene and changes the transmittance characteristics of the metasurface. Hu et al. demonstrated the anomalous launching and vortices generation of surface plasmons in a THz near-field metasurface platform by tuning the orientation as well as the geometric phase of the surface unit structure. By introducing nanofins made by phase change VO_2 material into the metasurface, Song et al. proposed a temperature-controllable multifunctional metasurface lens based on phase transition material. The metasurface based lens can be switched among dual focus, single focus, and no focus at any position. For the similar focusing functionality, Yan et al. employed phase discontinuity of the three-layer square element based reflective metasurface for a high focusing efficiency of 82%. Sun et al. further demonstrated a metasurface with three-layer aperture structures to achieve a beam deflection to the desired angle of high efficiency.

From the experimental side, various mechanisms for realizing tunable metasurface can be employed to create intelligent wave control devices. Wei et al. and Wei et al. proposed the

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switch transparency, reflection, and absorption of metasurfaces by loading PIN diodes in the structure. They experimentally demonstrated high power transmission modulation in the frequency range 8–12 GHz and an active metasurface with a continuous changing absorption peak between 8.5 and 9.1 GHz. Xu et al. presented a review on the experimental progress of tunable metamaterials based on nematic liquid crystals. They showed that liquid crystal-based metamaterials are promising for the remarkable improvement of the bandwidth and may facilitate related applications at terahertz or even optical regimes.

This Research Topic provides an interesting overview of the different metamaterials and metasurfaces that incorporate tunable or reconfigurable mechanisms for breaking the limitation of narrow-operation wavelengths. These new results demonstrate recent progress in tunable metamaterials and their potential usefulness in various aspects, both experimentally and theoretically. We expect that more and more metamaterials/metasurfaces will be demonstrated for fundamental wave control phenomena in physics and that novel functional meta-devices with smart properties will soon emerge.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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