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Editorial of special issue on optical metasurfaces: fundamentals and applications

An optical metasurface is an ultrathin optical design composed of subwavelength meta-atoms that have demonstrated unprecedented capabilities in manipulating light propagation. By now, numerous functionalities have been realized, such as beam engineering, wave plates, polarizers, holograms, and metalenses. People are expecting a new version of metasurface 2.0 that will not only enrich the frontiers of optical sciences but also revolutionize traditional optical devices and technology in practical applications. Aiming to present the impressive progress in this field, *Chinese Optics Letters* publishes this special issue focusing on multifunctional metasurfaces, coupled plasmonic metasurfaces, reconfigurable metadevices, quantum metasurfaces for entangled photons, and neural network metadesigns that indicate the development directions of metasurfaces to a great extent.

In Ref. [1], Yu *et al.* demonstrated a photoreconfigurable and electrically switchable terahertz metadevice, which is implemented by a liquid crystal integrated metasurface. The device can be arbitrarily programmed via photoreorienting the directors of liquid crystals, which can be further driven by an electric field to reach a rapid switch function. Amplitude modulation and the lens effect are demonstrated with modulation depths of over 50% at 0.94 THz.

In Ref. [2], Dong *et al.* proposed a deep neural network to characterize these parameters of unknown plasmonic nanostructures/metasurfaces through simple transmission spectra. The network architecture is established based on simulated data to achieve accurate identification of both geometric and material parameters, which indicates a simple and intelligent characterization approach for future metadesigns.

In Ref. [3], Huang *et al.* addressed a detailed insight on the coupling behavior of a complex metasurface with its unit cell composed of nanobars and nanorings. They developed the temporal coupled-mode theory to show the effects of propagation phase in the coupling of plasmonic modes. This study proposes a new theoretical framework for comprehending the interaction of light and matter and offers some guiding implications for possible applications.

In Ref. [4], Zhang *et al.* predicted that ultrathin nonlinear lithium niobate metasurfaces can generate and diversely tune spatially entangled photon pairs. They theoretically showed that by leveraging the strong angular dispersion of the metasurface, the degree of spatial entanglement quantified by the Schmidt number can be decreased or increased by changing the pump laser wavelength and a Gaussian beam size. This flexibility can facilitate diverse quantum applications of entangled photon states generated from nonlinear metasurfaces.

In Ref. [5], Khalid *et al.* proposed a spin-insensitive design principle based on metasurfaces that can perform identical functionality (on co- and cross-polarization channels) irrespective of the handedness of the incident/transmitted light. As a proof of concept, they designed and numerically realized two types of spin-insensitive wavefront engineering devices: the spin-insensitive metahologram and the spin-insensitive beam deflector.

In Ref. [6], Wang *et al.* proposed a cascaded metasurface to independently encode information into multiple channels. Based on the orientation degeneracy of anisotropic metasurfaces, each single metasurface can produce a quick-response image in the near field, governed by Malus's law, while the combined channel can produce a holographic image in the far field, governed by geometric phase.

In Ref. [7], Li *et al.* proposed a double-layered metasurface composed of complementary elliptical and reversal ring resonator structures to achieve simultaneous and independent control of the reflection and transmission of circular polarization waves at two independent terahertz frequencies, which integrates three functions of reflected beam deflection, reflected Bessel beam generation, and transmitted beam focusing on the whole space.

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