Editorial

Metasurfaces are ultrathin structured interfaces consisting of planar arrays of subwavelength artificial nanostructures, which emerge as excellent platforms for optical wave manipulation. Owing to their unprecedented capacities to manipulate the polarization, amplitude, phase and frequency of optical waves at the subwavelength scale, metasurfaces enable various novel optical functionalities that go beyond which can be attained from conventional optical elements. After more than a decade of rapid development, research on metasurfaces has progressed from low efficiency, single functionality, static operation towards multifunctionality, high efficiency, broad band operation, and dynamic tunability in manipulation of optical waves, which makes them a promising candidate for optical information multiplexing and multifunctionality. The developments of metasurfaces also benefit from the reduction of design complexity and the incorporation of new optimization toolsets such as deep learning algorithm. Owing to these new developments, metasurfaces are playing an increasingly important role in nanophotonics and flat optics as they benefit the integration and miniaturization of optical devices.

This special topic on metasurfaces of novel designs and functionalities, composed of four articles, aims to help the researchers in related fields to better capture the recent advances in metasurfaces and the possible future development directions. In the invited review, Li et al. [1] present the overview of some recent progress in few-layer metasurfaces from the viewpoint of their scattering properties. As a novel design concept, few-layer metasurfaces with judiciously engineered interlayer interactions and multiple degrees of design freedom provide unprecedented possibilities for asymmetric and full-space manipulation of electromagnetic waves and the integration of multiple electromagnetic functionalities. In the News & Views, Li [2] discusses the advantages of metalenses in imaging technology. Owing to their miniaturization capability and expanded functionalities, metalenses are expected to revolutionize real world optical technologies. Wu et al. [3] propose a novel design of a broadband transmission-type few-layer coding metasurface for dynamic manipulation of the electromagnetic beam, such as microwave scanning, in the third article. Specifically, the proposition of the concept of coding metasurfaces makes it possible to dynamically manipulate the electromagnetic waves in a digital manner. Finally, Ma et al. [4] present a comprehensive deep learning model for the design and characterization of metasurfaces. The implementation of the inverse design of metasurfaces using deep learning technologies can simplify the design process of metasurfaces, which will extremely benefit the design of metasurfaces with on-demand optical functionalities.

We would like to thank all the authors who have contributed to this special topic. We believe that the novel approaches and several promising directions of metasurfaces proposed here will benefit the development of metasurfaces.

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1 Z. Li, W. Liu, H. Cheng, and S. Chen, *Sci. China-Phys. Mech. Astron.* **63**, 284202 (2020).

2 T. Li, *Sci. China-Phys. Mech. Astron.* **63**, 284231 (2020).

3 R. Y. Wu, L. Bao, L. W. Wu, and T. J. Cui, *Sci. China-Phys. Mech. Astron.* **63**, 284211 (2020).

4 W. Ma, and Y. Liu, *Sci. China-Phys. Mech. Astron.* **63**, 284212 (2020).