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A novel wavefront engineering approach for producing new classes of optical components with enhanced functionality

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A novel wavefront engineering approach for producing new classes of optical components with enhanced functionality

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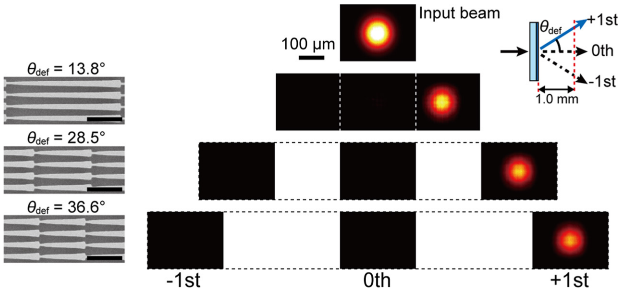
Scientists demonstrated highly efficient transmissive dielectric metasurfaces capable of forming a spatially continuous phase profile for complex wavefront engineering, enabling new classes of ultra-thin, high-performance optical components.



Optical metasurfaces are thin-film, artificial materials that can shape light properties with subwavelength resolution. The materials are composed of arrays of subwavelength-scale metallic or dielectric patterned structures, offering a new route to replace bulky optical components with easy-to-fabricate, ultrathin and lightweight optical devices. One of the key features of metasurfaces is their ability to shape optical wavefronts by locally shifting the phase of incident light, which can help realizing ultrathin optical components. However, due to the discrete character of metasurfaces with space between structures, conventional metasurfaces inevitably generate a spatially discrete multi-level optical phase profile when interacting with light, which mismatches the ideal continuous phase profile and hinders the creation of high-performance optical components such as high-efficiency, large-angle deflectors and high numerical aperture lenses.

Recently Miyata et al. reported a novel dielectric metasurface capable of creating a spatially continuous phase profile that matches an ideal optical phase profile for complex wavefront engineering. Based on the novel metasurface, the researchers realized a variety of ultra-thin optical components and experimentally demonstrated the components' enhanced efficiency and functionality compared with conventional metasurface-based counterparts.

To develop the novel metasurface, the researchers explored the optical properties of amorphous-silicon nanobeam arrays in both simulation and experiments by systematically varying their geometric parameters. They found that an array of amorphous-silicon nanobeams with gradually modulated width can yield near-unity light transmittance due to impedance-matching property and create continuous phase profile thanks to the spatial variations of the array's refractive index, which are ideal for bending and shaping light waves. Since designing optical phases in deep-subwavelength regimes is critical for free-space optics, the new approach will enable new classes of high-efficient, high-performance optical components with complex wavefront engineering.

Source: "Impedance-matched dielectric metasurfaces for non-discrete wavefront engineering," by Masashi Miyata, Mitsumasa Nakajima, and Toshikazu Hashimoto, *Journal of Applied Physics* (2019). The article can be accessed at https://doi.org/10.1063/1.5087027.

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