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Dual-functional metalenses for the polarization-controlled generation of structured beams

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The ability to generate different structured beams in a compact optical path by controlling the input polarization has been a challenge of the last few years in the optics and photonics field. In this regard, we propose designing, fabricating, and characterising new dielectric dual-functional metaoptics that generate 3D orbital angular momentum beams or vector beams along custom-define trajectories with on-demand different behaviours acting on the input light's polarization. Our meta-optics are designed as an array of periodic subwavelength metastructures (the so-called meta-atoms) composed of silicon nanofins on a silicon substrate. Each nanorod acts like a half-wave plate that exploits both the geometrical and dynamical phases in a different way depending on its position on the entire optic. The optical elements have been fabricated in the form of phase-only metasurfaces (meta-atoms) with high-resolution electron-beam lithography and characterized with a custom-made optical bench. The main result of this work is the design of tiny high-resolution optics generating longitudinally-variant vector beams and spheres of light that are able to impart new peculiarities to the light. In particular, the proposed metaoptics could open new applications of structured light for holography, super-resolution imaging, optical trapping and particle tweezing.

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