METAMORPHOSIS OF NANOSTRUCTURED LENSES: HYBRIDIZATION AND FREE-FORM METALENSES FOR TOTAL ANGULAR MOMENTUM CONTROL

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Moving from free-form refractive/diffractive optics to metalenses, novel tools for structuring optical materials are provided for the generation of nanostructured optical layouts. New optics are designed for the control of total angular momentum in structured light beams implementing basic and complex optical operations.
Keywords: metasurface, orbital angular momentum

A metamorphosis is occurring in the design and fabrication of nanostructured optical devices. By encompassing two emerging fields, structured optics and structured light, the design of a new generation of metasurface optics is expected to provide the key-elements of future optical architectures based on the control of the total angular momentum of light.
Parallel sorting of orbital angular momentum (OAM) and polarization has recently acquired paramount importance and interest in a wide range of fields ranging from tele communications to high-dimensional quantum cryptography. We present the design, fabrication and test of a Pancharatnam-Berry optical element in silicon implementing a *log-pol* optical transformation at 1310 nm for the realization of an OAM sorter based on the conformal mapping between angular and linear momentum states [1]. The metasurface is realized in the form of continuously variant subwavelength gratings, providing high-resolution in the definition of the phase pattern. A hybrid device is fabricated assembling the metasurface for the geometric-phase control with multi-level diffractive optics for the polarization-independent manipulation of the dynamic phase.

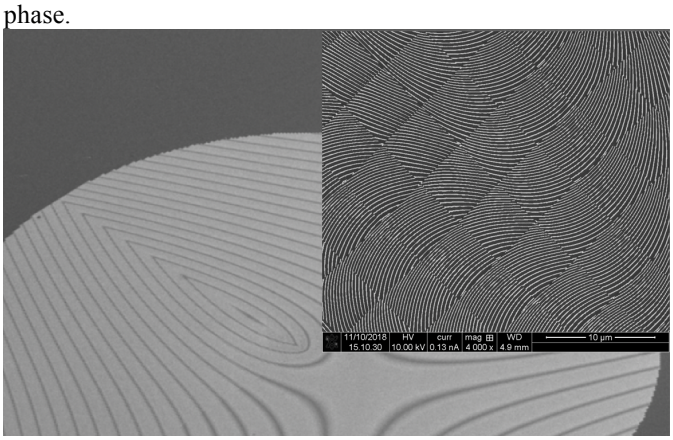

Fig. 1 Transformation optics in form of Pancharatmen Berry optical elements designed and fabricated for sorting OAM modes spectroscopy.

We also present a method to efficiently multiply or divide the orbital angular momentum (OAM) of light beams using a sequence of two optical elements [2]. The key-element is represented by an optical transformation mapping the azimuthal phase gradient of the input OAM beam onto a circular sector. The optical elements have been fabricated in the form of phase-only diffractive optics with high-resolution electron-beam lithography. These elements can find applications for the multiplicative generation of higher-order OAM modes, optical information processing based on OAM-beams transmission, and optical routing/switching in telecom.
The main objective is to accelerate the technological implementation for extending the spectrum of applications, by providing a novel and innovative set of miniaturized, planar, multi-functional and efficient optical elements which can be easily integrated into the silicon photonics framework or in optical layout of microscopes.

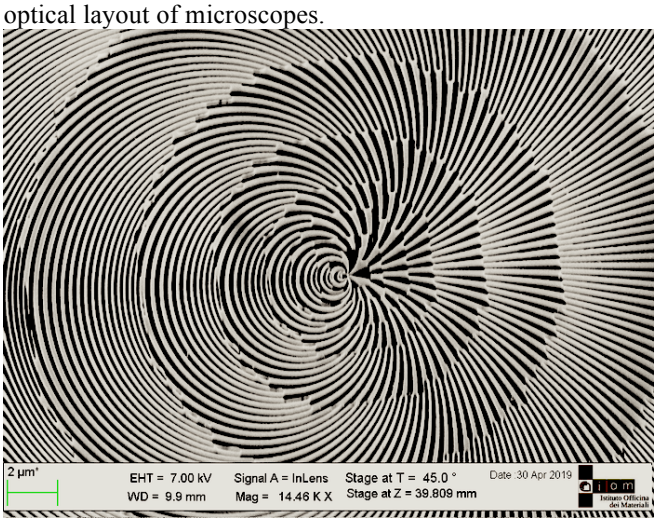

Fig. 2 Metalens designed to obtain a q-plate.

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