Nanometric transverse displacement metrology in range of hundreds of micrometers with polarization-encoded metasurface

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Abstract

A long range, high precision and compact transverse displacement metrology method is of crucial importance in many research areas. We propose and experimentally demonstrate the first prototype polarization-encoded metasurface for ultrasensitive transverse displacement metrology. The transverse displacement of the metasurface is encoded into the polarization direction of the outgoing light via the Pancharatnam-Berry phase. By measuring the output light polarization direction, the metasurface's position can be readout directly according to the Malus law. We experimentally demonstrate nanometer displacement resolution with the uncertainty on the order of 100 pm for a large measurement range of 200 μm with the total area of the metasurface being within 900 μm x 900 μm . The measurement range can be extended further using a larger metasurface. Our work largely broadens the existing application areas of metasurface and opens new avenue of applying metasurface in the field of ultrasensitive optical transverse displacement metrology.

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