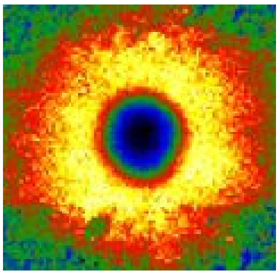

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Hybrid full-space metasurface for ultraviolet light

Great attention has been drawn to the manipulation of ultraviolet (UV) light because of its application in the telecommunication and consumer electronics industry, where extreme-UV lithography is a primary workhorse. However, absorption and tight precision constraints set limits on the fabrication of optical components, such as lenses, suitable for this part of the spectra. Nanophotonics offers a solution in the form of metasurfaces which can manipulate the amplitude, phase and polarization of the incident light by engineering its building blocks. Moreover, metasurfaces are lightweight, compact and multifunctional, following the nowadays popular trend of miniaturization in not only the electronics industry.

With optical applications in mind, where low absorption is a key requirement, dielectric metasurfaces are mainly used because of their significantly lower losses compared to metallic metasurfaces based on plasmonic resonances. In literature, UV metasurfaces are mostly explored or proposed on material platforms composed of oxides (HfO_2, Nb_2O_5, Ta_2O_5, ZnO) and nitrides (AlN, Si_3N_4) [1]. These materials are not mouldable like, e.g., the traditional fused silica, but they still offer large bandgaps that prevent UV light absorption. All of these materials were so far used for metasurfaces operating in transmission, meaning they were able to manipulate the transmitted light only. Recently, Jiang et al. [2] theoretically explored and proposed a metasurface that could project two distinct holograms simultaneously yet independently, both in reflection and transmission, a so-called full-space metahologram. Such a metasurface expands the application palette of UV metasurfaces in applications such as integrated optical circuits, optical storages and so on.

In our work, we demonstrate a metasurface capable of lensing both in transmission and reflection simultaneously yet independently using CMOS-compatible materials. Such a metasurface could find an application as a controlling device for laser stability, in on-chip UV photodetectors and UV LiDAR systems. To achieve simultaneous operation in reflection and transmission, we utilize two types of nanostructures. The first one is composed of pure HfO_2 for its large bandgap of 5.7 eV and the second one is composed of HfO_2 and Al, forming a hybrid nanostructure. In this hybrid nanostructure, Al serves as a backside mirror to ensure high reflectivity of the incident light.

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