All-dielectric hybrid silicon/$Ge_2Sb_2Te_5$ optical metasurfaces for tunable and switchable light control in the near infrared

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Abstract: We report a novel reconfigurable metasurface based on the combination of all-dielectric arrays of silicon meta-atoms, with deeply subwavelength (< λ_0/150) $Ge_2Sb_2Te_5$ layers. Our approach allows to selectively and individually control electric and magnetic resonances.

All-dielectric nanophotonics are becoming the most promising platform for controlling light at the nanoscale, since (contrary to their plasmonic counterparts) they do not suffer from ohmic losses at optical frequencies [1]. This technology is therefore opening up a new route towards the development of high efficiency and compact photonic metadevices with applications in different fields, such as flat lenses or holograms, frequency selective surfaces, and structural color generators [2,3]. However, the response of such devices is in general fixed by design, which significantly limits their utility.

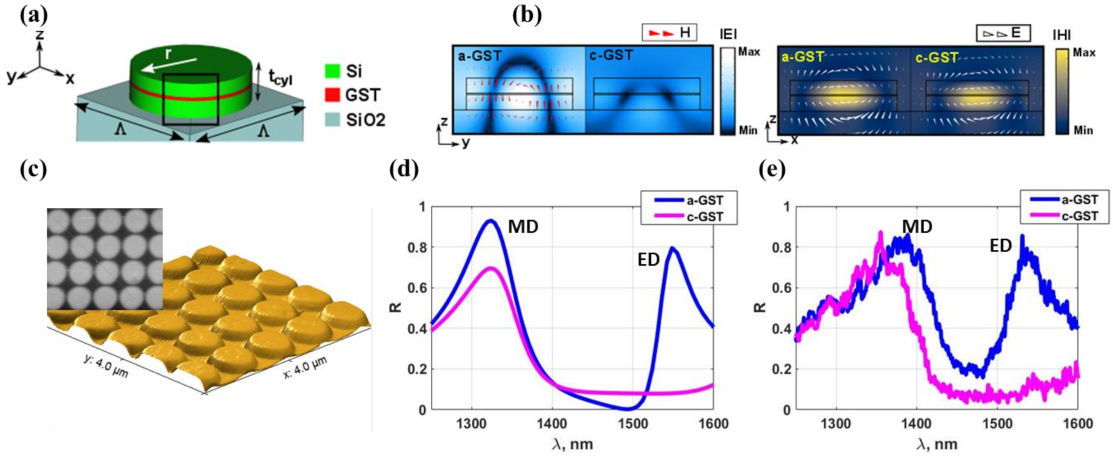

Fig. 1 (a) Schematics of the unit cell employed in our study (b) Electric (left) and magnetic (right) field profiles, for amorphous and crystalline states (c) AFM profile of a fabricated device (d) Reflectance of the device calculated via FEM, for amorphous and crystalline states of GST. (e) Experimentally obtained reflectance.

In this work, we present a novel reconfigurable metasurface based on the combination of all-dielectric arrays of silicon meta-atoms, with deeplysubwavelength sized phase-change material inclusions. Fig. 1a shows a schematic of the unit cell employed, which consists of a silicon nano-disk, with an ultra-thin phase change layer (here, $Ge_2Sb_2Te_5$ or GST). The proposed interface offers separate control over reflectivity resonances originating from electric and magnetic Mie modes of single disks (Fig. 1b, 1d and 1e). This can be achieved via strategically locating the GST in the antinodes of the electric field of the electric resonance (Fig. 1b, left), which allows to selectively turn on and off the mode by changing the film between amorphous and crystalline states. At the same time, as it can be seen from Fig.1b (right), the magnetic dipole mode remains stable after crystallisation, due to weak interactions of the electric fields with the GST layer.

We believe that the proposed reconfigurable metasurface provides a wide range of new possibilities and degrees of freedom towards the realisation of various tunable and highly efficient meta-devices.

References

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