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PhD THESIS DEFENSE: Reconfigurable metasurfaces based on thermo-optical and optomechanical controls

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Optical metasurfaces established themselves as potential platform for planar and integrated optics. Progress in the material sciences and fabrication process paves the way towards ultra-thin metasurface based devices, also known as meta-devices. Meta-devices include holograms, flat lenses, wave-plates, polarizers and deflectors. Amongst these meta-devices, great effort focuses toward the development of high performance, aberrations-free, and multi-functional metalenses.

High refractive index and lossless dielectric materials have enabled metalenses with near-unity transmission and high numerical aperture. However, the static nature of metalenses limits their use for the applications where continuous and on demand tunability of lens operation is required such as imaging and adaptive vision.

In this thesis, I developed two different techniques to achieve reconfigurability in metasurfaces which I used to create reconfigurable metalens devices. devices based on two types of reconfigurability techniques. First technique achieves focal length tunability of a dielectric metalens by utilizing the electro-thermo-optical effect to change the refractive index of the surrounding media. The electro-thermo-optically controlled metalens exhibits linear and continuous focal length tunability, high efficiency and low power consumption with switching time of the order of 100 ms. The second varifocal metalens Device takes advantage of the optomechanial effect to introduce change in the geometry of the metalens itself. Carved onto a freestanding ultra-thin silicon membrane, the metalens exhibits continuous and linear focal length tunability with fast response time as short as a few ?s.

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