Vanadium dioxide-enabled tunable metasurfaces

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Abstract: We numerically demonstrate output tuning in vanadium dioxide (VO_2) metasurfaces at 1550 nm, which is enabled by the phase transition of VO_2. The designs could be utilized in applications such as imaging and LiDAR sensing.

Optical metasurfaces are judiciously designed planar nanostructures that can manipulate the propagation of light waves. They have emerged as next-generation optical components with wide-ranging potential applications, where dynamic tuning is often a highly desired functionality. Several approaches have been established to achieve dynamic tuning, e.g., structural deformation [1] and coherent control [2]. This work belongs to the approach that utilizes changes in intrinsic material properties, and the tunable material used here is VO_2. VO_2 has a phase transition near room temperature, which is accompanied by a large change in its optical properties. Recent advancement in atomic layer deposition has also made deposition of high-quality VO_2 thin film more reliable and repeatable [3]. These factors make VO_2 an ideal material for tunable metasurfaces. In this work, we present several VO_2-based tunable metasurfaces and discuss their properties such as temperature dependence. The figure below shows an example device, where the metasurface functions as a light-focusing lens. The focus of the metalens changes with temperature across the phase transition.

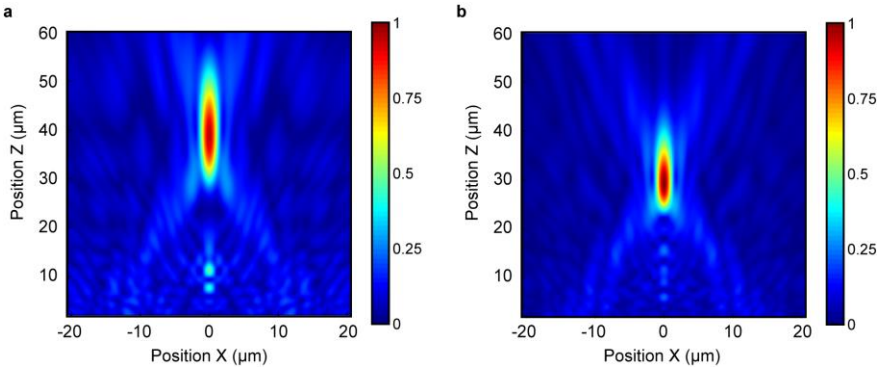

Figure 1. A tunable VO_2 metalens, showing a shift in focus with phase transition.

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