First lithium niobate metasurface electro-optic modulator realized

Ya Cheng^{*}

School of Physics and Electronic Science, East China Normal University, Shanghai 200241, China

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Although metasurfaces provide a new paradigm for creating unconventional optical properties that are not found in nature, they are still challenged for their specific functionality initially designed owing to their limited tunability [1]. Recently, immense efforts have been devoted to transforming static metasurfaces into their active counterparts so as to dynamically control their response by external stimuli in a reversible manner. In principle, an active tunability of the optical characteristics of metasurfaces can be achieved by altering the near-field interactions within or between metaatoms. However, because of the extremely short optical path of photons within the ultrathin metasurface layer, such near-field alterations are too weak to cause any sufficient changes in the far-field radiation properties as required by applications. An efficient solution is to utilize high-quality factor (high- Q) resonant modes with a narrow spectra linewidth, which significantly extend the effective optical path and in turn the photon lifetime in the metaatoms, thus yielding an enhanced modulation to the electromagnetic fields [2].

By implementing such a high- Q active metasurface, Gao et al. [3] from Nankai University have demonstrated for the first time an electro-optic (EO) modulator by lithium niobate (LN) metasurfaces. The LN shows comprehensive merits of low price, high optical transparency, good mechanical and chemical stability, and most importantly large EO coefficient,

holding a firm position in manufacturing high performance EO modulators in modern communication systems [4]. Herein the authors selectively milled a 200 nm thin LN film using a focused ion beam, and fabricated a periodic nanograting array, namely metaatoms. Such nanostructures could support an intriguing high- Q mode called bound states in the continuum (BICs) [5]. The excited BIC mode effectively trapped the light field in the metaatoms to enhance the EO effect, leading to a significant phase modulation of the transmitted light. The results evidence a promising feasibility of the LN metasurfaces for new generation ultra-compact EO modulators that have wide applications in the fields ranging from optical beam shaping to optical information processing.

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^{*}Corresponding author (email: ya.cheng@siom.ac.cn)