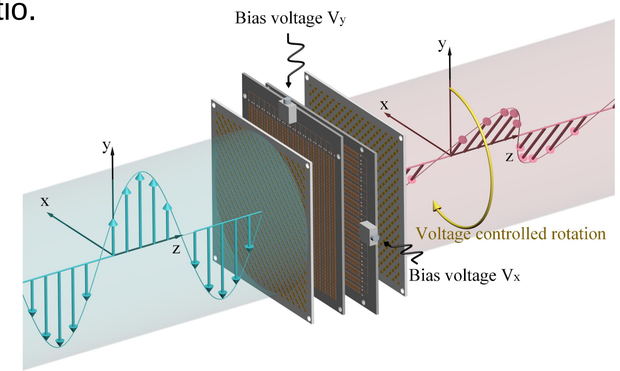
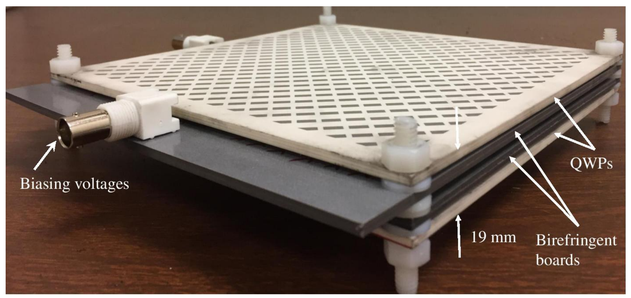
Tunable metasurfaces

- Metasurfaces are surfaces textured at a subwavelength scale to achieve tailored electromagnetic responses.
- Electronic devices such as varactor diodes, transistors and MEMS, as well as 2D and phase change materials, can be integrated into metasurfaces to provide dynamic control over the electromagnetic properties.
- We introduced tunable, transmissive metasurface [1] at X-band frequencies that is capable of electronically rotating the polarization of an arbitrarily polarized incident wave, without changing its axial ratio.

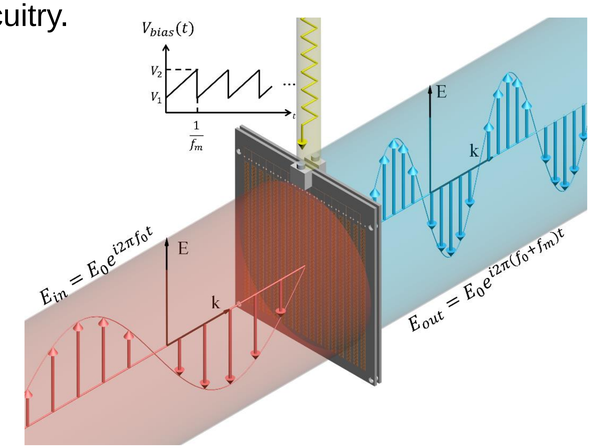


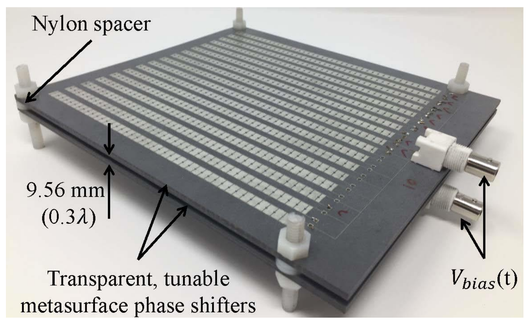


[1] Z. Wu, Y. Ra'di and A. Grbic, "Tunable Metasurfaces: A Polarization Rotator Design," Physical Review X, vol. 9, no. 1, p. 011036, 2019.

Frequency translation

- A transparent, highly miniaturized metasurface was developed that functions as a single-sideband frequency translator (serrodyne frequency translator) [2]. A radio-frequency sawtooth waveform is used to modulate the metasurface, allowing Doppler-like frequency translation.
- In contrast to a sinusoidally-driven mixer, the serrodyne frequency translator suppresses the image frequency without added image rejection circuitry.

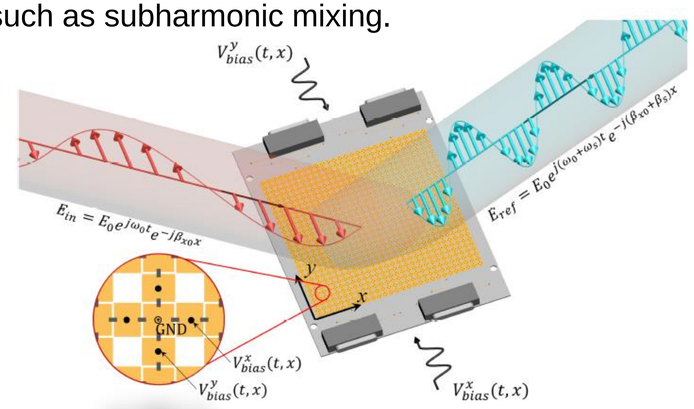


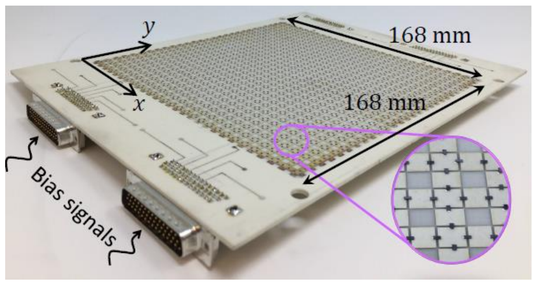


[2] Wu, Zhanni, and Anthony Grbic. "Serrodyne frequency translation using time-modulated metasurfaces.", IEEE Trans. on Antennas and Propagation, vol. 68, no. 3, pp. 1599-1606, 2019.

Subharmonic mixing

- We characterized a dual-polarized, ultra-thin (0.06λ) metasurface that provides spatio-temporal control of its reflection phase [3]. With this metasurface we demonstrated full, dynamic control of reflected wavefronts, including beam-steering, polarization control, frequency conversion and non-reciprocal beam directing.
- In addition, we introduced the concept of spatially-discrete, space-time modulation (SD-STM), where the finite number of unit cells in one spatial modulation period leads to new physical phenomena such as subharmonic mixing.





[3] Z. Wu, C. Scarborough, A. Grbic, "Theoretical and experimental investigations of spatio-temporally modulated metasurfaces with spatial discretization," arXiv: 2006.06394, Jun. 2020, (submitted to Physical Review Applied).