A Tunable Polarization Rotator Based on Metasurfaces

Zhanni Wu*[1], Younes Ra'di[2], and Anthony Grbic[1]

[1] University of Michigan, Ann Arbor, MI, 48109

[2] The University of Texas at Austin, Austin, TX, 78712

In recent years, there has been an increased interest in metasurfaces that possess reconfigurable/tunable functionalities. Such tunable metasurfaces can provide a multi-functional platform for the manipulation of electromagnetic wavefronts. Although progress has been made in the realization of tunable metasurfaces (D.F. Sievenpiper, J.H. Schaffner, H.J. Song, R.Y. Loo and G. Tangonan, IEEE Trans. Antennas Propag., vol. 51, no. 10, pp. 2713-2722, 2003), the area remains wide open for exploration.

We propose an electronically tunable polarization rotator based on tensor metasurfaces operating at 10 GHz. The proposed polarization rotator can control the polarization tilt angle of a transmitted wave, given a linearly polarized incident wavefront. The polarization rotation is accomplished through a simple biasing mechanism. The tunable polarization rotator consists of a tunable birefringent structure sandwiched between two static quarter-wave plates. The quarter-wave plates are rotated $+45°$ and $-45°$ with respect to the optical axis of the birefringent structure. Each quarter-wave plate is realized by cascading three patterned metallic claddings (C. Pfeiffer and A. Grbic, IEEE Trans. Microw. Theory Tech., vol. 61, no. 12, pp. 44074417, 2013.). It provides a $90°$ phase difference between two orthogonal polarizations. The birefringent structure is a broadband transmissive metasurface with an independently tunable phase shift for each orthogonal polarizations. Tunability of the birefringent structure is achieved by integrating varactor diodes into a bandpass metasurface. The diodes are biased by metallic lines that provide both the required DC bias voltage and inductive response for the bandpass performance of the birefringent structure. By applying different bias voltages to the birefringent structure, the polarization rotator can tilt the linear polarization of the transmitted wave. The range of achievable tilt angles spans $150.92°$, while maintaining a simulated transmission coefficient magnitude greater than -5 dB.

It should be noted that the proposed polarization rotator allows transmitted phase and polarization tilt angle to be changed independently. This feature could potentially enable the structure to manipulate direction of radiation, in addition to controlling its polarization. At the conference, analysis of the proposed polarization rotator as well as simulation and measurement results will be reported.