Monolithic MEMS-tunable Orthogonally-polarized Dual-band Reflective Unit Cell for Mobile Two-way Connectivity

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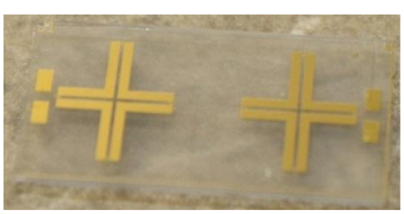
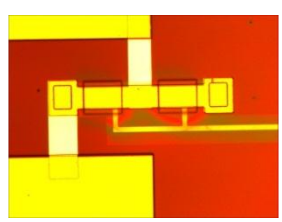
Mobile two-way connectivity has been receiving much attention recently due to its application in mobile satellite internet, telemedicine and security. This type of communication requires high-gain antennas which are not only operational in two bands and polarizations, but also capable of independent beam-forming in each band for tracking purposes. Tunable reflectarray antennas have the potential to leverage these requirements. The radiating aperture of these antennas is comprised of a periodic unit cell loaded with tuning elements in order to manipulate its radiating phase. Several techniques have been applied for achieving dual-band or dual-polarized operation. The simplest way is to use multilayer reflectarrays where each layer operates in a specific band and polarization. However, multi-layer structure is avoided in order to keep the design easy and maintain a low profile and fabrication cost. In another technique, unit cells of different operating frequency and polarization are interlaced over a single substrate. But, such antennas suffer from reduced radiation efficiency in each band and higher side-lobes. Besides, the reflective unit cells in literature are capable of only operating and tuning a single band (J. Perruisseau, IEEE Trans Ant, vol. 58, no. 5, pp. 1494-1502).

This paper presents a monolithically-fabricated single-layer single-sided reflective unit cell tuned by two pairs of MEMS varactors. While being simultaneously and independently tunable for each of its two operating bands, the proposed unit cell accommodates dual orthogonal linear polarization and allocates only one state of polarization to a given operating band. Each pair of varactors, tune one of the frequency/polarization's (F/P). The resultant RA can have two scanned beams at different F/P's. MEMS elements are used here because of their near-zero DC power consumption, very weak nonlinear effects such as intermodulation distortion in case of high power transmission signals and also low equivalent resistance. A common problem in tunable antennas originates from DC bias lines. The routing of bias lines is optimized and also the bias lines are made out of a highly resistive material in order to minimize the cell loss. A custom monolithic six mask fabrication process is designed for fabrication of DC bias lines, reflective cells and also the MEMS varactors. The fabrication process is under run. A WR75 waveguide setup will be used to characterize the reflection of cells. Each die includes 2x1 cells that fit WR75. Four DC pads are considered in each die for biasing all varactors and testing the independence of operation of each band and polarization. Four pins are also considered inside the waveguide for connection to the pads. Some preliminary Figures of the fabricated samples and MEMS elements are shown below. The results will be presented in the conference.

A die including 2x1 cells with 4 biasing pads; A MEMS varactor across the unit cell slot with DC bias lines.