MM-Wave High Gain Beam-Scanning Focal Plane Arrays with Microfluidically Switched Feed Networks

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Microfluidic based reconfiguration techniques are promising for realizing low-loss, low-cost, and high power handling RF devices. However, rapid oxidization and lower conductivity of liquid metals pose issues for their reliable use and applicability at higher frequency bands. Our recent work removed these issues by utilizing selectively metallized plates within the microfluidic channels. This technique already allowed to realize devices that handle high power, exhibit wide frequency tuning range, and operate in mm-waves.

This presentation will focus on our beam-scanning Microfluidic Focal Plane Array (MFPA) concept (A. A. Gheethan and G. Mumcu, "Passive Feed Network Designs for Microfluidic Beam-Scanning Focal Plane Arrays and Their Performance Evaluation," IEEE Transactions on Antennas and Propagation, vol. 63, no. 8, pp. 3452 – 3464, Aug. 2015) by introducing a novel feed network to further enhance its efficiency, bandwidth, and beam-scanning speed. The proposed microstrip line feed network lies under a focal plane aperture coupled 30 GHz patch antenna array and utilizes a selectively metallized plate within the microfluidic channel to perform RF switching functionalities. The switching is achieved by using a 6μm thick low loss benzocyclobutene layer as the microfluidic channel wall to realize strong capacitive coupling between the metallized plate and microstrip line feed network. Individual switch design and characterization shows that the insertion loss of each switch can be kept below 0.2 dB. Hence, multiple switches in series can be utilized to develop a convenient feed network topology that would also operate over a significantly wider bandwidth as compared to our prior work, which relied on resonance mechanisms. The presented feed network allows for a highly efficient beam-scanning high gain antenna that is free from the costs and design complexities associated with the need of including active RF devices. In addition to the design details, the presentation will also report recent experimental verifications of the proposed microfluidically actuated switch, feed network, and MFPA. Design techniques/approaches that can be utilized to extend the MFPA concept to achieve 2D beam-scanning will also be discussed.