Microfluidic Based High Gain Beam-Scanning Antenna Arrays for MM-Waves and Beyond

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Microfluidic reconfiguration techniques that rely on liquid metals have been recently shown to offer unique advantages in terms of high power handling capability, wide frequency tuning range, flexibility, low cost, high radiation efficiency and low insertion loss. However, rapid oxidization and an order of lower conductivity of liquid metals (as compared to copper) currently stand out as the major limitations for their reliable use and applicability at higher frequency bands. To alleviate this issue, the reconfigurable microwave filters and antennas (A. Dey and G. Mumcu, "Microfluidically Controlled Frequency Tunable Monopole Antenna for High Power RF Applications," IEEE Antennas and Wireless Propagation Letters, 2015) introduced by our research group have utilized a novel microfluidic reconfiguration technique by relying on metalized plates movable within microfluidic channels that are constructed from bonds of ultra-thin low-loss dielectric materials and mold substrates. The use of regular high conductivity metals and repeatable positioning with micropumps allow the metalized plate technique to be applicable to mm-wave frequencies and beyond. By taking advantage of this technique, more recently, a beam-scanning high gain 30GHz focal plane array has been successfully demonstrated without needing any RF switches (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). Specifically, this mm-wave array has utilized a metalized plate as a patch antenna movable over a strategically designed passive microstrip line feed network that is located at the lens' focal plane.

In this presentation, we will demonstrate that *selectively* metalized plates that are in-plane movable within the microfluidic channels allow for compact low-loss phase shifters and beam-forming networks suitable to realize low-profile and highly efficient beam-scanning mm-wave antenna arrays. The selective metallization allows to utilize a minimum number of actuators within the system (e.g. two micropumps for performing combined elevation and azimuth scans). The high efficiency performance of this technology is also expected to remain mostly intact when the proposed devices and arrays are physically scaled down to operate well beyond the mm-waves (e.g. within the low THz band). However, the physical scaling down necessitates to devise approaches to precisely control the movement of the metalized plates and potentially replace the external micropumps with internal actuators. These aspects will also be discussed at the time of the conference.