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Beam Steering Leaky-Wave Antenna for High Efficiency Terahertz Communication and Sensing

James Churm[(1)], Muhammad Rabbani [(1)], and Alexandros Feresidis[(1)]
(1) The University of Birmingham, Edgbaston, B15 2TT, UK, e-mail: J.R.Churm@bham.ac.uk

In the coming decades it is envisaged that terahertz frequencies (0.1 – 10 THz) will play a major role in numerous wireless systems [1,2]. As path losses at these frequencies are incredibly large, there is a need for high gain and beam steerable antennas to sustain radio links in dynamic environments [1-3]. Conventional methods of beam steering are limited at terahertz frequencies due to factors which include loss performance and availability of off-the-shelf components [3]. In the millimeter wave, we have recently proposed a new tuning mechanism that utilizes the micro-motion of a piezoelectric actuator (PEA) to provide ultra-low-loss phase shifting and beam steering [4,5]. In this contribution we build upon this work and will present a leaky wave antenna (LWA) concept that provides 18° beam steering at 280 GHz.

The LWA consist of a partially reflective surface (PRS) suspend over a ground plane to form a cavity of variable height. The PRS in this case is an array of 600 µm diameter holes, with a periodicity of 750 µm, bored into a copper surface of 300 µm thickness. The cavity height between PRS and ground is then varied between 440 µm and 500 µm (which is easily achievable using a PEA) to produce a beam that is continuously controllable between 8° and 26° from broadside (i.e. a scan of 18°) at 280 GHz. The antenna radiation efficiency is up to 94%, and greater than 80% for all displacement states. This level of efficiency has not been yet reported for these frequencies.

It is possible to use the proposed technique of micro-motion controlled tuning across the millimeter wave and terahertz spectra, which maintains low loss performance due to the tuning mechanism being situated outside the high frequency circuit. Therefore providing no additional sources of loss. It may also be possible to further augment this effect by the addition of a high impedance surface component.

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