Microelectromechanical-Based Novel Antenna Design and 2-D Active Scanning Leaky-Wave Antenna Array

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Abstract

This thesis consists of two parts: Microelectromechanical technology based novel antenna design and the study of suppression of the reflected wave and beam-scanning features of the leaky-wave antenna array. In the first part, the design, fabrication and measurement of two types of micromachined antennas were presented. One is a flexible monopole antenna which was fabricated on parylene substrate, and the other is a 3D monopole antenna which was fabricated on both sides of a Pyrex 7740 glass wafer with through-hole connections. Flexible dual-band (2.4/5.2 GHz) monopole antennas were designed with meander-shaped metal tracks, because this can efficiently reduce the physical dimensions of the overall antenna size and maintaining the required electrical path-length. Due to parylene's excellent physical, mechanical and chemical properties such as low dielectric constant, high resistivity, and inertness to chemicals, it can serve as a substrate for an antenna in our study. The advantages of these antennas are their small size, light weight, low cost, dual-band characteristics, broad bandwidth, and flexible.

A compact 3D MEMS monopole antenna was also demonstrated. In order to reduce the size, the meandered monopole antenna was fabricated on both sides of a Pyrex 7740 glass wafer, and the metal lines on both sides were connected through via-holes. Measured performances of the fabricated 3-D antenna are in good

agreement to the designed values in terms of operating frequency at 2.45 GHz and with a bandwidth of 190 MHz. This simple fabricated size low cost antenna is suitable for communication applications.

In the second part of the dissertation, a two-directional linear scanning array was demonstrated by integrating a short leaky-wave antenna (LWA) with aperture-coupled patch antenna arrays on the backside. This active scanning antenna has many special functions known by experimental results. This architecture proposes a technique not only having the advantage of suppressing the back-lobe due to the reflected wave of the short LWA but also producing two separate linearly scanned beams in a different region of space. By tuning the backside individual phase shifter, the phase of this coupled signal to each antenna element can electronically control the patch antenna main beam on the backside. And simultaneously by changing the operating frequency, the main beam of the short LWA can scan on the front side. As a result, the two linear beam-scanning radiation patterns of individual direction can be created independently, which includes a narrow beam in the elevation plane at the front side and a broadside beam in the cross plane on the backside. This designed array scanning capability is suitable for military application, air traffic control, collision avoidance system, or radiolocation, etc. Thus, there is great potential for application in the future.