MICROMACHINED SI WAVEGUIDE FOR THZ APPLICATIONS

Peter L. Kirby, John Papapolymerou
Georgia Institute of Technology, 85 5th St NW - Room 543, Atlanta GA 30332

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: kirby20777

Date Received: September 23, 2004

1. (a) Peter Kirby
855 W Peachtree St
Unit 1133
Atlanta, GA
30308 USA
pkirby@ece.gatech.edu
(b) 404-385-6401
(c) 404-894-0222

2. B - Fields and Waves

3. (a)

4. C - Contributed Paper

5. No special instructions

There is increasing interest in using Terahertz (THz) frequencies for a variety of different applications. Since THz signals are non-ionizing and do not damage cells like X-rays, they offer great promise in the medical imaging field. THz signals have already been used for military applications such as scanning for land mines, space exploration and imaging. THz signals are generally conducted in a waveguide medium. Metallic waveguide is often difficult to machine for use at very high or THz frequencies, requiring the expert skills of an experienced machinist which can be very costly and generally not suitable for large unit production. For heterodyne imaging applications it is necessary to reduce cost of waveguide components in order to create large format arrays.

To realize a low cost approach, there must be a movement away from the metallic waveguide in to a different material. We propose to use a silicon substrate to form the waveguide. While this is not a new approach, the previous method of choice to form the waveguide has been done by wet etching. Although this is effective in forming simple waveguides, it can be limiting when choosing to form structures that are more complex. To this end we propose using a deep Reactive Ion Etching (RIE) as initial step toward using a more precise laser etching technique for frequencies greater than 600 GHz. In order to prove this approach to be valid we select to create design centered around 400 GHz (WR-2.5, 25 X 12.5 mils) for our initial step. This frequency allows for the challenges of very high frequency design, while keeping the dimension involved relatively large and manageable. For this phase we seek to construct and measure a straight section of 400 GHz waveguide and a 400 GHz bandpass filter.

We fabricate the complete waveguide by splitting the structure in the H-plane, forming two halves. Although this is not the preferred plane to split, it eases the fabrication of the bandpass filter. The waveguide and the die are etched using a deep RIE process and the two halves are mounted in a holder. The holder is assembled forming the complete waveguide with precision flange patterns on each face of the holder. The complete device is measured at Jet Propulsion Laboratories using an ABmm Network Analyzer.