35GHZ PATCH ANTENNA ARRAY BASED ON THE ELECTROMAGNETIC BAND-GAP STRUCTURE

Xiu-long Bao,1,2 Xiao-wei Sun,1 Zheng-fan Li,2 Wu-yun Bao,1 and Rong Qian1

1Shanghai Institute of Microsystem and Information Technology
Chinese Academy of Sciences, China, 200050
2Dept. of Electronic Engineering, Shanghai Jiaotong University
Shanghai, China, 200030

Received 5 August 2004

Abstract: The electromagnetic band-gap (EBG) structure, also called photonic band-gap structure, consisted by triangular arrays of air columns on the dielectric structure is designed and studied by using the FDTD method. According to the simulated and measured results, the EBG structure effectively suppressing surface wave for TE and TM modes is designed. The optimized EBG structure is presented. The proposed EBG structure is applied to the four-element microstrip patch array antenna. As results of simulation and measurements, the impedance bandwidth and the gain of proposed EBG patch array antenna are improved.

Key Words: Electromagnetic Band-gap (EBG) Structure, patch antenna array, TM/TE wave, Dispersion Curves.

1. INTRODUCTION

Electromagnetic band-gap (EBG), previously also called photonic band-gap (PBG) is periodic dielectric or metallic materials that have the property to forbid the propagation for the electromagnetic waves whose frequency is included within their frequency band-gap [1]. In recent years, the application of EBG structure to reduce surface wave radiation in the antennas has attracted growing interest. A number of studies were carried out in EBG antenna design for microwave application by drilling a periodic pattern in the dielectric substrate [2],
etching the periodic pattern in the ground plane [3-4], or using high-impedance electromagnetic surface [5]. The unique properties of the EBG structure to reduce the mutual coupling between elements of array antenna was demonstrated [6-7].

In this paper, the EBG structure with the holes on the substrate is utilized to restrain the surface wave and eliminate the coupling, and the performance of the array antenna is improved. The design of proposed EBG structure with the co-bandgap for the TM and TE modes is discussed in detail.

2. DESIGN OF THE EBG STRUCTURE AND MICROSTRIP PATCH ANTENNA ARRAY

The dispersion characteristics of EBG structure have been studied by various computation methods, such as the plane wave expansion (PWE), the transfer matrix method (TMM), and the finite difference time-domain (FDTD) [8-10], etc. Recently, FDTD becomes a main method in the computation of dispersion curves and propagation characteristics of 2-D and 3-D PBG structure. In this work, the FDTD method is used to calculate the dispersion curves of the proposed EBG structure, which is consist of the triangle lattices of air columns on an alumina substrate with dielectric constant of 9.8 and thickness of 0.8mm, its lattice size is 4.07mm and air column's radius is 1.88mm. Figure 1 shows the dispersion curves of the proposed EBG structure for TE and TM modes. At x axial, its wave vector dimension is expressed as the lattice size of the EBG.

![Dispersion Curves](image)

Fig. 1 The dispersion curves of the proposed EBG structure by using FDTD method.