ABSTRACT

A novel mushroom like electromagnetic band gap (EBG) structure for antenna improvement is presented in this paper. The idea proposed in this paper is etching several properly shapes in the metal surface of the mushroom-like compact EBG cell to introduce stop band in electromagnetic band gap structure. This band gap is represented by LC equivalent circuits, from which the resonant frequencies can be estimated. The effectiveness of the EBG as a surface wave suppresser is demonstrated using numerical simulations CST microwave studio. Two port method is used to analysis the band gap properties of the proposed structure.[1] Micro strip antenna surrounded by double layer of EBG structure presented in this paper which enhance return loss and bandwidth of conventional micro strip antenna

Keywords— Electromagnetic Band Gap structure, Surface Wave, Band gap Property, Micro strip Antenna.

I. INTRODUCTION

EBG structures are periodical cell composed of metallic or dielectric elements. Unique feature of EBG structures is to create the forbidden band of frequencies in which surface waves cannot propagate. Surface wave propagation is a serious problem in microstrip antennas. Surface waves reduce antenna efficiency and gain, limit bandwidth, increase end-fire radiation, increase cross-polarization levels, and limit the applicable frequency range of microstrip antennas [2]. When the antenna operates in the frequency band of this prohibition, it will improve significantly enhanced features, such as increasing the antenna return loss and bandwidth, the back, gain etc.

An antenna that is placed on a high-permittivity dielectric substrate may couple power into substrate modes. As substrate modes do not contribute to the primary radiation pattern, these modes are a loss mechanism. EBG structure can offer a real solution to this problem. Utilized in patch-antenna configurations as substrates, EBG structure suppress both substrate modes and surface waves that would otherwise be excited in the substrate by the radiating element. Suppression or reduction of surface waves improves antenna efficiency and reduces the sidelobe level that is caused by the diffraction of surface waves at the edges of the antenna substrate [3]. Surface-wave diffraction plays a major role when thick substrates are used to increase the bandwidth of the antenna. Power losses due to surface waves can be as high as 60% of the radiated power when thick substrates with high dielectric constant value are used.

There have been many proposed EBG structures with applications in wide band. Overall, there are two types of EBG is very widely used today is mushroom-type EBG [3] and uni-planar EBG [4]. Mushroom like EBG structure is proposed in this paper This model mainly use metal plates with grounding bias. By etching alternative symmetric square slots on the patch of the structure, it has created the equivalent elements LC resonant circuit. As shown in fig 1. They behave as a network of parallel LC resonant circuits, which act as a two-dimensional electric filter to block the flow of currents along the sheet [3].
Table 1
Dimensions of layer

<table>
<thead>
<tr>
<th>Layer</th>
<th>Ground</th>
<th>Substrate</th>
<th>Cylinder</th>
<th>Slots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>PEC</td>
<td>FR-4 (lossy)</td>
<td>PEC</td>
<td>vacuum</td>
</tr>
<tr>
<td>Dimension (mm)</td>
<td>7.5×7.5</td>
<td>7.5×7.5</td>
<td>h=1.676</td>
<td>r=.1</td>
</tr>
</tbody>
</table>

Fig 3: Front view of EBG unit cell

Fig 4: Side view of EBG unit cell

### III. BAND GAP ANALYSIS

The frequency band gap of EBGs is directly related to the geometrical parameters and material parameters of the host medium. The band gap is specified by magnitude of transmission coefficient (S21) using full wave simulator CST MWS, which describes the propagation characteristics of an EBG structure. Performance of 2×4 EBG array has been investigated by two port method [1] as shown in fig 5. Band gap of 2×4 EBG array is simulated by introducing port on each side of EBG array. Proposed array exhibit two band gap region as shown in fig 6. First band gap region (BG1) spread over the frequency range 0 - 4 GHz and second band gap region spread over the frequency range 7.2 - 11.2 GHz. Due to above characteristics proposed array is also referred as dual band EBG array.

Fig 5: Band gap measurement set up

Fig 6: Band gap result of 2×4 EBG array

### IV. MICROSTRIP ANTENNA WITH EBG SUBSTRATE

Conventional Rectangular Micro Strip Patch Antenna is designed on FR-4 (lossy) substrate. The parameter specifications of rectangular microstrip patch antenna are mentioned in table 2.

Table 2
Dimension of microstrip patch antenna (mm)

<table>
<thead>
<tr>
<th>Length (L)</th>
<th>Width (W)</th>
<th>Cut Width</th>
<th>Cut Depth</th>
<th>Path Length</th>
<th>Width Of Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.4</td>
<td>45.6</td>
<td>5</td>
<td>8.6</td>
<td>28.8</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Fig 7: Conventional micro strip antenna at 2GHz
According to the theory [5] Surface wave exist in Convensinal microstrip antenna. To reduce surface wave, convensinal microstrip antenna is surround by dual layer of EBG structre as shown in fig 8.

![Microstrip Antenna with EBG structure at 2GHz](image)

**Fig 8: Microstrip Antenna with EBG structure at 2GHz**

**V. RESULT**

Conventional micro strip antenna with PEC ground plane and FR4 substrate has been simulated on CST MWS. Return loss and Bandwidth of conventional rectangular micro strip patch antenna is shown in fig 9. According to this fig 9, return loss and bandwidth are -14dB & 35MHz respectively. To enhance the characteristics of conventional micro strip antenna, it is surrounding by dual layer of EBG structure as shown in fig 8 and simulated. EBG layer provide improvement in return loss and bandwidth as shown in fig 9. According to result, return loss reached at -25dB and bandwidth reached at 45MHz.

![Comparison of transmission coefficient](image)

**Fig. 9: Comparison of transmission coefficient**

**VI. CONCLUSION**

A mushroom like EBG structure for antenna improvement has been analysis in this paper. Band gap has been achieved by changing the different shapes of top layer of proposed structure in order to create suitable LC resonance condition. The band stop properties of the structure have been investigated by using CST Microwave Studio. Band gap is investigated by two port method. EBG structure applied on convensital rectangular microstrip antenna, (which improve the -10dB return loss and increase of 10MHz bandwidth). This enhancement occurs due to reduction of surface wave in substrate region.

**REFERENCES**


