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A Slotted Tri-Band Patch Antenna Embedded on Textured Pin Dielectric Substrate

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Abstract: The propagation of surface waves in the microstrip patch antenna proves to be proves to serious hindrance to radiation mechanism of the antenna. The periodic arrangement of shorting pins is embedded in the dielectric substrate at specific location to enhance the gain by around 4-5dB. The slotted perturbations have been done for achieving tri-band characteristics. The antenna is suitable for operation at three resonant frequency bands centered at 2.2421 GHz, 5.7632GHz and 7.7633GHz, which makes it suitable for WLAN applications.

Index Terms: microstrip, slots, side patch, tri- band, WLAN

I. INTRODUCTION

The planar geometry of microstrip patch antennas enables it to be used in variety of applications in wireless communications. The cost of fabrication and weight is also advantageous for installation. The losses are high in microstrip patch antenna due to propagation of surface waves. The textured pin substrate enables the antenna to achieve superior radiation characteristics.

The metallic cylindrical vias or pins embedded in the dielectric medium prohibits the surface wave propagation through the dielectric substrate, thus it provides negative dielectric permittivity. These structures are also called as Electromagnetic bandgap Structure (EBG). Different Electromagnetic Bandgap structures [1-7] are being employed so far for gain improvement.

The artificial dielectric designed is embedded with grid of cylindrical metallic vias which leads to high impedance of the medium. The cylindrical pins are embedded near the radiating side of the patch antenna. This helps in improving gain and radiation characteristics. The surface waves are attenuated as they experience high impedance while propagating in the dielectric substrate, thus this medium focuses the antenna radiated power towards the major lobe of the antenna radiation. This way it boosts the radiation and reduces surface wave losses due to surface waves. The cylindrical pins embedded throughout the substrate are being incorporated in several antenna designs. But this leads to higher conductor loss as the complete dielectric substrate is embedded with metallic cylindrical pins. For meeting the requirements of the antenna designed with low conductor loss the metallic cylindrical pins have been etched at specific locations near close proximity of the radiating patch side. This facilitates ease in fabrication as well.

The single feed circularly polarized antennas [1-2] have been discussed in literature. In this article a square slotted circularly polarized microstrip patch antenna embedded on artificial dielectric substrate has been presented. The slots have been etched at diagonal vertices to meet the requirements of circular polarization. The slotted perturbations etched over the patch antenna enable the achievement of compact design and resonance at three different frequency bands for WLAN applications. The proposed antenna exhibits enhanced antenna radiation characteristics.

II. ANTENNA DESIGN AND ANALYSIS OF PROPAGATION OF SURFACE WAVE MODES

The patch antenna as shown in Fig.1 is designed to operate at three different frequency bands centered at 2.2421 GHz, 5.7632GHz and 7.7633GHz.

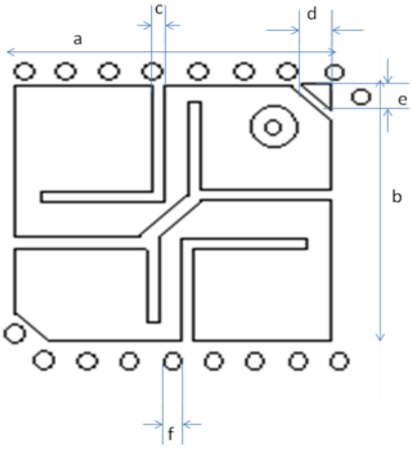

Fig. 1 Top view of the

The antenna design parameters are shown as under:

Table1. Antenna design parameters

Parameter	a	b	c	d	e	f
Dimension(mm)	28	28	1	2.3	2.2	1

The triangular perturbations at the diagonal vertices are done in such a way that it follows the relationship [8]

$$\frac{\Delta S}{S} = \frac{1}{Q_0}.$$

where ΔS is the perturbed area of the patch antenna, S is the total area of the metallic patch and Q_0 is the antenna quality factor. The space wave efficiency [9]

$$\eta = \frac{P_{sp}}{P_{sp} + P_{sw}}$$

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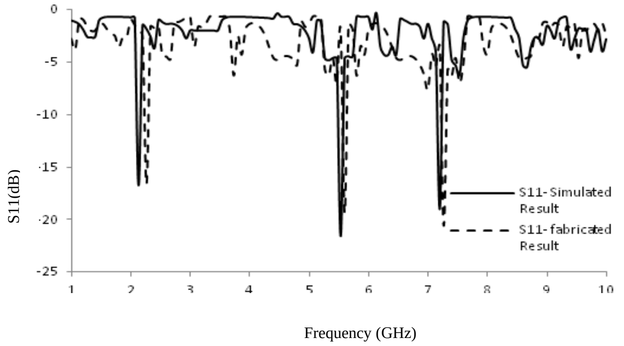
where, P_{sp} = Space wave Power , P_{sw} = Surface wave power

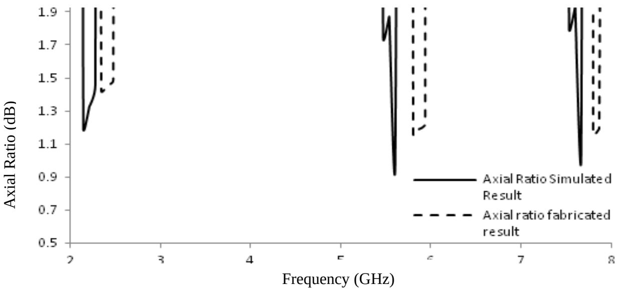
The space wave efficiency comes out to be around 42% using the above equation. The space wave efficiency can be improvised using the high dielectric substrates. The suppression of surface waves is done by using array of metallic pins embedded around the patch antenna.

III. RESULTS AND CONCLUSION

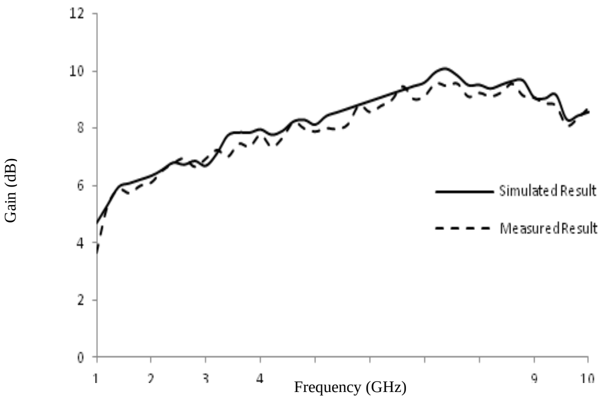
The structure has been simulated using Ansoft HFSSv12. The results shows Axial ratio of around 1 dB, but the gain and radiation efficiency is observed very low. The degradation in parameters is due to propagation of surface waves. The TM_0 surface wave mode gets excited very easily as it has very low cutoff frequency.



The resonance frequency bands are centered at 2.2421 GHz, 5.7632GHz and 7.7633GHz.



The axial ratio of around 1 dB is being obtained resonance peaks centered at WLAN application based frequency bands. The axial ratio characteristics shows that around 230 MHz axial ratio bandwidth is achieved at first resonant frequency band, 126 MHz axial ratio bandwidth is achieved at second resonant frequency band and 116 MHz axial ratio bandwidth is achieved at the third resonant frequency band.



The peak gain of around 6-10 dB is observed throughout the frequency range.

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Manidipa Roy is M.Tech. in RF and Microwave Engineering. She had been associated with AIACT&R, Delhi. Currently she is working as Assistant Professor in ABES Engineering College, Ghaziabad, Uttar Pradesh. She has teaching and research experience of around seven years. She had been a Research fellow at Ambedkar Institute of Advanced Communication technologies and Research, Delhi. She had guided many under graduate and post graduate students in their projects. She has several publications in International and National Journals and Conferences. She is involved in several Sponsored projects and consultancy projects. She has been awarded Gold Medal in M.Tech. RF and Microwave from Guru Gobind Singh Inderprastha University, Delhi.

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