Efficient Design of a 2D EBG Circular Microstrip Antenna for 5G Applications

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ABSTRACT

This paper deals with the design of circular microstrip antennas etched on 2D electromagnetic band gap (EBG) substrates for 5G applications. The obtained results for the FR2 NR band (at 28 GHz) show that this alternative will allow overcoming many limitations such as narrow bandwidth, low gain/directivity and potential decrease in radiation pattern due to the presence of surface waves. A good agreement was found with data available in the literature.

Keywords: Photonic Crystals, Electromagnetic Band Gap, Microstrip Antenna

1 Introduction

Modern communication systems have undergone a dramatic technological advancement in the last decade due to an ever-increasing demand. Among the system blocks that have attracted more attention, planar antennas are indispensable elements to ensure transmission and reception of electromagnetic waves(EM) in wireless communication systems for more mobility and flexibility [1]. The new 5G generation of mobile communications is an evolutionary technology that supports new features and aims to increase speed and reactivity of wireless networks [2]. Moreover, 5G communication systems must combine several technologies in order to reach a mobile network that can meet the above requirements and facilitate the integration of hundreds of radiating elements at the base station level by taking advantage of their short wavelengths. Therefore, the challenge is to propose planar antenna structures with minimal size while conserving their electromagnetic characteristics [3], [4]. The EBG materials present a periodic modulation of the relative permittivity in one or more directions EBG's properties were exploited in antennas to reduce the level of side lobes and increase directivity [5]. In this paper, the EM properties of a circular microstrip antenna etched on a 2D photonic crystal substrate are simulated with CST Microwave Studio. The effects of geometrical parameters on S-parameters, resonance frequency, directivity and gain, were investigated and good improvements were obtained.

2 Design of The Proposed Microstrip Patch Antenna

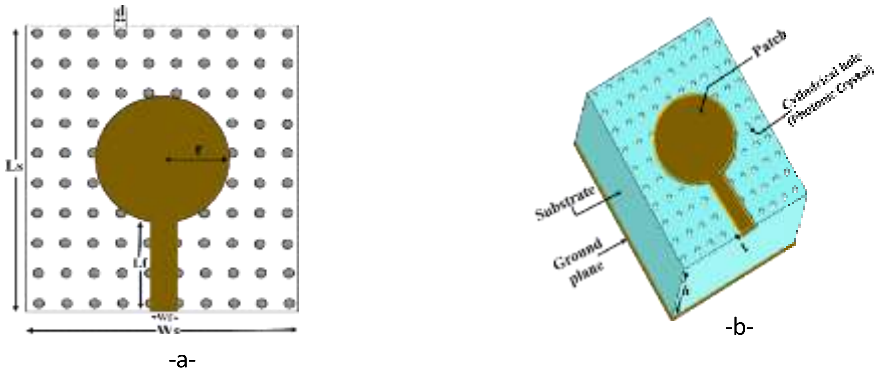

Figure 1: *Model of proposed antenna (a) Top View (b) 3DView.*

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The proposed prototype antenna shown in Figure 1 is a circular microstrip patch antenna. Thedimensions and resonant frequency are calculated based on relevant expressions. The effective radius, relative permittivity, and free-space wavelength are the key parameters in determining the dimensions of the patch and feed line width. Additionally, the length andwidth of the substrate are also evaluated using specific expressions.

3 Results and Discussion

The effects of various geometrical parameters and the EBG substrate on the performance of the designed antenna are investigated through simulations. The studied parameters include frequency, bandwidth, and directivity in the FR2 band at 28 GHz, with specific values assigned to the geometrical parameters. The simulation results demonstrate the influence of these parameters on the reflection coefficient S_{11}, directivity, and gain of the antenna. The comparison of antenna properties, as shown in Table 1, reveals significant improvements in terms of the S_{11} parameter, bandwidth (BW), VSWR, directivity and gain for the EBG substrate antenna in comparison to [6] and [7].

Table 1: *Comparison of the antenna parameters with conventional substrate and EBG substrate*

	[6]	**[7]**	**Standard Substrate**	**With EBG Substrate**
Resonant Frequency (GHz)	28	27.99	27.93	28.23
S11(dB)	-14.15	-2053	-16.84	-21.10
BW(GHz)	0.80	0.40	1.55	2
Directivity(dBi)	-	-	5.85	6.58
Gain(dB)	6.06	6.21	5.59	6.54
VSWR	1.48	1.02	1.33	1.19

4 Conclusion

This paper proposed an efficient design of of a circular microstrip antenna etched on a 2D EBG photonic crystal dedicated to 5G applications in FR2 band. The antenna performances were compared to those of conventional ones and good improvements were obtained in terms of gain and bandwidth. Otherwise, the effect of 2D EBG structure was analyzed, and a good compromise found in terms of compactness, gain and bandwidth. Such performances make the proposed EBG antenna a good candidate for future wireless millimeter wave communication components. It remains to validate the simulated results experimentally. Moreover, we expect in the future to improve the antenna radiation properties by extending the study to a multilayer configuration.

How to Cite

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