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Triband dielectric resonator antenna with uniaxial anisotropic materials

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Abstract

A triband dielectric resonator antenna with uniaxial anisotropic materials is investigated in this paper. By using uniaxial anisotropic materials, the antenna can achieve three different resonances to cover the desired bands while maintaining a small size and simple structure. Based on this concept, a prototype tri-band antenna is designed. The simulated results show that the antenna has impedance bandwidths of 300 MHz (8.2-8.5 GHz), 400 MHz (10-10.4 GHz) and 200 MHz (11.6-11.8 GHz). The reflection coefficient, radiation pattern, and antenna realized gain of the triband dielectric resonator antenna were simulated using Ansoft HFSS.

Keywords

Triband, dielectric resonator antenna, uniaxial anisotropic materials.

1. Introduction

The dielectric resonator antenna has received extensive attention due to a number of advantages such as its small size, lowloss, light weight, high radiation efficiency, and ease of excitation [1, 2]. Many efforts have been devoted to developing multiband or wideband dielectric resonator antennas [3, 4]. In [5], a dualband dual-slot circular polarization antenna with a dielectric cover is investigated. It consists of a zonal slot antenna and an annular slot antenna, which are located on the sidewall and top face of the cavity, respectively. A dualband operation can also be obtained by simultaneously exciting the first (fundamental) and second resonant modes of the slot [6]. However, in this method, the higher resonance frequency cannot be determined at will because it is about twice the fundamental resonance frequency. In [7], a composite aperture has been conceived to excite cylindrical dielectric resonator antenna simultaneously with two different modes, resulting in broadside radiations at two adjacent bands. However, there has been very little research into tri-band dielectric resonator antennas using uniaxial anisotropic materials. In this paper, a tri-band dielectric resonator antenna is presented, which has a simple structure.

2. Antenna Configuration

Figure 1 shows the configuration of the proposed triband dielectric resonator antenna. The dielectric resonator block of the DRA has dimensions of a = 20.8mm, b = 10.5mm and d = 18.5mm, and its dielectric constant follow the permittivity tensor of a uniaxial anisotropic medium, specifically $\varepsilon_x = \varepsilon_y = 10$ and $\varepsilon_z = 2$.

$$\bar{\bar{\varepsilon}} = \varepsilon_0 \begin{bmatrix} \varepsilon_x & 0 & 0 \\ 0 & \varepsilon_y & 0 \\ 0 & 0 & \varepsilon_z \end{bmatrix} \quad (1)$$

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The square copper ground plane has a dimension of g1=150mm, with a thickness of 0.3mm. The substrate under the ground plane, fabricated with a dielectric constant of ε_r = 2.94, has a dimension of g1 = 150 mm. The dimensions of the coupling slot in the ground plane and substrate are L = 10.5 mm and W = 2.6 mm. The bottom feed line is made of copper with the dimensions f_l = 82.2 mm, f_w = 1.94 mm and a thickness of 0.3 mm.

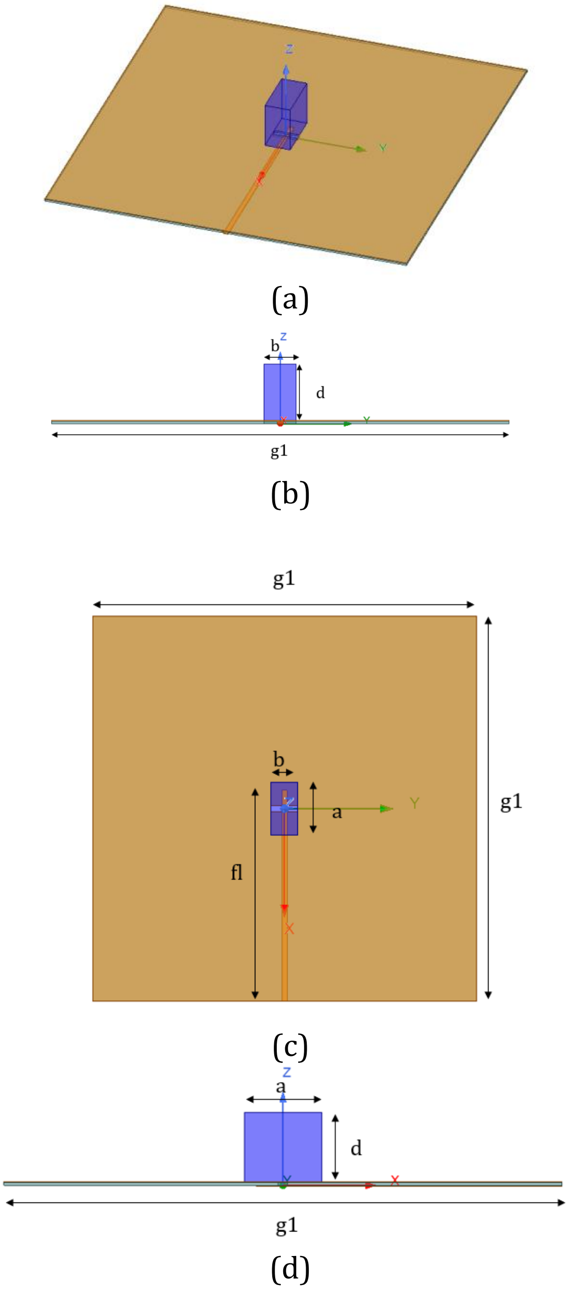

Figure 1: Configuration of the proposed antenna. (a) 3D view (b) Front view. (c) Top view. (d) Side view .

3. Simulated Results

The simulated result using HFSS is shown in Figure 2, Figure 3, Figure 4 and Figure5. In Figure 2, it is shown that the internal electric field. Figure 3 shows three resonant frequencies of 8.4 GHz, 10.2 GHz and 11.7 GHz for the given configuration dimensions. The simulated impedance bandwidths are 300 MHz (8.2-8.5 GHz), 400 MHz (10-10.4 GHz) and 200 MHz (11.6-11.8 GHz). In the bandwidth from 8.2 to 8.5 GHz, the maximum realized gain is 7.8 dBi, and in the

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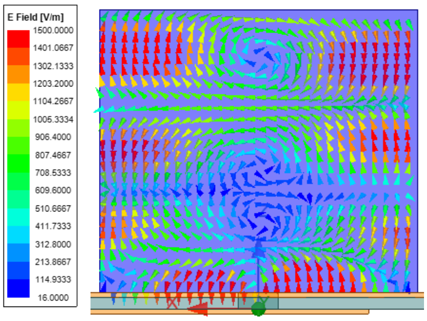
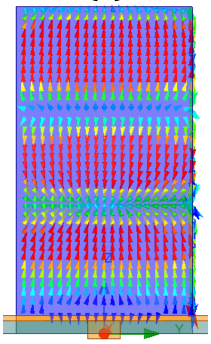
bandwidth from 10 to 10.4 GHz, the maximum realized gain is 4.5 dBi, and in the bandwidth from 11.6 to 11.8 GHz, the maximum realized gain is 7.3 dBi, as shown in Figure 4. As shown in Figure 5, the radiation patterns of x-z plane and y-z plane at 10 GHz. The cross-polarization in z-axis direction is even less than -20 dB, which shows the good cross-polarization of the proposed antenna.



(a)



(b)

Figure 2: The internal electric field distribution of the proposed DRA structure. (a) X-z plane. (b) Y-z plane.

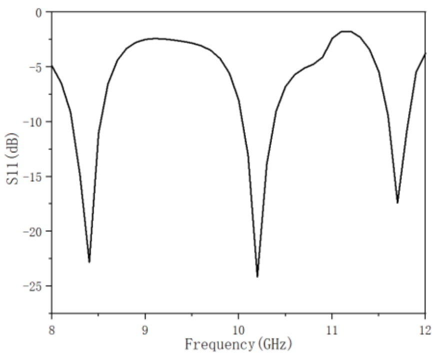


Figure 3: Simulated S-parameters of the presented DRA.

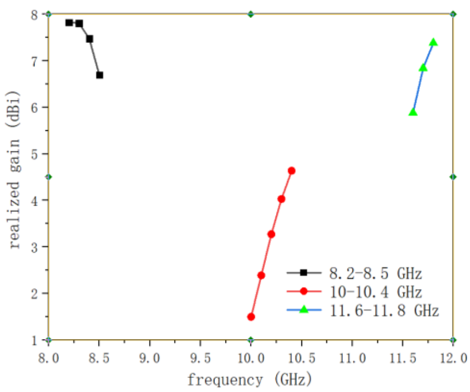
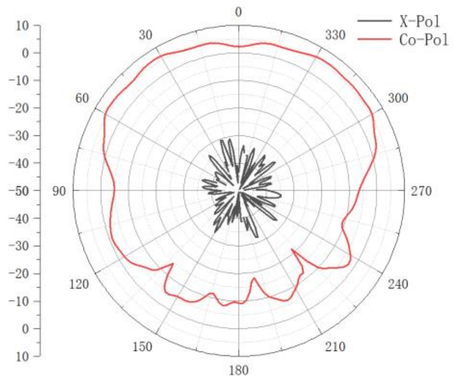
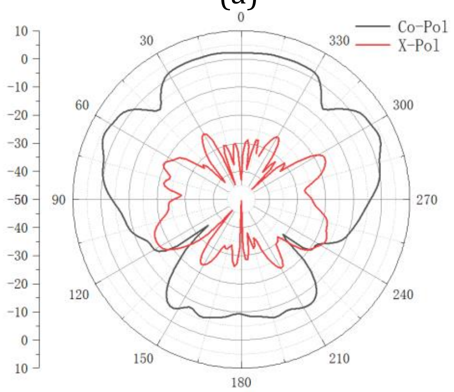


Figure 4: Simulated realized gain of the presented DRA.



(a)



(b)

Figure 5: Simulated and measured radiation patterns at 10 GHz (a) X-z plane. (b) Y-z plane.

4. Conclusion

In this paper, a tri-band dielectric resonator antenna with uniaxial anisotropic materials has been investigated. The reflection coefficient, radiation pattern and realized gain of the proposed configuration were simulated using Ansoft HFSS. Simulated impedance bandwidths of 300 MHz (8.2-8.5 GHz), 400 MHz (10-10.4 GHz) and 200 MHz (11.6-11.8 GHz). In the 8.2 to 8.5 GHz bandwidth, the maximum realized gain is 7.8 dBi; in the 10 to 10.4 GHz bandwidth, the maximum realized gain is 4.5 dBi; and in the 11.6 to 11.8 GHz bandwidth, the maximum realized gain is 7.3 dBi.

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