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Study of a Microstrip Antenna with and Without Superstrate for Terahertz Frequency

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ABSTRACT: In this letter, we proposed a comparative study of a rectangular Microstrip patch antenna at Terahertz (THz) frequency ranging from 0.6 to 0.8 THz with and without superstrate. First, the simulation was carried to a simple micro-strip antenna, was then added an upper layer (superstrate) by varying the height to improve impedance matching and optimizing the performance of the antenna. The matching bandwidth and the maximum radiation gain obtained are around 22.47 % (10.43 dBi at 0.6929 THz), respectively. The performance of the dielectric resonator antenna is simulated by electromagnetic simulator CST Microwave Studio.

KEYWORDS: Microstrip, Superstrate, Antenna, Tera-hertz.

1 INTRODUCTION

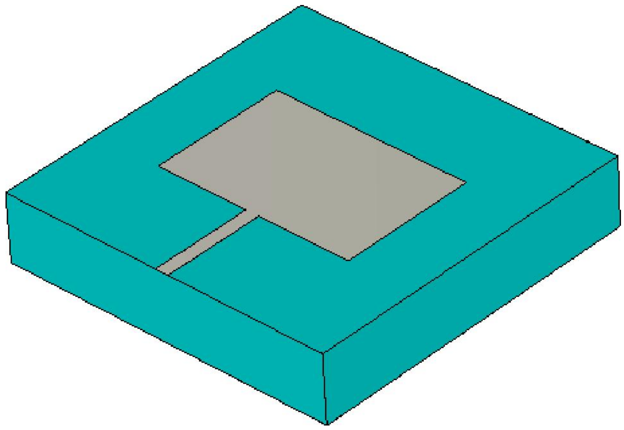
Today, the telecommunications industry has an incredible interest in the miniaturization of Microwaves circuits and components. Regarding wireless communicating objects, this effort focuses particularly on the antenna, which is usually one of the most cumbersome elements of the system. Several technologies have been developed in this direction, and micro-strip antennas are among the most interesting technological solutions and providing features uncountable [1].

However, the use of this class of antennas is hampered by limitations in the efficiency of radiation and the bandwidth remains generally very narrow. These limitations can be overcome by the implementation of various techniques such as the use of slots or superstrate [2]-[3].

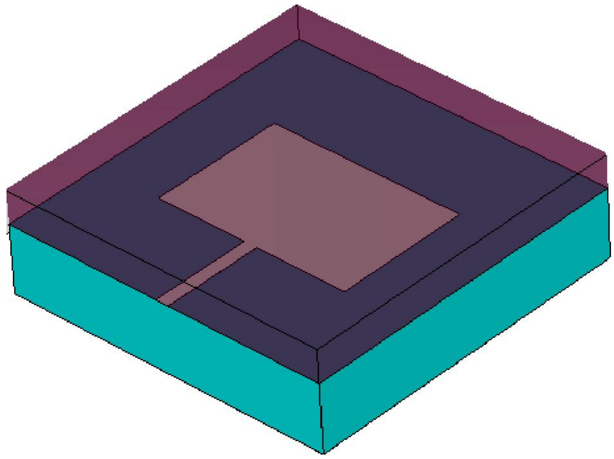
In this context, we present the results of a parametric study of a rectangular patch antenna in the frequency band Tera-hertz (THz) ranging from 0.6 to 0.8 THz with and without superstrate. First, the simulation was carried to a simple micro-strip antenna, was then added an upper layer (superstrate) by varying the height to improve impedance matching and optimizing the performance of the antenna.

2 ANTENNA DESIGN

The schematic of the proposed antenna is shown in Fig. 1. It consists of a rectangular patch and a RT/Duriod 6006 superstrate with a relative dielectric constant ε_r = 6.15and a tangent delta of 0.0019 (tan δ) [4].



(a) Without superstrate



(b) With superstrate

Fig. 1. Schematic of the proposed antenna

We have considered four antenna configurations with the same basic design consideration. The developed prototypes are printed on a RT/Duriod 6006 dielectric substrate with a thickness of 200 µm (h). The ground plane dimensions are 1000 µm by 1000 µm and the metal cladding is t = 0.018. Dimension of rectangular patch is 600µm ×400µm. Dimension of the feed line is 40µm × 300µm.

The studies carried out in this paper have shown that the adjustment of the height of superstrate (h) can readily control the impedance matching. The performance of the studied antenna is rigorously simulated using CST Microwave Studio.

3 SIMULATED RESULTS AND DISCUSSION

We have varied the height of superstrate and selected four conditions in which we noticed some improvement in antenna performance. Fig. 2 shows simulated return loss of the proposed Microstrip Patch Antenna with h = 0 um (denoted as prototype I here), 50 um (prototype II), 75 um (prototype III), and 100 um (prototype IV).

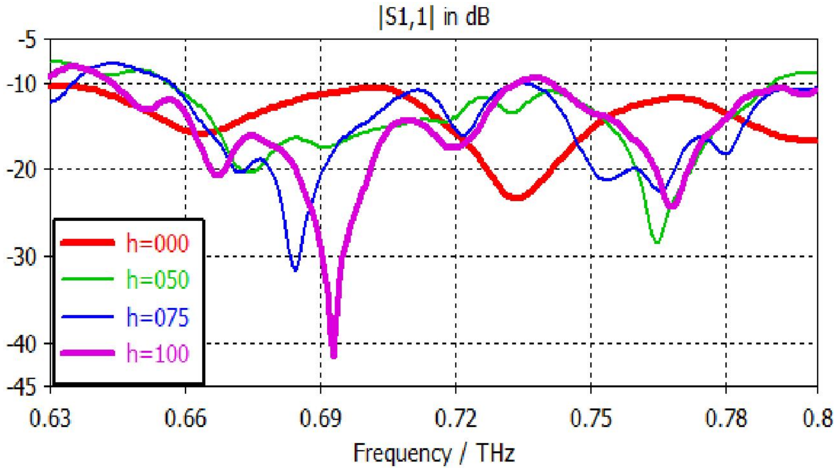


Fig. 2. Comparison of the reflection coefficient for the structure with and without superstrate. Prototype I: h = 0 um. Prototype II: h = 50 um. Prototype III: h = 75 um. Prototype IV: h = 100 um.

The corresponding performances are summarized in Table I.

The -10 dB percent bandwidth and the return loss are around 19.80 % and -23.36 dB for prototype I, 18.51 % and -28.50 dB for prototype II, 19.63 % and -31.70 dB for prototype III, and 22.47 % and -41.65 dB for prototype IV, respectively.

Table 1. Performances of the Five Antenna Prototypes (I, II, III, and IV)

	h (um)	Bandwidth	Return Loss (dB)	Antenna gain (dBi)
Prototype I	0	19.80 %	-23.36	9.804
Prototype II	50	18.51 %	-28.50	8.674
Prototype III	75	19.63 %	-31.70	9.504
Prototype IV	100	22.47 %	-41.65	10.43

Thus, during our studies we have seen the effect of superstrate on the antenna return loss and percentage bandwidth.

4 CONCLUSION

In this paper, we have discussed about reduced microstrip antenna in THz frequency range and considered the effect of superstrate on the performance of antenna. The return losses coefficient and the matching frequency band of the suggested antenna design are presented. As results, this antenna has a -10 dB percent bandwidth of around 22.47%. The maximum radiation gain obtained is 10.43 dBi at 0.6929 THz.

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