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Performance Analysis of Microstrip Antennas for different materials

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Abstract

The Micro-strip antennas are widely used due to its compactness, simple manufacturing process, budget friendly and versatility. Most abundant element carbon is utilized in the process for the design and fabrication of antenna patch. Seeds of lapsi (Choerospondias axillaris), the indigenous plant of Nepal is used to extract carbon. As much as possible, the experiment is to be conducted by recycled products, so the seeds are of one of them. The obtained carbon is then activated using various chemical processes. For the comparison of antenna performance, first the antenna with graphite patch is designed and simulated in High Frequency Structural Simulator (HFSS) software. The substrate used was a polycarbonate with aluminum as a conducting ground plane. Fractal swastika shape slot is designed in the square patch which gives better results and makes the antenna suitable for multiband frequencies. The performance of antenna is optimized using the genetic algorithm. The optimized graphite patch antenna resonates at dual band frequencies. It can be operated at 8.2 GHz and 19.4 GHz with VSWR of 0.1901 and 0.3057 resp. and S- parameter of -39.2 dB and -36 dB resp.

Keywords: *Micro-strip antenna, Swastika slot, Resonating Frequency, VSWR, S- parameter*

1. Introduction

Among various antennas, micro-strip antennas are popular and commonly used. These antennas consists of ease of analysis and fabrication, and their attractive radiation characteristics, especially low cross-polarization radiation. they are low-profile, comfortable to planar and non-coplanar surfaces, simple and inexpensive to fabricate using modern printed circuit technology, mechanically robust when mounted on rigid surfaces, compatible with MMIC designs, and very versatile in terms of resonant frequency, polarization, pattern and impedance [1]. Design, simulation and analysis of antenna can be done in HFSS which is a commercial finite element method solver for electromagnetic structures from Ansys [2]. Antenna consisting of a circular monopole

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which is evolved into the swastika shaped dotted monopole by incorporating slots into the plane circular monopole has enhanced the bandwidth as well as gain. disc monopole antenna, swastika shaped monopole antenna and swastika shaped monopole antenna with dots has a impedance bandwidth of 10.56 GHz, 9.47 GHz and 11.53 GHz with a gain of 2.17 dB, 5.16 dB and 6.18 dB respectively [3].

All designs does not give desired results, so certain optimization/improvement is needed to be done. Genetic algorithms are capable of handling a large number of design parameters and work for optimization of bandwidth of a patch antenna is very important area of research. Genetic algorithm is also required for miniaturization of the patch antenna [4].

Using genetic algorithm, the dual band micro-strip patch antenna with fractal swastika slot is designed and simulated in HFSS. The designed antenna can be operated at the frequency of 2.4 GHz and 4.7 GHz [5]. A technique based on the combination of genetic algorithm with HFSS presented to perform optimization of broadband micro-strip antenna. A comparison between original patch and optimized patch was made, the optimized patch antenna exhibited a fourfold enhancement in achievable bandwidth [6].

2. Methodology

Seeds of lapsi (Choerospondias axillaris), the indigenous plant of Nepal is taken and washed, then dried for days. Then it is crushed and made into powdered form. The powdered form of raw material in mixed with phosphoric acid. Then the mixture is filled into quartz tube of tube furnace with controlled supply of nitrogen gas at 400oC. After heating, unwanted dust and chemicals are separated leaving behind the activated carbon in the quartz tube. X-ray Diffraction (Bruker D2 phaser Diffractrometer) is used for the identification of crystalline phase of carbon sample. It is also used to measure the average crystalline size, strain, or micro-strain effects in Carbon sample.

A dual band microstrip patch antenna is designed in HFSS as shown in figure 1 and 2. An antenna is designed in Ansoft HFSS simulation software. The substrate is chosen as polycarbonate with graphite as a patch. Rectangular inset edge feed technique is used to feed the antenna. Here, the patch of 25 cm*25 cm with aluminum as a ground plane is used. After the completion of design, genetic algorithm was used for optimization for better results. Seeds of lapsi (Choerospondias axillaris), the indigenous plant of Nepal is taken and washed, then dried for days. Then it is crushed and made into powdered form. The powdered form of raw material in mixed with phosphoric acid. Then the mixture is filled into quartz tube of tube furnace with controlled supply of nitrogen gas at 400^{o}C. After heating, unwanted dust and chemicals are separated leaving behind the activated carbon in the quartz tube. X-ray Diffraction (Bruker D2 phaser Diffractrometer) is used for the identification of crystalline phase of carbon sample. It is also used to measure the average crystalline size, strain, or micro-strain effects in Carbon sample.

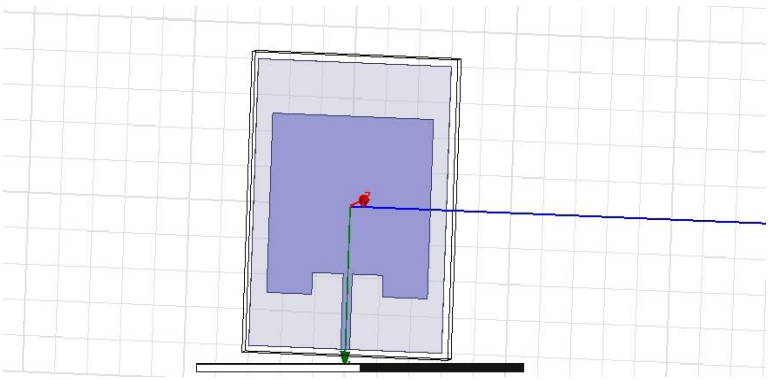


Figure 1. Reference antenna

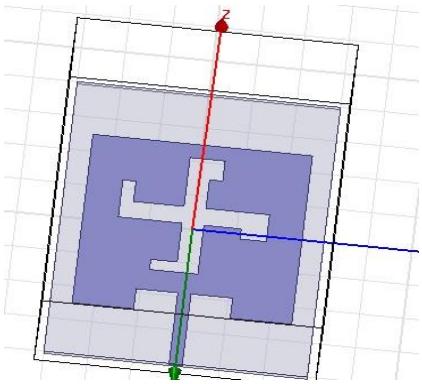


Figure 2. antenna with swastika slot

A swastika fractal shape is introduced in the same reference antenna. The lengths of arms are optimized through genetic algorithm.

3. Results and Discussions

3.1 Results of dual band reference antenna without any fractal slots

After optimization of a square patch antenna, the S-parameter of reference antenna obtained from simulation is shown in figure 3. Graph shows that the antenna can be used for dual band with return loss of -13.7428 dB at 3.8 GHz and that of -9.3729 dB at 7 GHz.Also there resonating frrequency at 8.6 GHz but is not taken into account for its low return loss.

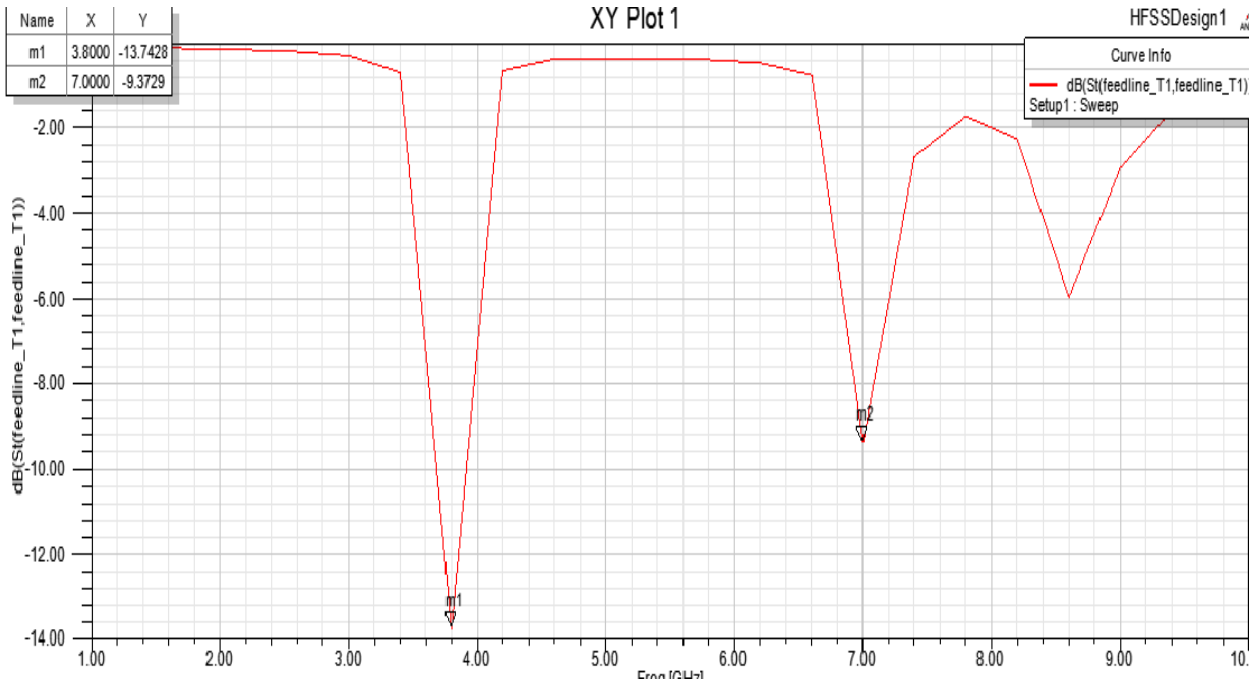


Figure 3. S-parameter of reference antenna

The VSWR of reference antenna is 3.6219 at 3.8 GHz and 6.1493 at 7 GHz.

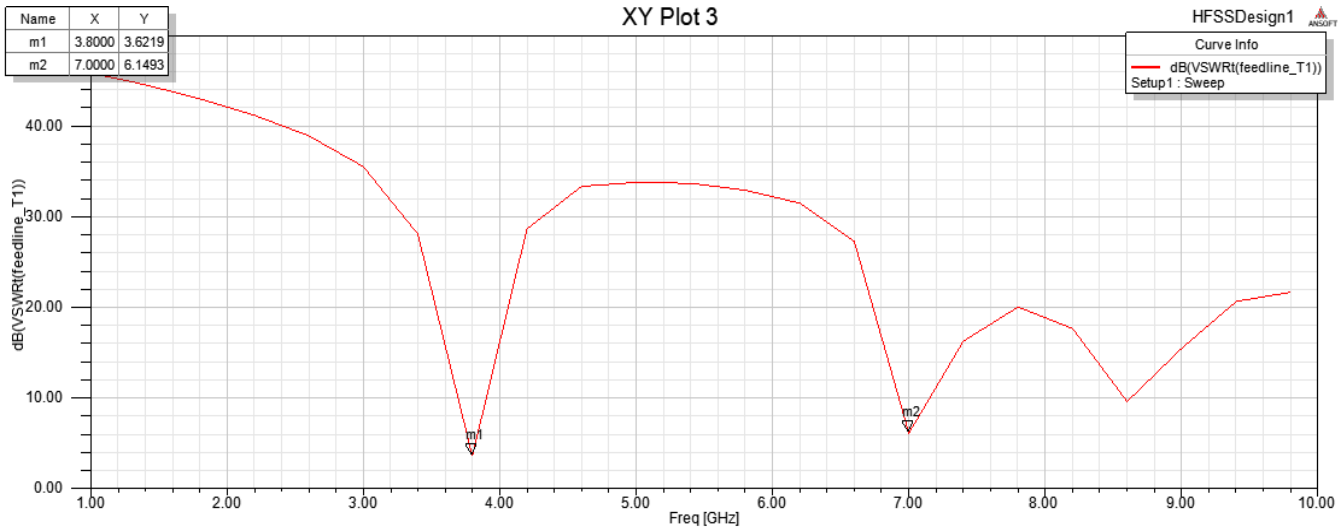


Figure 4. VSWR of reference antenna

4. Results of dual band antenna with single swastika slot

The designed antenna resonates at dual band frequency at 8.2 GHz and 19.4 GHz with S11 parameter of -39.21 dB and -35.09 dB.

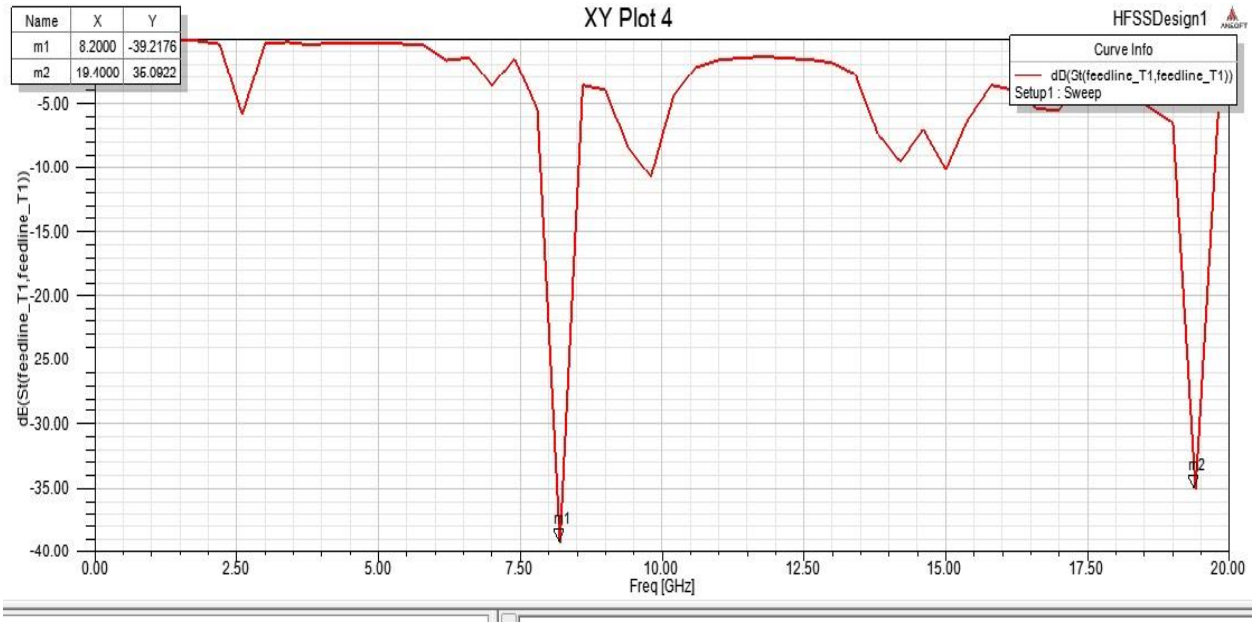


Figure 5. S- parameter after swastika fractal slot

The VSWR of this antenna is 0.1901 and 0.3057 at the resonating frequencies of 8.2 GHz and 19.4 GHz.

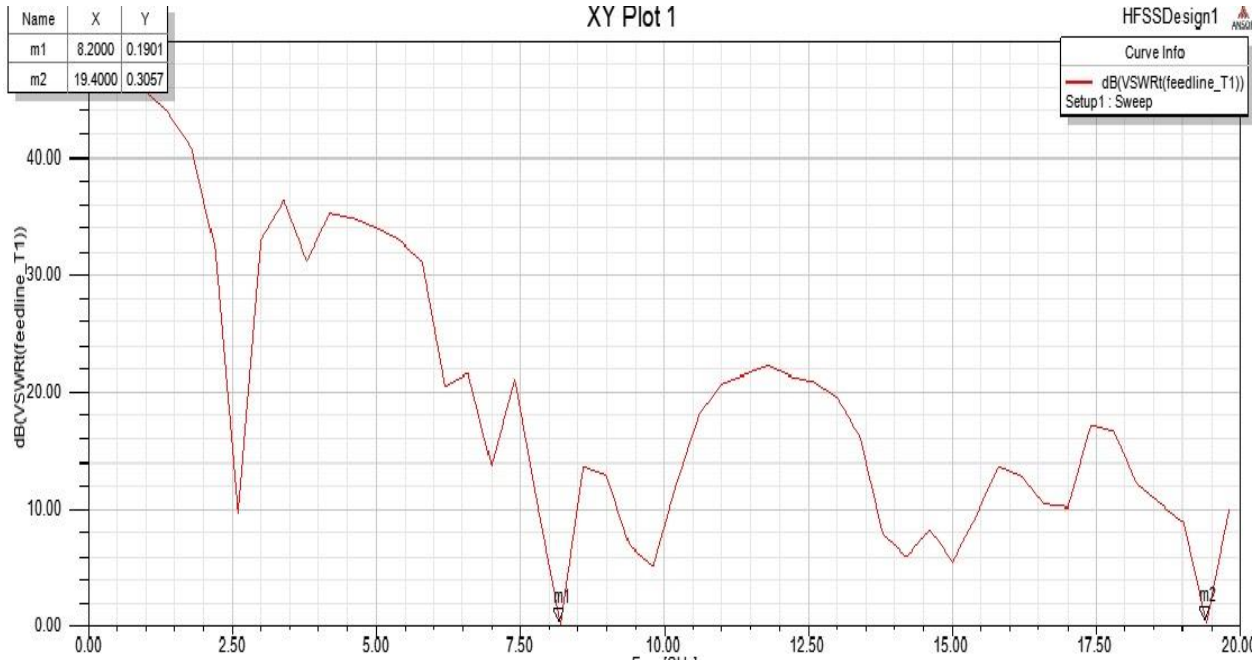


Figure 6: VSWR after swastika fractal slot

A dual band square patch antenna with rectangular inset fed is designed as reference antenna and its performance is compared with the same antenna but with a fractal swastika shaped slot. Initially the reference antenna resonated at dual frequencies of 3.8 GHz and 7 GHz. It's S- parameter were -13.74 dB and -9.37 dB with VSWR of 3.6 and 6.1 were found resp.

After the introduction of swastika fractal slot, the antenna resonated at the dual frequencies of 8.2 GHz and 19.4 GHz with S parameter of -39.2 dB and -36 dB resp. VSWR was found to be 0.1901 and 0.3057.

5. Conclusion

After the introduction of fractal slots, antenna parameter was enhanced. Resonating frequency from 3.8 GHz and 7 GHz were increased to 8.2 GHz and 19.4 GHz. S- parameter and VSWR were enhanced too. Parameter of less than -10 dB and VSWR of less than 2 is suitable for a real life antenna. Both the criteria is met in the swastika slot case after optimization. So, introduction of fractal slots greatly enhances the property of an antenna. This also helps in reducing the surface area of patch.

Acknowledgements

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