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*Research Article*

# Fusion Execution of NaCl on Tree-Shaped MSA

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Fractal tree microstrip antenna utilizing NaCl execution strategy is exhibited in this paper. The fractal tree MSA provides scaling down and multiband operation. NaCl affidavit is a standout amongst the most intriguing method. Trial result on the return loss over the band of 1 to 11 GHz and radiation pattern were exhibited. It is well known that atmospheric corrosion of the metal is accelerated by the sea salt particles near the seashore environment. Objective of the paper is to add NaCl manually on tree-shaped MSA and test the result at different environmental condition. NaCl testimony system unmistakably demonstrates the moving of all resonance frequency bands from high frequencies to low frequencies. VSWR is under 2 for all resonance frequency. Same antenna tried following half year to know the conduct of the MSA and the result is exhibited.

## 1. Introduction

The MSA is utilized for different applications because of their points of interest like light weight, simple to create, little size, and minimal effort. The microstrip patch antenna (MSPA) has a few applications; for example, global positioning system (GPS), Bluetooth, WLAN, GSM, radar, satellite communication, and so forth. Be that as it may, MSPA has limitation like low gain and narrow bandwidth transmission.

Change of bandwidth capacity is conceivable by expanding height of substrate. Be that as it may, by expanding height of substrate, MSA winds up plainly massive [1]. To upgrade the bandwidth transmission, the microstrip line is nourished by fork-like tuning stub [2]. The gain of the MSA is 2 dB and bandwidth is around 500 MHz. Fork-like tuning stub is utilized to enhance bandwidth capacity; however, it is confounded structure for creation [3].

Today's antenna with multiband application is generally alluring. Diverse methods have been utilized to accomplish multiband normal for antenna [4–7]. Double and triple band receptions are acquired utilizing U opening patch [4]. Defected ground structure additionally used to get triple band antenna [5]. Utilization of fractal geometry for fix configuration is one of the least difficult methods to accomplish multiband reception. Multiband Sierpinski gasket is accounted for in [6, 7]. Impact of progress in the angle of Sierpinski gasket geometry on the execution of antenna is given in [8]. Fractal gives log periodic conduct since it has self-similarity trademark. It is conceivable to accomplish wanted dispersing between log intermittent groups as given in [9]. The fractal tree MSA is an arrangement of free emanating dipoles which dispersed in space [10–13].

Fractal tree microstrip antenna is covered with the NaCl. NaCl has the accompanying properties. Fascination between the Na+ and Cl− ions in the solid is strong to the point that lone exceptionally polar solvents like water break up NaCl well. At the point when broken up in water, the sodium chloride system breaks down as the Na+ and Cl− particles wind up noticeably encompassed by the polar water atoms. These arrangements comprise of metal water complex with the recipe $[Na\ (H_2O)_8]+$, with the Na–O separation of 250 pm. The chloride particles are additionally emphatically solvated, each being encompassed by a normal of 6 atoms of water. Arrangements of sodium chloride have altogether different properties from unadulterated water. The point of solidification is −21.12°C (−6.02°F) for 23.31% of salt, and the

breaking point of immersed salt arrangement is almost 108.7°C (227.7 °F). From frosty arrangements, salt takes shape as they get dried out NaCl•2H2O.

We break up NaCl in bubbling water and stored the water over the microstrip antenna and keep the antenna cool to such an extent that NaCl layer is saved over it. This is an irregular affidavit. Typical fractal-shaped MSA and antenna with NaCl statement appeared in Figure 1.

This paper gives commitment about multiband fractal tree-shaped MSA with increment in size, minimal effort, and omnidirectional radiation pattern with less side lobe level. Likewise, correlation of the basic fractal tree MSA and same antenna wire with NaCl affidavit system were compared and presented. Further, the same antenna is given a look over after six months and again the result is compared with the earlier one.

## 2. Antenna Design

The proposed fractal-shaped MSA is planned utilizing HFSS. The antenna is developed utilizing FR-4 (lossy) substrate, which has relative permittivity $\varepsilon_r = 4.4$ with loss tangent (tan$\delta$) 0.02 which is minimally estimated dielectric substrate material with 1.6 mm height. The strip-line feeding is utilized in light of the fact that it effectively matched the input impedance and can undoubtedly create as well as fabricate.

The proposed fractal tree-shaped MSA has measurements of L × W is acquired to the resonant antenna at multiple frequency appeared in Figure 2, which is printed on the substrate of dimensions $80\,\mathrm{L} \times 100\,\mathrm{W} \times 1.6\mathrm{h}\,\mathrm{mm}^3$. The specification of proposed antenna is shown in Table 1.

Figure 2 shows two fractal tree MSA with the specification given below. One antenna without and second with the arbitrary NaCl affidavit.

## 3. Simulation Result of an Antenna

The recreation after effects of proposed fractal tree-shaped MSA is reviewed utilizing HFSS.

*3.1. Return Loss.* Figure 3(a) indicates simulation result for return loss; proposed antenna gives great impedance matching at resonance frequency 5.8 GHz, 7.1 GHz, 8.2 GHz, 9.5 GHz, 10.3 GHz, and 10.8 GHz with most extreme—18.579 dB. Figure 3(b) demonstrates the experimental trial result for antenna with NaCl testimony. This demonstrates the shift of overall frequency to marginally down range, where least resonant frequency is 4.8 GHz and same changes in left over resonant frequencies. This figure also demonstrates the return loss for the fractal tree-shaped MSA, which keeps keen for the half year with NaCl fusion, which demonstrates the multiband result overall converted into single band output. Resonant frequency is accessible at 9 GHz.

(a) Return loss simulation.

(b) Experimental result of return loss for NaCl-coated antenna and same after 6 months.

*3.2. VSWR Plot.* Figure 4 demonstrates the voltage standing wave ratio versus frequency plot in GHz of proposed fractal tree-shaped MSA. The perfect estimation of VSWR is 1. Figure 4(a) demonstrates great impedance coordinating for multiband yield. Figure 4(b) indicates great VSWR result for the resonant frequency begins from 4.8GHz. This figure also demonstrates the brilliant outcome for 9 GHz. Figure 4(b) likewise demonstrates the multiband yield changed over into single band yield.

(a) VSWR simulation

(b) Experimental result VSWR for NaCl-coated antenna and same after 6 months

*3.3. Gain of the Proposed Antenna.* Figure 5(a) demonstrates the gain (dB) versus frequency (GHz) plot. The gain of proposed fractal tree-shaped MSA at various resonant frequency 5.8 GHz, 7.1 GHz, 8.2 GHz, 9.5 GHz, 10.3 GHz, and 10.8 GHz. Figure 5(b) demonstrates the gain is passing near 1.

(a) Gain (dB) simulation.

(b) Gain (dB) for NaCl-coated antenna and same after 6 months.

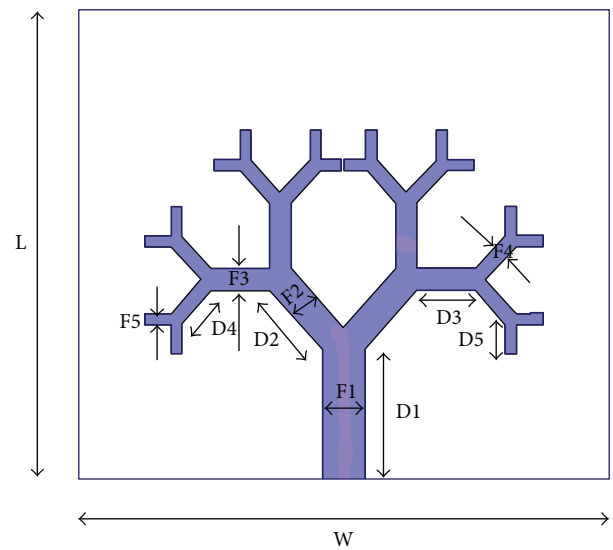



Figure 1: Photos of fabricated antenna without and with chemical deposition.

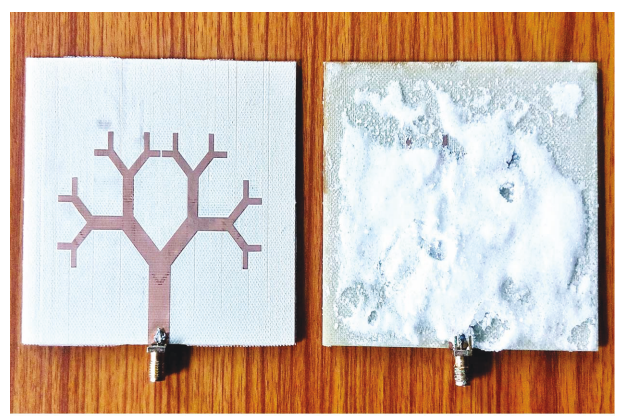
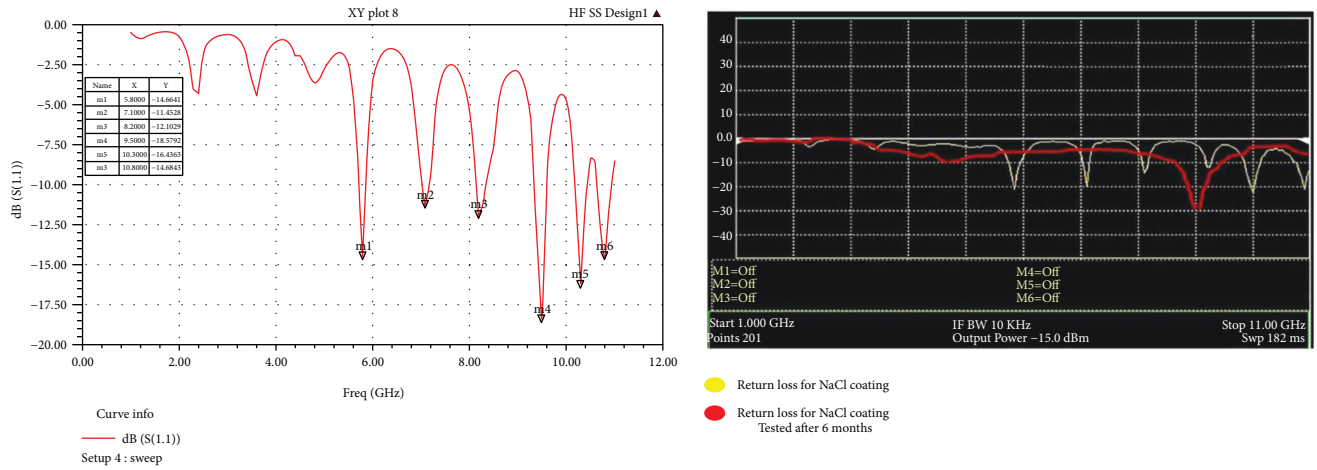


Figure 2: Proposed antenna design.

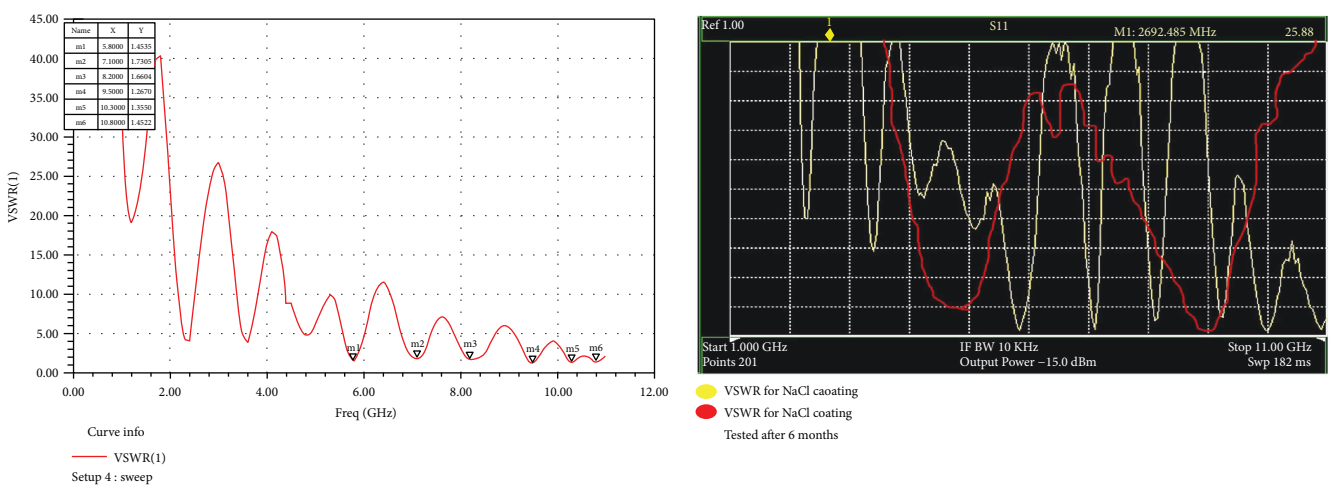
Table 1: Specifications of the antenna parameters of the proposed antenna.

| Design | Dimension (mm) | Design | Dimension (mm) | Design | Dimension (mm) | Design | Dimension (mm) |
|---|---|---|---|---|---|---|---|
| W | 100 | D5 | 5 | D2 | 14 | F3 | 4 |
| L | 80 | F1 | 8 | D3 | 11 | F4 | 3 |
| D1 | 22 | F2 | 6 | D4 | 8 | F5 | 2 |




(a) (b)

Figure 3: Return loss plot for design antenna.




(a) (b)

Figure 4: VSWR versus frequency plot (GHz).

*3.4. Radiation Pattern of an Antenna.* Figure 6 demonstrates the radiation pattern of proposed fractal tree-shaped MSA for frequency 5.8 GHz at phi = 0 degree and phi = 90 degree. Additionally, the figure demonstrates the radiation pattern design from the resonant frequency go from 7.1 GHz, 8.2 GHz, 9.5 GHz, 10.3 GHz, and 10.8 GHz. The radiation pattern of proposed antenna demonstrates the omnidirectional conduct. The radiation pattern design has low side lobe level.

Table 2 summarizes the simulation result in terms of resonant frequency, return loss bandwidth, and VSWR bandwidth. Measured result shown in the next section perfectly matches with the simulation results. Simulation result and measured results provide 6 frequency bands shown in the table.


(a) (b)

Figure 5: Gain (dB) versus frequency (GHz) plot.

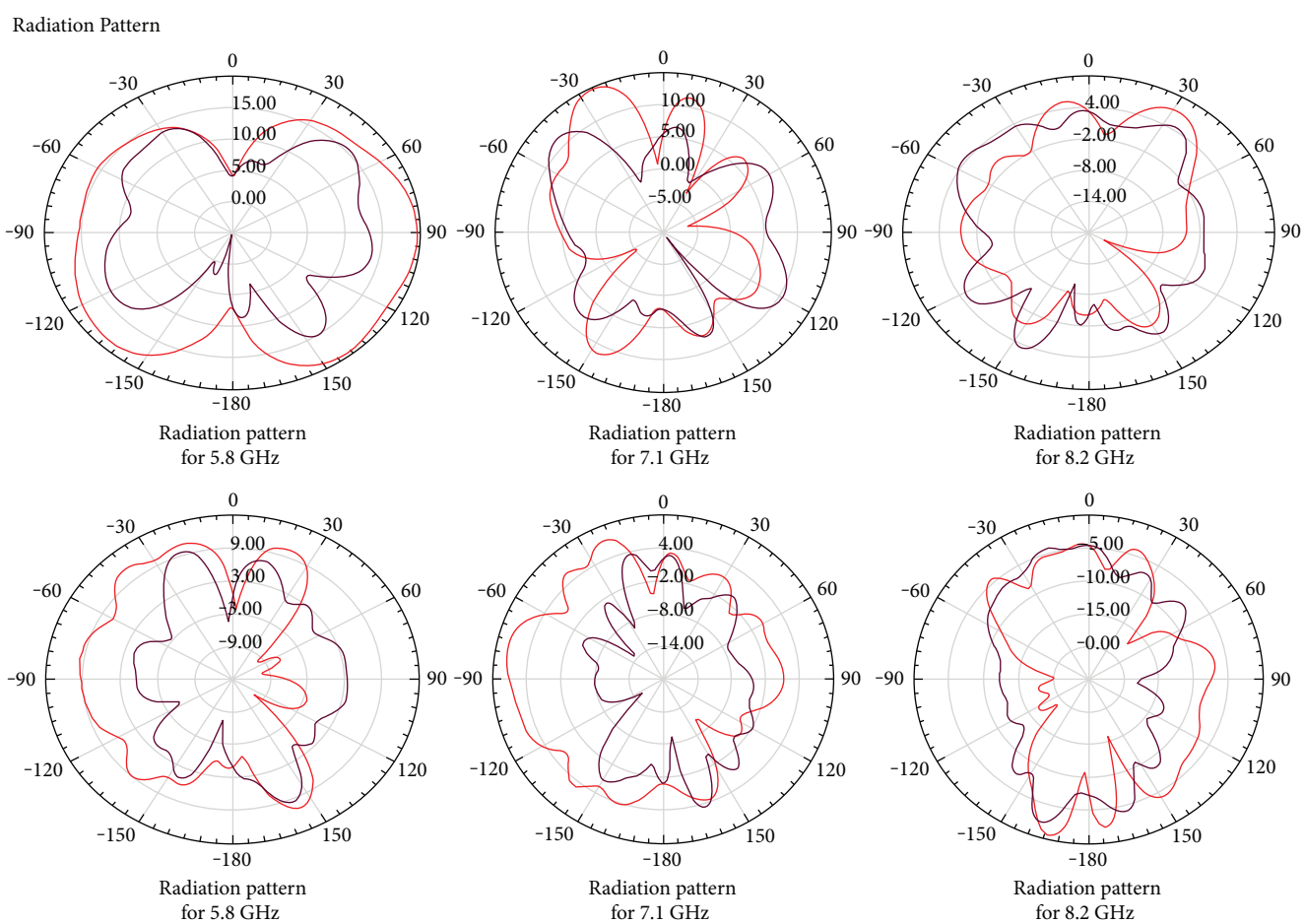


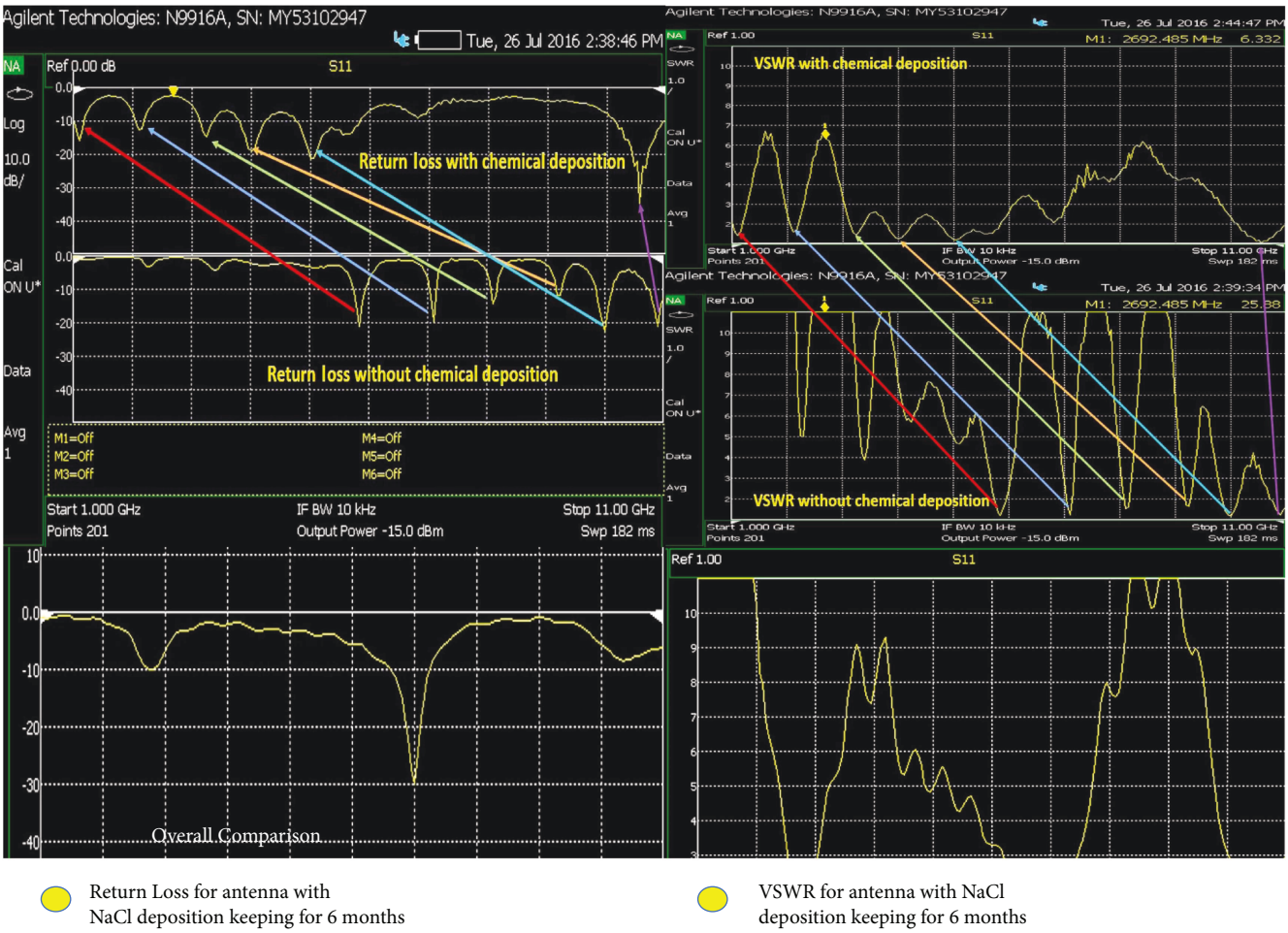

Figure 6: Radiation pattern of antenna at phi = 0 degree and phi = 90 degree.

## 4. Measured Result of an Antenna

This fractal tree-shaped MSA is tried in Terna Engineering College New Mumbai with Agilent Vector Network Analyzer. Measured result appeared here for the correlation. Fractal tree-shaped MSA is tried for without testimony, with NaCl statement and with NaCl affidavit keeping as it is for a half year.

Table 2: Resonant frequency, impedance bandwidth, and VSWR bandwidth.

| SN | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Resonant freq. | 5.8 GHz | 7.1 GHz | 8.2 GHz | 9.5 GHz | 10.3 GHz | 10.8 GHz |
| Impedance B/W | 5.7–5.86 GHz | 7.02–7.17 GHz | 8.14–8.35 GHz | 9.34–9.59 GHz | 10.17–10.44 GHz | 10.63–10.93 GHz |
| VSWR | 1.45 | 1.73 | 1.66 | 1.26 | 1.35 | 1.45 |




Return Loss for antenna with NaCl deposition keeping for 6 months

VSWR for antenna with NaCl deposition keeping for 6 months

Figure 7: Experimental result for the antenna with, without NaCl deposition, and with deposition for 6 months.

It is well known that atmospheric corrosion of the metal is accelerated by the sea salt particles near the seashore environment. Objective of the paper is to add NaCl manually on Tree shaped MSA and test the result at different environmental condition. NaCl solution is deposited not only on the metallic patch but also on the entire MSA and measured its characteristics in three steps: (a) before the deposition of NaCl, (b) after deposition of NaCl, and (c) after 6 months placing the antenna near seashore. Results are compared for all the three steps. NaCl is deposited freely on MSA and not on the conformal housing. NaCl erodes the metallic strips over time. It is because of the atmospheric condition near seashore and antenna kept there without any protection for six months.

The permittivity of aqueous NaCl varies as per signal frequency. The values of permittivity are at 1 GHz is 80-j5 and at 10 GHz 60-j30. The real part of the permittivity is exponentially decaying, whereas imaginary part is exponentially rising as increase in frequency [11]. Equation of the resonant frequency is given below

$$f_r = \frac{C}{\sqrt{\epsilon_r}}\left(\frac{1}{2L}\right) \tag{1}$$

This equation suggests that effective resonant frequency is increases up to 80 from 1 which is for the air. Hence, resonant frequency is shifted to the lower values.

Measured outcome for the return loss of the fractal tree-shaped MSA without affidavit is superbly matched with the simulated return loss result that appeared in Figure 7. Scope of the resonant frequencies differs from 5.8 GHz to 10.8 GHz for the outcomes.

## 5. Conclusions

The novel property of this structure is the shift in the resonant frequency for the antenna with NaCl deposition techniques from high frequency range to low frequency range. The resonant frequencies of the structure are related to the length distribution over the fractal shape. The self-similarity behavior can be explained by assuming that the structure is composed with independent radiating dipoles randomly distributed in space, and each branch of the tree antenna resonated at a wavelength four times its length. Finally, fractal tree structure with multiband behavior, good gain, and radiation characteristics, compact size, and natural shape represents a new engineering solution. Same antenna with NaCl deposition was kept in storage and once again tested for the VSWR, return loss, and gain. The antenna is degraded and all the branches of the antenna are completely connected with the NaCl deposition, and hence, the multiband behavior is converted into single band behavior, which shows the resonant frequency at 9 GHz. But still it shows the good VSWR and return loss with gain also.

In this paper, a fractal tree-shaped MSA is acknowledged by utilizing NaCl affidavit strategy. Antenna is recreated and tried in the frequency from 1–11 GHz, on the return loss, VSWR, and radiation pattern. Reproduced and test result for antenna with and without NaCl thought about. Likewise, same antenna keep for a half year in store near the seashore and by tried to know the change in trial conduct.

The novel property of this structure is the shift in the resonant frequency for the fractal-shaped MSA with NaCl testimony strategies from high frequency range to low frequency range. The resonant frequencies of the structure are identified with the length distribution over the fractal shape. The self-similarity conduct can be clarified by accepting that the structure is made with free radiating dipoles arbitrarily dispersed in space, and each branch of the fractal tree-shaped MSA resonated at a wavelength four times its length. At long last, fractal tree structure with multiband conduct, great gain and radiation pattern attributes, smaller size, and regular shape speaks to another designing arrangement. Same antenna with NaCl testimony was kept away and indeed tried for the VSWR, return loss, and gain. The antenna is debased and all the branches of the fractal tree-shaped MSA is totally associated with the NaCl testimony, and thus, the multiband conduct is changed over into single band conduct, which demonstrates the resonant frequency at 9 GHz. Yet at the same time, it demonstrates the great VSWR and return loss with increase in gain too.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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