RIS Based Poly Fractal Boundary Microstrip Antenna

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***Abstract* —** A circularly polarized microstrip antenna with poly fractal boundary is proposed. The sides of a square patch are replaced with Minkowski and Koch fractal curves along x and y axes respectively for generating asymmetry in the structure to get circular polarization in the radiation. The corresponding poly structure is implemented over a Reactive Impedance Surface (RIS) for broadband operation. Simulations for poly fractal antenna are carried out with square and fractal RIS elements.

Index Terms - Poly fractal, Minkowski, Koch, Reactive impedance surface

I. INTRODUCTION

Microstrip antennas have been studied and investigated in the last three decades extensively because of their low profile characteristics. To avoid multi path effects circularly polarized (CP) antennas are preferred. Several CP antennas based on slits and slots on the patch structure are available in open literature [1] – [3]. However, bandwidth of all these approaches is very narrow. To improve the radiation characteristics of the antenna, lot of research is going on the metamaterial based structures. Reactive Impedance Surface (RIS) substrate is evolved to improve the bandwidth of the patch antennas. Various antennas based on RIS technique for bandwidth improvement are proposed in open literature [4] – [7]. Here, both RIS technique and fractals concept are combined to improve the 3-dB axial ratio of CP poly fractal boundary antennas.

II. ANTENNA GEOMETRY

Initially simple poly fractal antenna is designed by replacing edges with Minkowski and Koch fractal curves along the orthogonal sides. Later the designed poly fractal antenna is implemented over RIS substrate for bandwidth enhancement. The proposed antenna structure is given Fig. 1. The specifications of the simulated antenna are FR4 epoxy with dielectric constant 4.4 is used as bottom layer, RT/Duroid is used as top layer, and indentation depth of Minkowski fractal used along x-axis is 0.11, and indentation angle of the Koch curve used along y-axis is 45^0. 5×5 RIS elements are used. The RIS element dimensions are a_1=8 mm, a_2=9mm, L_1=36mm, L_2=44mm, L_3=46mm, h_1=3.2mm, h_2=3.2mm.

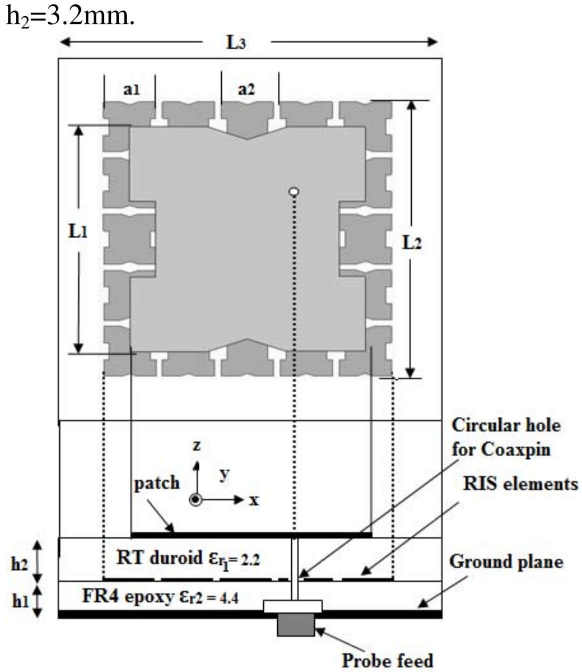
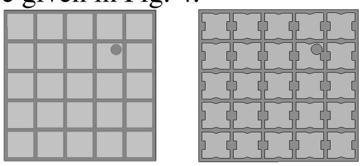


Fig. 1. Proposed antenna RIS Poly fractal antenna.

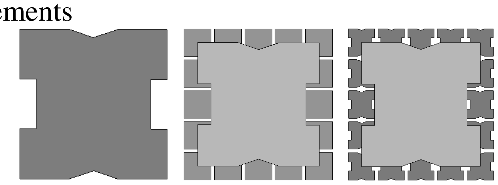
III. PROPOSED STRUCTURES AND SIMULATION RESULTS

The PEC ground plane of RIS surface after a thickness exhibits inductive nature which comes in parallel combination with capacitance created by the RIS patches on the substrate, thus forming the LC parallel circuit. The PEC ground plane of single layer antennas is replaced with the 5 × 5 square elements of RIS substrates as shown in Fig. 2, to generate higher bandwidth. The RIS is an RLC resonating circuit. To enhance the CP bandwidth further, the square RIS elements are replaced with the optimized fractal elements. The top view of proposed patch structures is pictured in Fig. 3. The simulated graphs are given in Fig. 4.



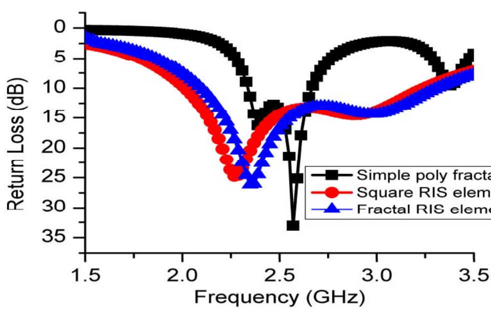
(a) (b)

Fig. 2. RIS structure: (a) with 5 × 5 square RIS elements, and (b) with 5 × 5 fractal RIS elements

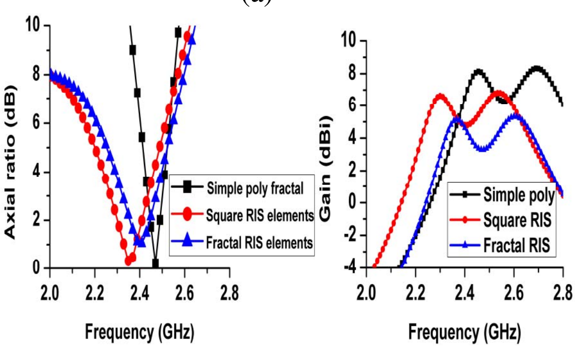


(a) (b) (c)

Fig. 3. The Proposed antenna top view: (a) Simple Poly fractal, (b) Fractal with square RIS elements, and (c) Fractal with fractal RIS elements.



(a)



(b) (c)

Fig. 3. The simulation results: (a) Return loss, (b) Axial ratio, and (c) Gain plots.

IV. CONCLUSION

A simple single probe feed circularly polarized poly fractal antenna has been proposed. The poly fractal patch is implemented over RIS substrate with square and fractal RIS elements and improvement in the 3-dB axial ratio CP bandwidth is observed. The obtained 10-dB return loss and 3-dB axial ration CP bandwidths of the simple poly fractal, Poly fractal with Square RIS and fractal RIS are 13.2%, 40.25%, 45.83% and 2.3%, 7.5%, 8.3% respectively. Lowering of the resonance frequency with RIS is observed which indicates the possibility of antenna miniaturization along with the improvement in the bandwidth.

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