Novel Frequency Selective Surface with Quasi-Elliptic Response

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***Abstract* – A compound frequency selective surface (FSS) with quasi-elliptic band-pass response is presented in this paper. The proposed FSS element is implemented using metallic via holes in a multiplayer structure which includes two dielectric layers and three metal layers. The designed FSS element is easy to fabricate and shows a band-pass response over the frequency range from 24GHz to 26GHz. When the insertion loss decreases from -3dB to -10dB, the frequency decreases from 23.98GHz to 24.36GHz for low frequency and 26.71GHz to 26.90GHz for high frequency, respectively. Furthermore, all these features can be controlled at a wide angle range.**

***Index Terms*—FSS, High selectivity, Wide angular response.**

1. Introduction

Frequency selective surface (FSS) has been an active subject for many years [1-4]. They are widely used in various microwave applications, such as sub-reflectors of the frequency reuse system, radomes for radar cross section (RCS) control as well as spatial filters for microwaves radar communication and so on [5-7]. In all these systems, the selectivity and wide angular response of FSSs are highly needed. Therefore, several approaches have been put forward to achieve these goals, such as the use of substrate integrated waveguide (SIW) technology, the multi-substrates and patches [8]. As we know, the employment of SIW cavities can realizes the quasi-elliptic band-pass response of the FSS, if along with the multilayer FSS, the result maybe more idealized. But considering the coupling effect, the compound multilayer FSS technology is not only difficult to design but also hard to fabricate. Meanwhile, the effect of different angle of incident wave is another factor we have to take into consideration.

In this paper, the proposed FSS element is implemented using SIW technology in a multilayer printed circuit board structure. Frequency transmission characteristics for different angles of TE polarization is presented through simulations. The results illustrate that the structure can provides the quasi-elliptic band-pass and wide angular response. In what follows, the design procedure and simulation results of proposed FSS are presented and discussed.

2. Structure Design

The proposed FSS structure consists of three metal layers separated by a dual-layer dielectric substrate with metallic via holes. The configuration of this structure is shown in Fig.1. Fig.1. (a) is perspective view of this structure. Fig.1. (b) is the side view of the proposed FSS. For further particulars, the metallic layers is illustrated in detail in Fig. 2. Fig.2 (a) is the top view of the front and back layers and Fig.2 (b) is the top view of the middle layer.

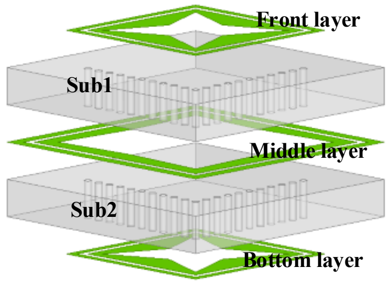
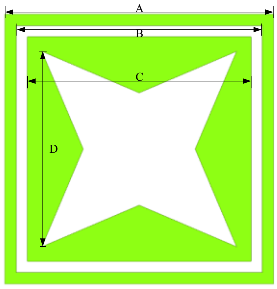
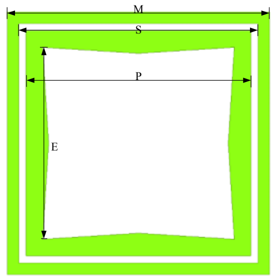


Fig.1. Illustration of the proposed FSS



(a). Top view of front and back layers



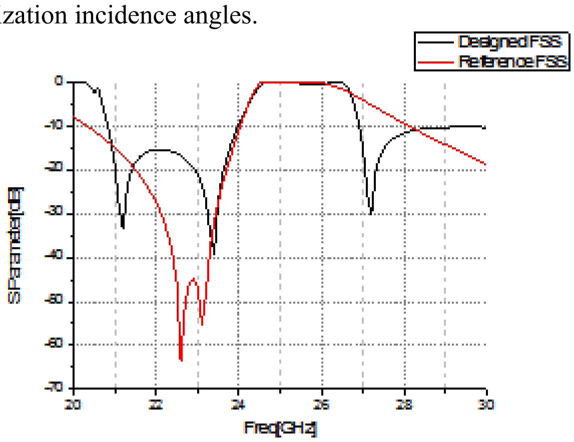
(b). Top view of middle layer
Fig.2. Illustration of the units

The proposed FSS used two identical thin substrates with relative permittivity of 3.4 and a dielectric of loss tangent of 0.0018. The FSS elements are distributed uniformly on the top, the middle and the lower layer, among which the top and the lower one are the same. As shown in Fig.2 (a), the top layer or the lower cell contains two concentric square loops with different dimensions and a patch with cross-star slot. The middle layer includes one square loop and a patch with cross-star slot, whose dimension different with this top one. All set of optimal dimensions are as follow:

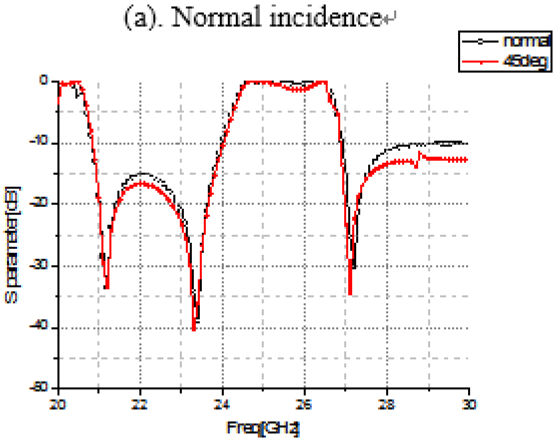
3. Simulation Results

Simulations were performed by Ansoft HFSS 15.0 simulation tool, which utilizes the finite element method to determine and analyze the EM behavior of the structure. Floquet ports were used to simulate the periodic and determine the transmission coefficients of the proposed FSS unit cell. The frequency response of this proposed structure compared with the reference is presented in Fig.3. (a). It can be seen that the center frequency of the novel FSS is 25.6GHz, the transmission zero can be seen at 23.3GHz and 27.1GHz, when the insertion loss decreases from -3dB to -10dB the frequency decreases from 23.98GHz to 24.36GHz for low frequency and 26.71GHz to 26.90 GHz, thus the transition band is only 0.38GHz and 0.19 GHz, respectively.

The simulation results of the angular stability of the resonant frequency of the proposed structure at 0° and 45° for TE polarizations is shown in Fig.3. (b). From this image, we can see that the band-pass and transmission zero characteristic are maintained stable for different TE polarization incidence angles.



(a). Normal incidence



(b). Oblique incidence

Fig.3. Simulated S parameters under oblique incidences

4. Conclusion

In this Letter, we propose and report a novel frequency selective surface based on a multilayer substrate and the use of SIW technology, which has the quasi-elliptic band-pass and wide angular response for TE polarization. A simulation is performed by the commercial software to obtain the characteristics of the structure. It is observed that the proposed structure can provide a high selectivity and wide angular response. Regret is that presented structure in this Letter is under fabrication for experimental verification.

References

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