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Bandpass Planer and Hemispherical FSS Comprising of Tripole Element

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ABSTRACT

This paper presents same type of infinite planer FSS and finite hemispherical curved frequency selective structure. It compares the characteristics of both the structures. The analysis is done by Method of Moment. Some basic property is observed by this study. A band pass hemispherical FSS is designed with pass band 8 GHz to 10 GHz frequency and shows sharp roll off.

Keywords: Frequency selective surface, Curved, Planer, band pass, roll off

1. Introduction

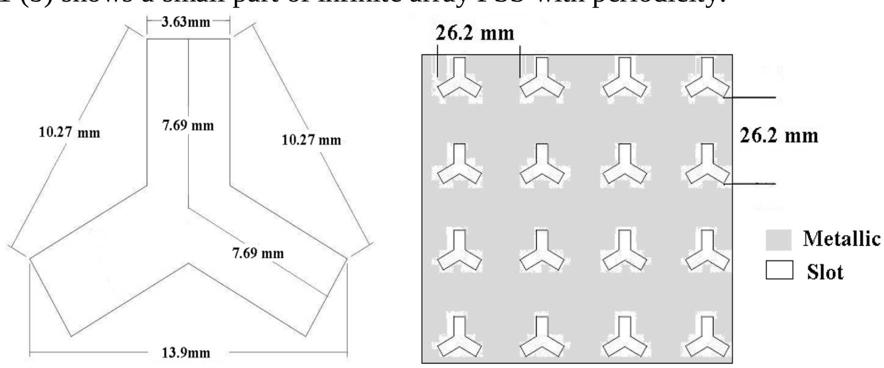
Frequency selective surfaces (FSS) used as electromagnetic filters, have been vastly studied over past forty years. It is used in different fields like antenna sub reflectors, polarizer, spatial filters etc [1]. Different analytical methods for planar or flat FSS have been investigated by many researchers. But the situation regarding curved FSS is completely different. The main advantage of planer FSS is a unit cell of infinite array can be considered and analysis to understand the nature of that whole structure. As the curved FSS cannot be deduced into a single unit cell, a large structure with a large number of arrays in it has to be computed [1-6]. So dealing with the curved FSS is quite problematic. Very few research works have been done till date regarding curved FSS. So it is difficult to have an experience or guide line by literature survey. In this paper hemispherical curved FSS structure is simulated using MoM based simulator FEKO and the results are compared with conventional planer FSS.

Curved FSSs are used as frequency selective sub-reflectors for frequency reuse systems, or high performance frequency selective radomes. The curved FSSs give mechanical and electromagnetic protection to antennas located inside the radome [2]. In near future aerodynamic ogive structure will be urgently required for design of an airplane nose by FSS. To maintain perfect aerodynamic property these structures cannot be constructed with plane FSS. The requirement of curved FSS originates from this point. There are two types of consideration for curved FSS when the excitation is an incident plane wave approaching the structure from the outside and when the excitation in an antenna inside the redom [4]. The first approach is concerned in this paper.

The response of FSS is dependent on the distance of the EM wave receiving source. So when an antenna is placed inside a redome, its location has to be specific in terms of getting particular transmission characteristics. In this paper a hemispherical band pass redome which is investigated, is transparent for the frequency range from 8 GHz to 10 GHz but reflect all other frequency apart from that. To achieve this at first a plane FSS is designed and it shows same nature. By maintaining the same FSS element structure, size and periodicity a hemispherical FSS is designed. Depending on the location of the EM receiver the nature of the FSS is shown and an optimum location is suggested.

2. Design

FSS is generally a periodic structure of patch or aperture type element. Patch type FSS acts like band stop filter and aperture type works like band pass filter [1-6]. As band pass FSS which passes only frequency 8 GHz to 10GHz, is to be designed, aperture type FSS is investigated. The most favorable dimension required for the predetermined characteristics is chosen as shown in fig. 1. Fig.1 (a) shows single cell of the FSS and fig.1 (b) shows a small part of infinite array FSS with periodicity.



(a) (b)

Figure 1: (a) Single cell of FSS and (b) Periodic array of FSS

This FSS design is projected on a hemisphere. The element structure, size and periodicity are kept same. Plane wave excitation is given for both cases. Generally curved FSS requires high computational resources. For this limitation only 100 mm radius metallic hemisphere (without dielectric) can be simulated and some very useful characteristics are observed. The aperture type hemispherical FSS is shown in Fig. 2.

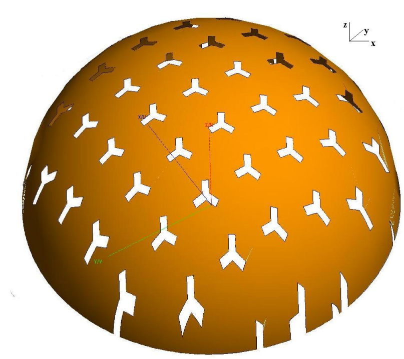


Figure. 2: Hemispherical FSS

3. Results and Discussions

It is found from previous experience that when flat FSS is converted into curved structure its resonating point is shifted towards lower frequency range and bandwidth is decreased. So the planer structure is selected considering that fact. The both (plane and curve) structure is excited by plane wave and transmission characteristics is calculated at different point in z direction. The distance is calculated from the surface of the structure. In fig. 3 (a, b, c and d) transmission electric coefficient vs. frequency for both flat and curved surface in different z points are plotted for comparison.

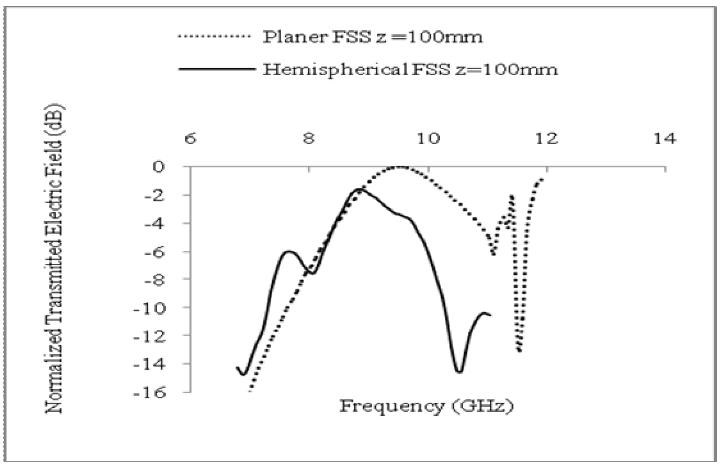


Figure 3 (a): Transmission coefficient vs. frequency curve at Z = 100 mm (from the surface)

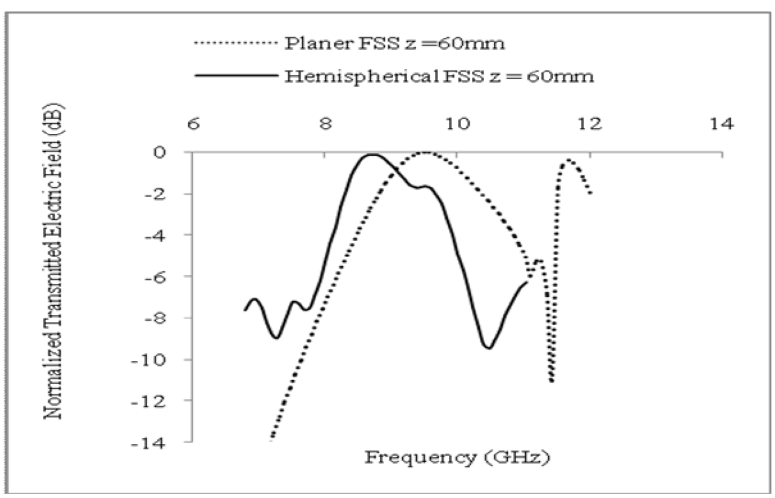


Figure 3 (b): Transmission coefficient vs. frequency curve at Z = 60 mm (from the surface)

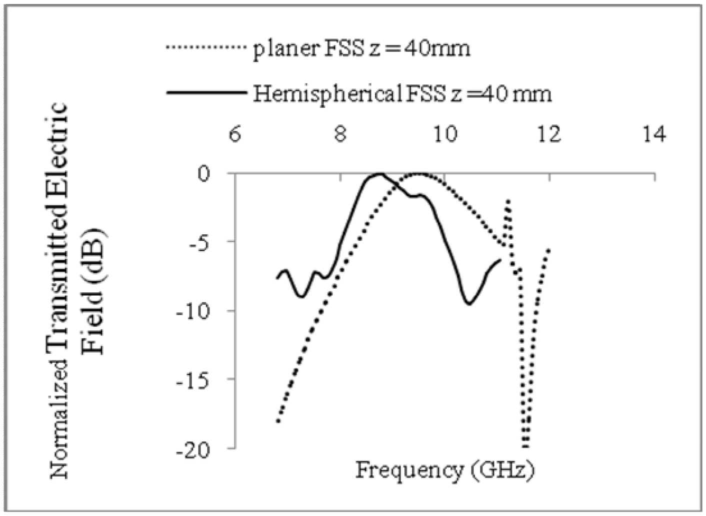


Figure 3 (c): Transmission coefficient vs. frequency curve at Z = 40 mm (from the surface)

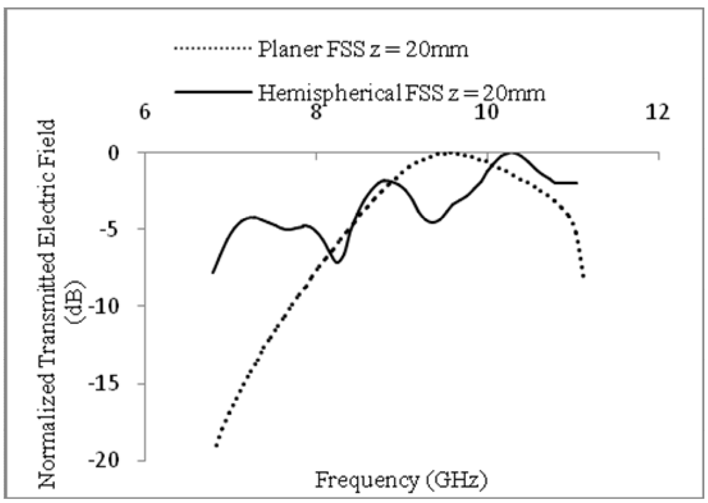


Figure 3 (d): Transmission coefficient vs. frequency curve at Z = 40 mm (from the surface)

From this figures it is observed that as the z point moved near the surface the transmission characteristics of the curved FSS is affected more than the planer FSS. Band separation decreases as z moved towards the surface. At z = 20 mm the planer FSS shows some band pass property but curved FSS losses its filtering capability. Fig. 3 (a) and (b) show almost same characteristics but according to band separation fig.3 (a) is better. On the other hand filtering is better in fig.3 (b) for the sharp roll off. So this FSS will act better when EM source is placed 60 mm away from the surface.

4. Conclusion

This paper presents some comparative studies between same type of curved and planer FSS. With this comparison some basic concept about curved FSS is also revealed. Simulation of curved structure is too much complicated, time consuming and required high computational resource than planer FSS. So some basic relation between planer and curved structure would be very useful for future curved FSS designer. In case of curved structure, generally bandwidth is less, resonating point always shifted towards lower frequency range and band separation became poor in compassion to planer FSS.

This paper also includes design of a curved hemispheric band pass frequency filter which passes 8 GHz to 10 GHz frequency. As the location in which the EM receiver is to be placed into the radom is important, characteristics at different z points are observed. It is suggested that for this FSS the receiver feed point should be placed at 60 mm distance from the surface to achieve good filtering property.

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