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Design of a Broadband Hemispherical Frequency Selective surface with Incident Angle independent Transmission characteristics and High Roll off

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Abstract

A single layer aperture type hemispherical broadband Frequency Selective surface with novel shaped slot has been designed and simulated. A stable transmission characteristics is achieved with variation of incident angle up to 30 degree. When EM is perpendicular to the structure then 5.6 GHz bandwidth with a sharp roll off has been achieved. Transmission characteristics of the FSS exhibits almost stable responses at various position between receiving antenna and FSS surface along the axis of the hemispherical.

Keywords: broadband, curved FSS, incident angle,high roll off, stable.

INTRODUCTION

Frequency Selective Surfaces (FSSs) are two dimensional array of metallic patches arranged infinitely on planar surface or finitely on the three dimensional (curved) surfaces[1]. The array of metallic patches on the dielectric substrate, is known as patch type, and its complement one is aperture type FSS[1]. The transmission properties of FSS, depend on the angle of plane EM waves impinge on the surface and the distance between FSS and receiving antenna [2]. The resonance frequency of a cylindrical aperture type FSS can be shifted by the variation with the parameters of dielectric slab. But almost same transmission bandwidth has been obtained[3]. In Characteristic basis function method (CBFM), direct solution of the equations can be used, where as Method Of Moment(MOM),multilevel fast multipole

method(MLFMM), fast multipole method(FMM) use iterative solution. In CBFM, nearly same transmission characteristics with MOM is achieved by less computing time due to parallel block process[4]. In this paper simulations are done using MOM method for accuracy. In the various application fields of FSS, such as subreflector or radomes, planar FSS is not useful properly. So to make it applicable fruitfully curved FSS concept is arised [5]. Multilayer FSS can be used as a superstrate to enhance the broadside gain up to 14.2 dBi [6]. A finite hemispherical Curved Frequency Selective Surface(FSS) represents a pass band from 8GHz to 10GHz(2GHz)[7].A stable transmission response up to 30 degree incident angle with a good roll off of an aperture type double layer curved FSS was presented in the paper [8]. In this paper a better roll off with a broad pass band of a hemispherical FSS is designed and simulated.

DESIGN

In this paper, a hemispherical aperture type FSS with novel shaped slot has been designed and simulated. The novel shaped structure which is shown in fig1 is formed by inserting four rectangular slits in a circle with diameter 20mm.The hemispherical FSS is designed by AutoCAD and FEKO simulation software. Diameter of the hemispherical surface which is in fig 2, is 150mm.The novel shaped slots are arranged on the metallic hemispherical surface with the periodic distance 26mm apart finitely. Electromagnetic plane Wave is incident on the surface from -30 degree to +30 degree along X-axis in Z direction. Here, for single layer hemispherical FSS, air is considered as a dielectric substrate. Aluminium foil paper is used as metallic sheet. The simulation of FSS has been done by keeping all other parameters same. The transmission characteristics of FSS is taken at distance between receiving horn antenna and curved FSS along Z -axis at 0mm, 5mm and 10mm.

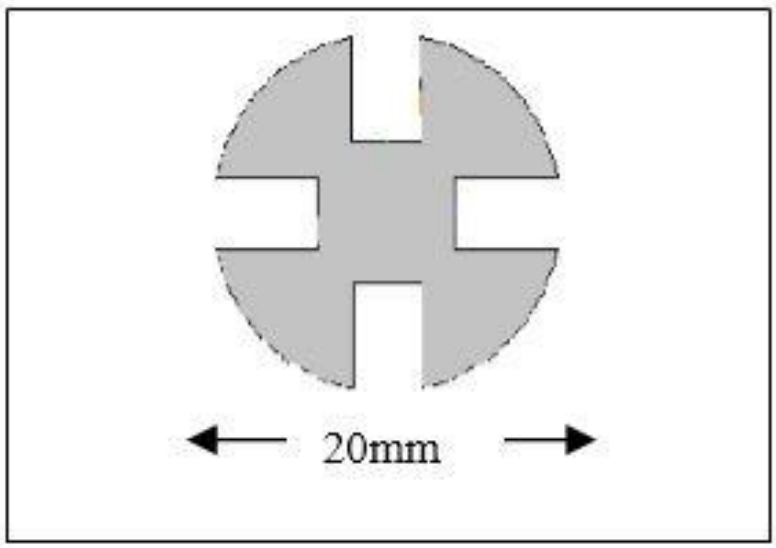

Figure 1: Novel Shaped slot

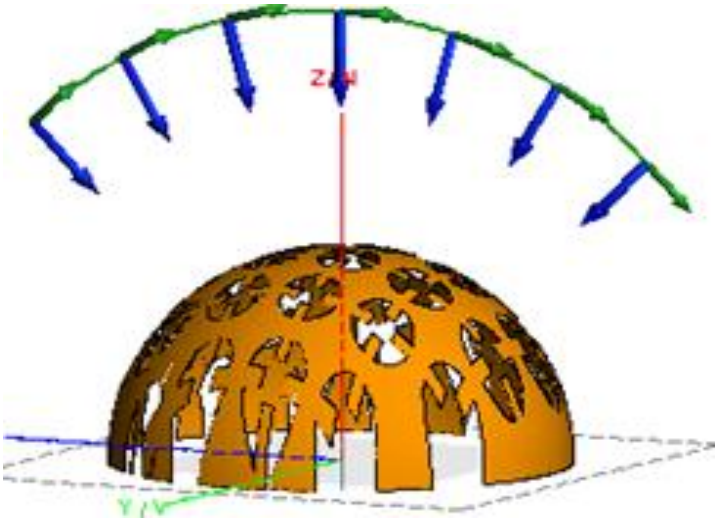

Figure 2: Hemispherical single layer FSS

RESULT

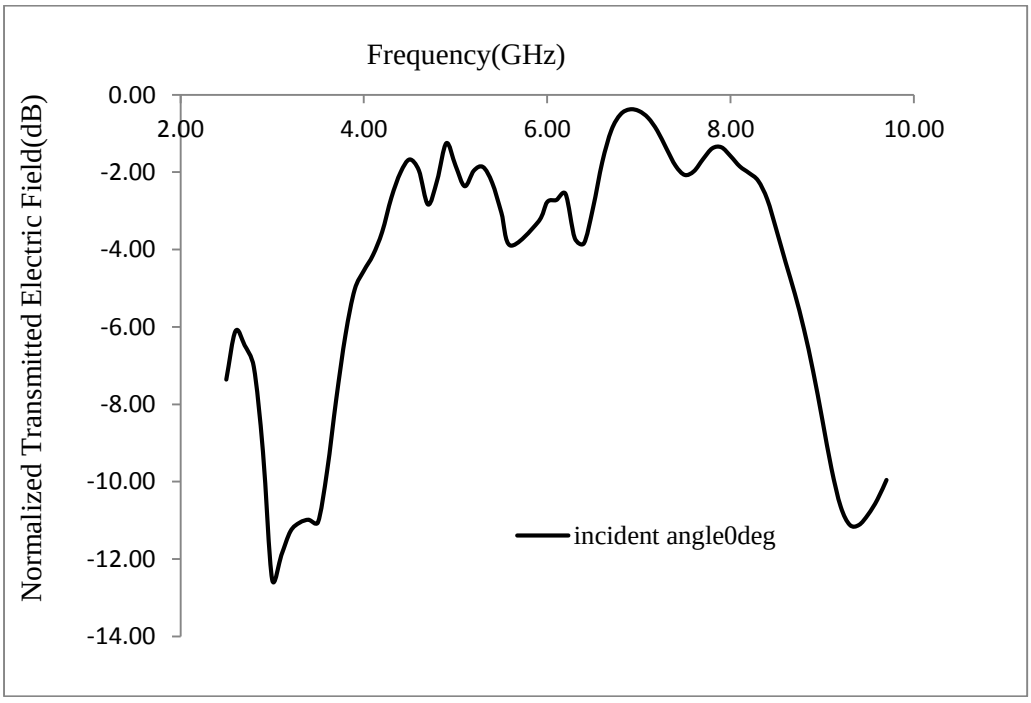

Figure 4: Transmission characteristics of FSS at 0 degree incident angle

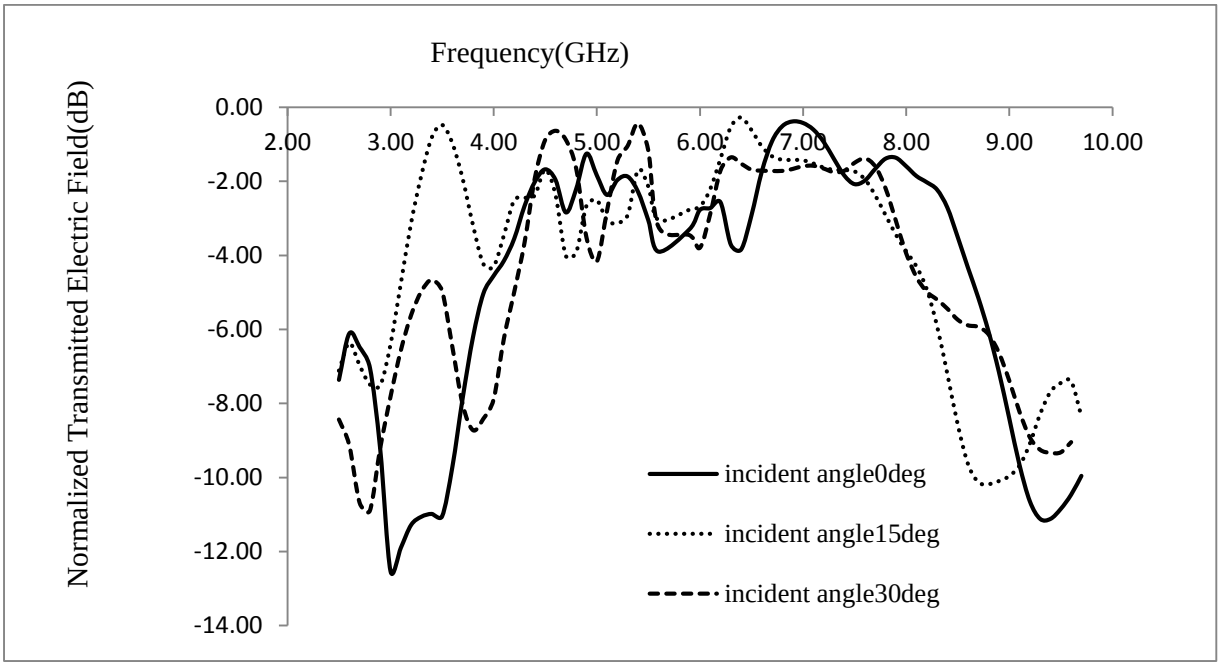

Figure 5: Transmission characteristics of FSS at various incident angles

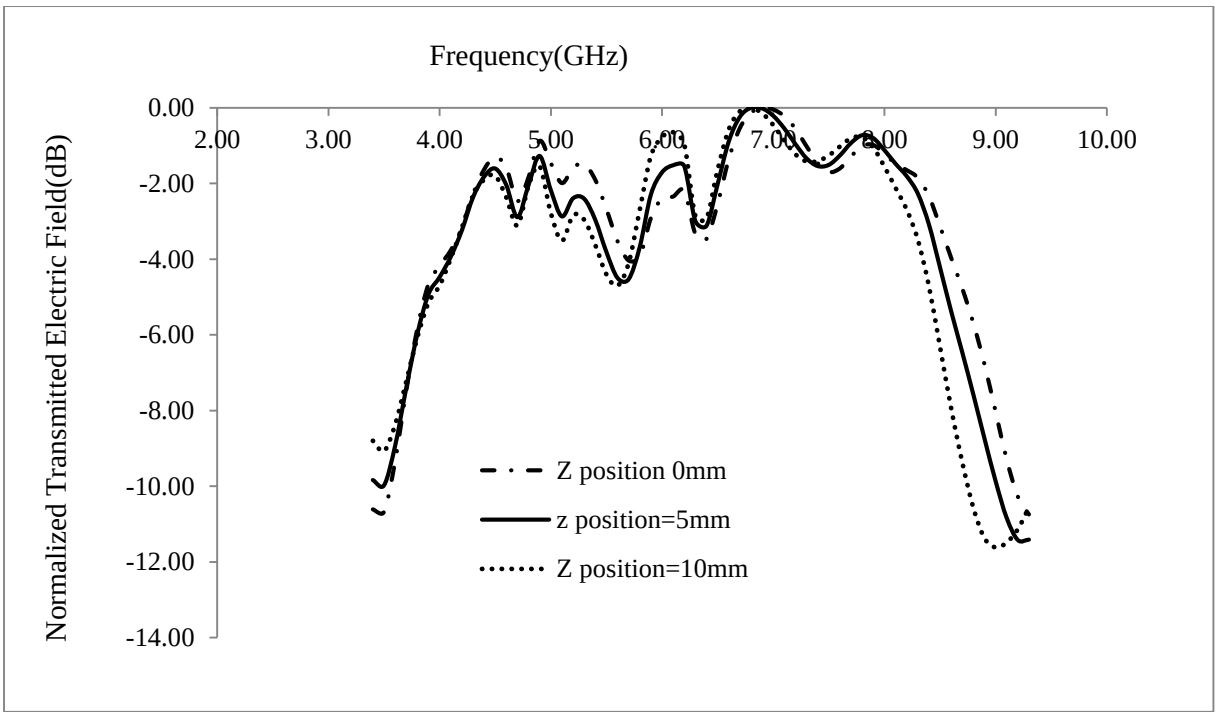

Figure 6: Transmission characteristics of FSS at various distance between receiving horn antenna and curved FSS along Z -axis

Transmission characteristics of curved single layer FSS at various incident angles is shown in the fig 4 and fig 5. At 0 degree incident angle of Electromagnetic wave on the FSS, from fig 4 it has been observed that left hand and right hand side roll off are 8.98dB/GHz and 9.93dB/GHz respectively. A good bandwidth has been achieved i.e 5.60GHz(% bandwidth 81.15%). Almost stable responses of FSS have been obtained at various incident angles up to 30degree and also for different distances between receiving antenna and curved FSS. The transmission characteristics of FSS at a distance between receiving horn antenna and curved FSS along Z -axis at 0mm, 5mm and 10mm have been shown in fig 6.

CONCLUSION

The proposed aperture type wideband FSS can be applied in different fields due to curved structure with stable frequency responses with various incident angles. This properties of an FSS, control the interference from indoor adjacent signals or frequency reuse to improve in communication field. Also good roll off is useful to remove noise in communication field.

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