Hybrid Ground of Microstrip Antenna Based on Principle of Phase Cancellation and Absorption

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Introduction

Electromagnetic metamaterials have long been widely used in antenna stealth designs. In recent years, due to the rapid development of antenna stealth design, researchers have proposed many different ideas in order to ensure that the design can have better performance and adapt to more scenarios. Multilayer metasurfaces are a recent idea. By laminating a variety of metasurface units in multiple layers, different properties that meet the design requirements can be obtained. Several research groups have achieved RCS reduction by using specially designed multi-layer structure metasurfaces, phase-controllable absorbing frequency selection units and other structures. Besides, the two metasurface units can also be separated by a certain distance. Then some researchers put forward the concept of frequency selective absorber, which combines frequency selective surface with absorber. Most of the current practice is to use a combination of bandpass FSS and absorber. When a plane wave is incident, the incident wave can be transmitted within the working band and absorbed outside the working band[3]. In addition to the above-mentioned common ideas, two kinds of bandpass FSSs can also be used, so that the reflection amplitudes outside the transmission band are equal and the reflection phases are opposite. When the two FSS metasurfaces are arranged in a checkerboard and an absorber is placed under them, the incident waves in the working frequency band can pass through the frequency selector and then be absorbed by the absorber. Meanwhile，the phase of the incident wave outside the working frequency can be canceled out.

In this paper, a special wave absorber unit will be designed based on the AMC units, and the multi-frequency RCS reduction will be achieved by designing its reflection phase. Firstly a traditional resonant absorber is designed, and the reflection phase difference is introduced through two kinds of AMC units. In order not to increase the redundant structure, two AMC units are placed on the upper layer of the absorber to obtain two special absorber units. Finally a hybrid ground is formed.

Simulation Method

The geometry of the proposed absorber which can be loaded on the hybrid ground is shown in Fig. 1.It is implemented on a FR4 substrate (ϵ_r=4.4,loss tangent=0.02). The overall thickness of the absorbing unit is 2mm. And the upper metal layer of the absorber is a 5mm×5mm slotted rectangle, and the size of the slot is 6mm×0.4mm.

And the rate of absorption is 98.55% at 7.6GHz.

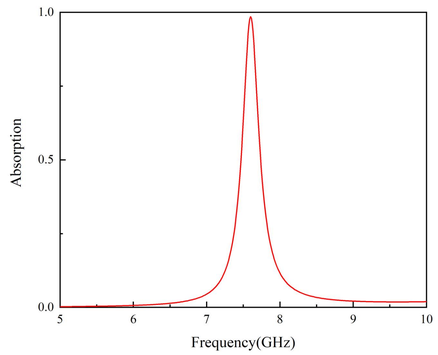

Fig 2. Absorption of the proposed structure

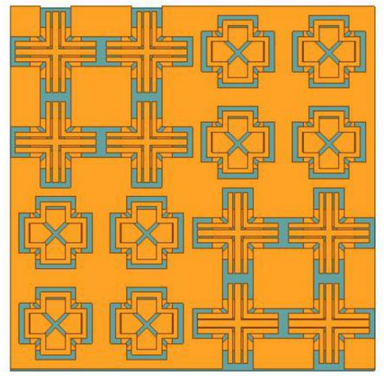

Fig 5. Layout of Hybrid ground

Then the two designed AMC units are loaded on the upper layer of the absorber units in order to introduce different reflection phases to the absorber. The thickness of the loaded absorber remains unchanged. The upper layer of it is AMC unit, the middle layer is the upper metal of the original absorber, and the bottom is metal grounding plate. The loaded absorbers are checkerboard arranged to form the absorbing surface as shown in Fig. 5 and used as a hybrid ground for anten

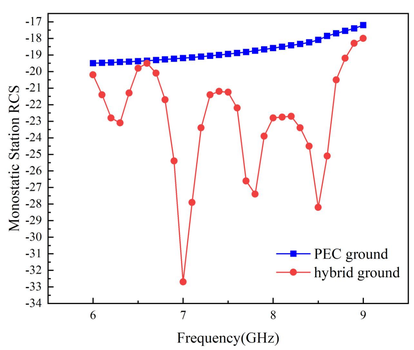

Fig 6. Monostatic Station RCS

PAll the simulations are carried out using Ansys HFSS. Firstly, the scattering performance of the hybrid ground is simulated and analyzed. Fig. 6 is a monostatic station RCS comparison diagram of hybrid ground and metal ground of the same size. From Fig. 6, the RCS of hybrid ground can be reduced at 7GHz, 7.6GHz and 8.5GHz. Therefore, the design idea of this paper has been affirmed.

Figure 7 shows the comparison of three-dimensional bistatic RCS at the three frequency points. It is noticed that reflected energy is transferred to other angles due to phase cancellation at 7GHz and 8.5GHz. And the basic shape of the three-dimensional image at 7.6GHz does not change because of absorption, but the overall beam becomes smaller.

Summary

A hybrid floor based on phase cancellation and absorbing principle is proposed. This paper is a study and application of hybrid Metasurfaces. Through loading AMC unit, the radar absorbing effect is realized on the basis of phase cancellation to reduce RCS. Compared with the metal ground, the RCS of the proposed hybridground is reduced at 6~9GHz.