Analysis on the Principle and Application of Super-surface Phase Regulation

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Abstract: Superstructured surfaces are often referred to as supersurface or two-position superstructure materials. They are a functional layer device based on subwavelengths. In the super-surface, a relatively abnormal phase mutation can be generated in its planar structure, which provides a more effective means for holographic display of some large fields of view. Compared with traditional optical devices, the super-surface has many advantages that are not available in common optical devices, such as the arbitrary regulation of sub-wavelength polarization, etc., and also has the characteristics of low loss and easy integration, so that in the real life, the super surface is subjected to a general emphasis. This paper analyzes the application of super-surface by expounding the principle of super-surface phase regulation, hoping to contribute its own strength to China's super-surface business.

1. Introduction

In recent years, due to the continuous economic growth, China's technology in science and technology has been continuously innovating and breaking through. The super-surface theory, testing and application have achieved a series of achievements. As China's super-surface theory is still being explored continuously, many applications of supersurface theory have also been proposed.

Based on this, it further explains the developability of the theory of supersurface, but there are many more challenges. Therefore, this paper elaborates and analyzes the principle and application of supersurface phase regulation, which is of great practical significance.

2. Principle of supersurface phase control

The so-called supersurface, which is also often referred to as a superatom or an artificial atom, is an artificially constructed structural material based on subwavelength. In the construction, it makes full use of the special electromagnetic phenomena in the subwavelength, so that the superscalar surface structure can present different electromagnetic properties from the common electromagnetic phenomena. In the current research status of supersurface in China, the super-structured materials have been able to photolithography or super-resolution imaging. In addition, in many applications, they can also display electromagnetic illusion stealth and other functions. The application of superstructure material in radiation antenna is very important in our country, but the metal loss of superstructure material is still a difficult problem to be solved. Therefore, in this context, in recent years, China has developed a new field of research, which is the superstructure surface, commonly known as the supersurface or artificial atom.

In the principle of supersurface phase regulation, the superstructure material is constructed by a kind of structural material called artificial atom, which makes use of the peculiar electromagnetic response of artificial atom and thus forms a new system. In the study of the principle of supersurface phase control, supersurface is a kind of artificial and manually constructed structural material, and in the construction process, it makes full use of the special electromagnetic response phenomenon. Through years of research in China, the supersurface has gradually become a relatively independent research system, but at the same time, this system is interrelated and combined with many disciplines such as hyperstructure materials. Only in this way can China’s system constantly complement each other and make common progress. Reviewing the research

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history of supersurface in China, it is found that the use of special electromagnetic response phenomenon is not an innovative concept. As early as in the 1940s, Kock has prepared metal structure materials in the foam of polystyrene, so that the microwave section of the material can fully realize the electromagnetic focusing function [1]. In this process, the microwave segment makes full use of the structure of subwavelength thickness. In this planar antenna structure, the phase delay of the supersurface electromagnetic wave can be continuously controlled. Besides, an electromagnetic control device has also appeared in the metasurface microwave section, which is realized based on a planar antenna structure. Electromagnetic control devices appear in the microwave phase of the metasurface. In the current research situation in China, a typical case is the transmitting array antenna. As the metasurface principle and technology are still in constant research, coupled with the limitations of technology and other reasons, China's construction of metasurface in the optical band has not been realized. With the rapid development of plasma theory in recent years, China has overcome one after another difficulties in the field of metasurface, and built a new optical metasurface that can conduct local phase modulation. The emerging optical metasurface device based on SP local phase control can change the constant of SP propagation by changing the metal slit in the local phase control of the gas price, thereby realizing the more flexible locality of the super surface. Phase regulation, and on the basis of this principle, the researchers have established a law based on the metasurface for tors-reflection, which is commonly referred to as the law of deflection and reflection in the broad sense [2].

3. The application of ultra-surface

Among the many applications of super-surface, the application of planar optics is one of the most promising applications of super-surface, and it is also a key factor in the development of photonic chip direction and photon integration direction in China. Therefore, the importance of planar optics is self-evident. It not only represents the advanced nature of China in the field of super-surface research, but also greatly reduces the complexity of the system in the work of optical systems in China, thus continuously promoting China. The optical system is moving forward. In planar optics, the super-surface uses MIM waves to propagate plasma and other substances on the surface. During this propagation, the propagation constant changes according to the slit width of the super-surface, and the variation range is about $0\sim2\pi$. Within this range, the phase can be changed at will. Since the equivalent refraction of the SP mode can be infinite in theory in the theory of catadioptric reflection, and because the equivalent wave is very short, the thickness of the planar optical device can theoretically be much smaller than the wavelength. Under the super-surface SP regulation principle, China's research has achieved many results, such as SP unidirectional coupler and so on.

In planar imaging devices, the structure of planar imaging devices can be more stable due to the phase regulation mechanism of supersurface devices. As a result, the planar imaging device is easy to integrate, and the design of the device becomes simpler. Therefore, this phase control mechanism is considered as the most likely to replace the traditional refractive device [3]. In addition, in the anti-symmetric mode of SP, the dispersion curve can be infinitely close to the visible light band so as to select the scattered SP wave independently with wood, and finally realize color filtering. The filter element of this plasma can have higher efficiency and special spatial resolution when performing relevant work. Therefore, it can be used in hyperspectral imaging and high resolution display. However, in planar optical devices, chromatic aberration is an urgent problem to be solved.

In addition to planar optical devices, supersurfaces are also widely used in achromatic optical devices. As early as 2016, China has developed an optical device that can make use of the mutual compensation between SP waveguide material dispersion and structural dispersion, so as to establish a colorless optical device in a wide band. The principle of this kind of optical instrument is that to remove the color differences in the Plane resonance by using the trait of resonance in the medium material.

Moreover, there is another method to construct the Ultra-surface device. In this pattern, the principle is based on the principle of Spatial modulation of refractive index, which can eventually realize the Spatial modulation of Ultra-surface by using the Periodic media column or Refractive index difference of pore structure, in order to construct the related optical device.

In terms of the Ultra-surface, the major barrier and blockade is the issue of color differences in the processing of the practical adoption of the Ultra-surface, because the nature of the Ultra-surface is a sort of the new-type optical device. Although the color differences of the Ultra-surface can be solved in a certain degree by using the Chromatic aberration compensation, whereas, it is still the one of paramount problems when it comes to the Ultra surface efficient broadband that how to remove the color differences.

The Intelligent regulation of super-surface in the optical band is the crucial component of the Intelligent electromagnetic device control system, and it also possess the promising application future in the radar aspect of our country. So far the Ultra surface in micro-band has realized the construction of Electromagnetic super-surface device that based on the construction of diode, and it is able to realize the real time respective regulation in several units in this Ultra-surface. Whereas, in the Optical wave band, although various regulations can be realized, such as electric regulation, it is still too hard to realize the respective regulation of each independent structural unit.

4. Conclusion

In the field of super-surface research in China, the super-structured surface can be designed based on sub-wavelength to achieve phase polarization within the relative scale, and the super-surface also has many materials unmatched advantages, such as low loss. The introduction and research of super-surface is largely due to the reduction of traditional optical load in China, and provides many effective measures and solutions for the integration of optical systems in China. In many specific application environments today, the introduction of planar optics in super-surfaces into optical systems instead of curved surfaces can reduce the complexity of the entire optical system, thereby increasing the reliability of the optical system and enabling optical system integration and space can be developed at a high speed.

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