Optical Principle Analysis of Surface Plasmon

Haijun Che, YongPing Wen, Yuexuan Li

Southwest Min Zu University, Chengdu, Sichuan 610041, China

CHJ1731012568@163.com

Keywords: Surface plasmon, Optical principle, Clear aperture

Abstract: Surface plasmon is a medium with high energy storage density. With the continuous development of high-power laser technology, its optical function is widely used in various fields. Based on this, an analysis of the principle of surface plasmon optics is proposed. By analyzing the surface plasmon nanostructure, the distribution of its resonance absorption peak is obtained. The transmission enhancement phenomenon of surface plasmons is obvious; the electro-optical switching function of the electrode can meet the needs of the light aperture, and the transmittance is high; the nonlinear optical rotation effect is strong, and the intensity and polarization parameters of the beam can be adjusted and the lattice structure The laser detection has an important role.

1. Introduction

Certain reasons for light and matter have an impact on the development stage of technology. In a specific surface state, the excimer will be excited by electromagnetic waves under certain circumstances. Metals and other materials can use the surface state to control the propagation effect [1]. With a certain change of light characteristics, an electromagnetic film will be produced under the wave, and the difference between the electromagnetic film and the photon is different at different frequencies [2]. Under normal circumstances, the electromagnetic film has a certain degree of independence, will not be harmed, and flow through the tiny ground radiation movement [3]. The surface of the metal is relatively time, and the propagation state of the particles is relative. Due to the heat reflection, the energy of the particles on the metal surface is gradually reduced, and the distance of light propagation is affected, and the particles are of the order of magnitude. Changes [4]. When these particles are on the metal surface, the free electron information in the metal will be affected, interact with the wave to a certain extent, and the reflection will change [5]. Meet the research of electromagnetic field. The traditional influence on the surface surface technology level cannot process the micron size technology, resulting in the insignificant optical characteristics of the surface properties, and different individuals have the understanding of the optical principles of the surface surface. . Based on this, this paper proposes an analysis of the principle of surface photonics, and through its optical principles, further research on laser technology and photonic components is realized.

2. Surface Plasma Nanostructure Analysis

Metal nanoparticles are the most common local surface plasmon materials. The surface electron cloud will polarize and produce resonance absorption when it encounters optical effect. The shape of the nanoparticle is affected by the resonance absorption peak, and the composition structure of the nanoparticle can be changed by adjusting the position of the resonance absorption peak. The resonant absorption peaks of precious metal materials such as copper and silver are adjusted in the visible band, and the outermost valence electrons are far away from the nucleus. The absorption peaks of aluminum, zinc and other metals are mainly concentrated in the ultraviolet band, and the resonance absorption peaks of plasma are about 105nm~210nm in the deep ultraviolet band.

The absorption spectrum of surface plasma is obtained by adjusting the alumina thickness outside the metal. In addition to precious metals, some semiconductors are also important surface plasmon materials. Compared with metal particles, the carrier concentration of semiconductors is

  DOI: 10.25236/iccem.2021.055

low, and the peak position of resonance absorption peak is mainly concentrated in the infrared band. The surface plasmon materials of semiconductors have a wide range of resonance peaks, ranging from near-infrared to far-infrared. The optical effect of semiconductor materials on the surface plasmon effect is of great significance.

3. Analysis of the Principle of Surface Plasmon Optics

3.1 Analysis of Transmission Enhancement

When light passes through the thin film of metal surface plasma, a single aperture circular hole array structure will appear, which is called transmission enhancement. Due to the excitation of surface plasmon, the electromagnetic field effect is enhanced, and the transmission effect of strong light is enhanced to some extent. When the resonant absorption peak changes in a small band, the transmission effect of surface plasmon is limited by the band. When the photonic circuit is restricted, the sub-wavelength size will be reduced, and the length of the light wave will be smaller. Due to the limitation of propagation and diffraction, the transmission phenomenon will also be hindered to a certain extent. The electromagnetic field of surface plasma is usually confined to the metal interface, and when the electric ions of the plasma are excited, they perform back and forth oscillating motions. The localized field effect of the plasma on the metal surface is strong, so that the photon energy is localized within the volume of the sub-wavelength size, which enhances the interaction between the plasma and the photon to a certain extent, and reduces the intensity of the incident light. Transmission provides some help.

3.2 Electro-Optical Switching of Electrodes

Plasma electro-optic switch is an important part of the development of laser field and plays an important role in the stable operation of laser control. By controlling the timing sequence of electro-optic switch, the performance of pulse can be locked, which is widely used in pulse slicing operation.

Optical components will be affected by changes in the damage threshold. In self-excited oscillation, the aperture must be changed to a size that meets the requirements, ultimately achieving the goal of reducing the beam density. In the experimental study of the laser device, the optical aperture of the beam is long, up to hundreds of nanometers. At this time, the electro-optical switch of the plasma is controlled, the optical aperture is set to the standard size, the standard damage threshold is reached, and the response speed of the electrode is improved.

Using transparent materials in optics, the longitudinal running mode of electric field is changed, and pulse voltage is applied to the electro-optic switch. The electro-optic switch of surface plasma is composed of a discharge cavity and electro-optic crystal. When the electrode switch is opened, the voltage pulse is rapidly transmitted to the discharge electrode. With the rising voltage in operation, the gas ionization in the discharge cavity gradually increases, and when it reaches a certain level, the aperture is filled with inert gas ionization. When the voltage pulse passes through the electrode, the polarization of the electro-optic crystal changes the polarization direction of the laser. The polarization detector is set to work together with the equipment to finally complete the function of the surface plasma electro-optic switch. In the electro-optical switching effect of the entire electrode, the lateral distribution of the surface plasma is relatively uniform, and there is no centralized distribution. In the continuous increase of voltage, the plasma conductivity is higher, which ensures the safety of the voltage increase. Plasma has outstanding advantages in damage threshold, which can meet the requirements of through-light aperture and optimize the optical characteristics of through-light aperture without affecting the threshold.

Among many electrode media, surface plasma is more suitable for electro-optical switches, achieving higher transmittance, and the operating efficiency of voltage switches exceeds 90.25% of electrode media.

3.3 Nonlinear Optical Rotation Effect of Surface Plasma

The non-linear absorption effect of surface plasmons is more obvious, mainly for the fluctuation of the absorption coefficient of the material caused by laser transmission, so as to realize the control of the beam intensity. Surface plasmons can also control the polarization parameters nonlinearly.

The dependence of plasma on light intensity changes from the refraction and optical rotation of matter. The lattice structure has symmetry, and its representative material can show the natural optical rotation effect, which gradually changes the symmetry into refraction. Birefringent polarized waves have certain differences in refractive index and absorption index, which makes some parameters of electromagnetic waves change. When the loss of refractive index can not be ignored, the main axis of polarized electromagnetic wave will deviate. At this time, the nonlinear optical rotation effect of surface plasma is obvious. From the analysis of optical principle, optical rotation effect is the response of surface plasma to electromagnetic wave, most of which is non-local response and will be affected by the distribution of nearby electric field. According to quantum theory, the irregular transmission characteristics of electromagnetic waves in optical crystals are also a form of nonlinear optical rotation effect.

The nonlinear response of surface plasmon medium is related to the distribution of free electrons. Nonlinear optical rotation is the most basic optical effect of surface plasmas, which is very important for laser detection of lattice structure.

4. Conclusion

The optical principle of surface plasmons is an important part of the development of laser technology and provides help for the development of photonic components. Based on this, this paper presents the principle analysis of surface plasmon optics. Through the analysis of this article, it can be seen that the surface plasmon has a transmission enhancement phenomenon, and it is more obvious; Electrode electro-optic switch has strong effect and the operating efficiency of voltage switch is higher than most electrode medium. The nonlinear optical rotation effect is obvious, which plays an important role in laser detection of lattice structure. In the future, the photonic function of surface plasmas should be studied.

References

[1] Peng Chengkai, Yan Jiyuan, Kang Yuchan, et al.Effect of plasma surface gradient silicon deposition on the electrical properties of epoxy resin[J].High Power Laser and Particle Beams, vol. 33, no. 06, pp. 152-160, 2021.

[2] Li Ping, Zhang Jun, Wei Xiaofeng.Plasma optics technologies: State of the art and future perspective[J].High Power Laser and Particle Beams, vol. 32, no. 01, pp. 35-45, 2020.

[3] Deng Ying. Surface plasmon resonance of metal nanostructures and Its Applications[J].Technology and innovation, no. 21, pp. 140-141, 2019.

[4] Guoying Yao, Qinglu Liu, Zongyan Zhao.Applications of Localized Surface Plasmon Resonance Effect in Photocatalysis[J].Progress in Chemistry, vol. 31, no. 04, pp. 516-535, 2019.

[5] Guo Qiangbing, Liu Xiaofeng, Qiu Jianrong. Research Progress of Ultrafast Nonlinear Optics and Applications of Nanostructures with Localized Plasmon Resonance[J]. Chinese Journal of Lasers, vol. 44, no. 07, pp. 79-88, 2017.