Study of Non-uniform Plasma Layer Variation with Optically-Controlled Microwave Pulses

Xue Wang, Ji-Hun Yun and Yong K. Kim
Division of Electrical Electronic & Information Engineering, Wonkwang University

Abstract : We study of the variation on non-uniform plasma in different layer of the semiconductor. The transient response in different plasma layer has been evaluated theoretically. The reflection function of dielectric microstrip lines resulting from the presence of plasma are evaluated by the transmission line model. The diffusion length is small compared to the absorption depth. The variation of characteristic response in plasma layer with microwave pulses which has in localized has been evaluated.

Key Words : Non-uniform Plasma, micro-strip lines, Transient Response, Optically- Controlled Microwave Pulses

1. INTRODUCTION

The dielectric constant of the optically illuminated semiconductor takes the complex form at microwave and millimeter-wave frequencies[1,2]. The reflection and transmission of millimeter waves from optically induced plasma in a semiconductor were studied as a means of optically controlling of microwave in a quasi-optical system [3, 4].

In this study, we have modeled the dielectric/plasma waveguide in the non-uniform layer using the multipoint boundary-value routine COLSYS. The exponential tail of free carriers extending into the waveguide continues to give a loss as the density increases because the fields can not be completely extinguished from the highly absorbing plasma region.

2. EFFECTS OF NON-UNIFORM PLASMA LAYER

The reflection characteristics of non uniform plasma layer line are theoretically investigated with respect to the illuminating light using an equivalent circuit model as shown in Figure1.

The presence of electron-hole plasma in the semiconductor layer produces of modification of the conductive as well as the dielectric properties of the semiconductor material [1, 3]. The dielectric constant in the plasma-induced layer semiconductor material can be analyzed by the equation of motion of charge carriers in the semiconductor considering the classical electron-hole plasma theory as predicted by the Drude-Lorentz equation [5].

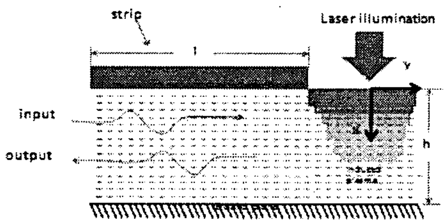

Fig. 1. The plasma layer induced non-uniform density with an open-ended illuminated termination.

The laser illumination induces electron-hole pairs in the semiconductor near the open end of the strip. The density of the induced carrier is assumed to be exponentially distributed from the surface to the interior. The plasma region ΔZ is assumed to have a uniform density of free carriers[5].

In the evaluating with simulation, our equivalent model transient response with optically-controlled wave pulses based on microstrip lines, can be written by $O(\omega) = \tau_{in}(\omega)\, e(\omega)$ where $\rho_{in}(\omega)$ is dielectric variation in the plasma-induced layer and $e(w)$ is characteristics response in the frequency reflection variation in our equivalent model.

3. VARIATION OF TRANSIENT RESPONSE IN PLASMA INDUCED LAYER

If we assume $a_l L_D >> 1$ and $a_l L_D >> S_T/L_D$, then the characteristic of variation in microstrip lines with optically controlled microwave pulse. In Fig. 5 the reflection of the input microwave was about $9x10^{-9}$ largest at the maximum density of the plasma in the surface of the semiconductor, as the density of the plasma increased below the reflection reduced and was closed to *0*.

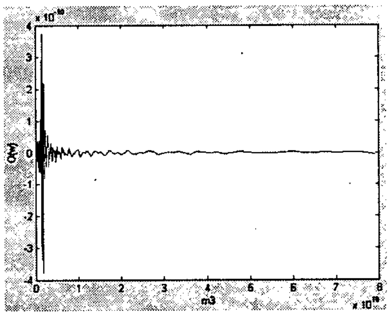

Fig. 2. The characteristic response in different density of the plasma layer.

The phase of the reflection of the microwave in the surface of the semiconductor is gotten. In Figure 3 the maximum phase was about $3.8x10^{-10}$ in the depth of 0.075*m*. If the diffusion length L_D is small compared to the absorption depth $1/a_l$, in Figure 3 the reflection of the input microwave was about $2x10^{-10}$ largest at the maximum density of the plasma in the surface of the semiconductor, as the density of the plasma increased below the reflection reduced and was closed to *0*.

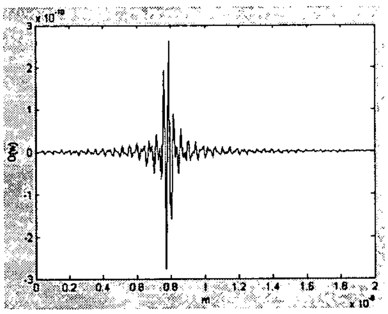

Fig. 3. The characteristic response in the different depth of plasma layer.

In Figure 4, we can see that the maximum phase was about $2x10^{-10}$ in the depth of 1.6μm with optically-controlled microwave pulse.

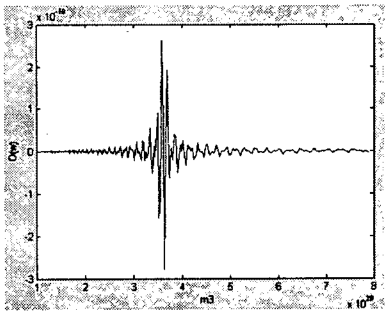

Fig. 4. The characteristic response in different density of the plasma.

4. CONCLUSION

As the temperature and the input wave frequency changing, we calculate the density of the induced carrier in different plasma layer. The reflection coefficient of the different layer in plasma can be gotten. We also calculate the density of the plasma in different layer of the semiconductor. The transient response of the microwave reflected from the different layer of the plasma in different situation for $a_l L_D >> 1$ and $a_l L_D >> S_T/L_D$ and the diffusion length L_D is small compared to the absorption depth.

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