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Remarking
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Plasmon Frequency Resonance on Surface of Sodium Fluorides in Presence of DC Magnetic Field

Abstract

In particular, by using the hydrodynamic model and Maxwell's equations, Kobayash studied the magneto static plasma wave oscillations of a SWCNT in the Voigt configuration. Moradi and Khosrav studied the dispersion relation of plasma waves which propagate parallel to the surface of the SWCNTs. Here we are interested to study the characteristics with help of the spatial dispersion relation for two modes coupling in metallic NaF nanosize in presence of an external D.C magnetic field. This study is applicable in electronic communication and fibre optics.

Keywords: Plasma Frequency, Plasma Oscillations, D.C. Magnetic Field, Dispersion Relation.

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Introduction

In recent years, many experimental theoretical works have been done to study the high frequency excitations (electron oscillations) in carbon nano tube. Wei and Wang[1] studied the dispersion relation of quantum ion acoustic wave (QIAW) oscillations in single-walled carbon nano tubes (SWCNTs) with quantum hydrodynamic (QHD) model which was developed by Haas[2,3]. Shyu[4] studied the magneto Plasmon of SWCNTs within the tight-binding model. The low-frequency single-particle and collective excitations of SWCNTs were studied in presence of a magnetic field by Chiu[5,6]. The energies of neutral and charged excitations and Plasmon frequencies of nano tubes as a function of magnetic field were analysed by Chaplik[7] and Gumbs[8], who calculated the dispersion relation of the collective magneto Plasmon excitations for an electron gas confined to the surface of nano tube when magnetic field is perpendicular to its axis. In particular, by using the Hydrodynamic model and Maxwell's equations, Kobayashi[9] studied the magneto static plasma wave oscillations of a SWCNT in the Voigt configuration. Moradi and Khosrav[10,11] studied the dispersion relation of plasma waves which propagate parallel to the surface of the SWCNTs. Here we are interested to study the characteristics with help of the spatial dispersion relation for two modes coupling in metallic NaF nanosize in presence of an external D.C. magnetic field. This study is applicable in electronic communication and fibre optics.

As Surface Plasmon's and Surface Optical phonons may interact with each other in polar semiconductors if their frequencies are of the same order. It must be known the dispersion relation which can be obtained by various methods. To study the coupling the Hydrodynamical model is one of the various methods to study the behaviour of Polaritons, Phonon on the geometrical surface of condensed materials of different geometries.

All the obtained dispersion relations have been reduced to the case of metals and the resulting equations have been found to match exactly with dispersion relation already obtained for corresponding cases for metals by other scientists. This study is most important in medical sciences, astrophysics, stars studies, nano biological sciences and communication sciences.

Theoretical Study

Bloch introduced a comparatively simple classical form known as Bloch's Hydrodynamical model which is applicable for small wave vectors. The Hydrodynamic model has proved to be very useful in describing the electrical transport and optical properties of conductors. The modified Bloch's equation for the semiconductor may be written as-

$$m\frac{D\bar{v}}{Dt} = -e\left[\bar{E} + \frac{1}{c}\left(\bar{\nabla}\times\bar{B}\right) - mv\bar{\nabla} - \bar{\nabla}\int_0^{n(\bar{r},t)}\frac{d\rho(n')}{n'}\right] \quad (1)$$

$$\bar{\nabla}\times\bar{B}=\frac{4\pi}{c}\bar{J}+\frac{1}{c}\frac{\partial\bar{D}}{\partial t} \quad (2)$$

$$\frac{\partial n}{\partial t}=-\bar{\nabla}.(n\bar{v}) \quad (3)$$

$$\bar{\nabla}.\bar{E}=\frac{4\pi e}{E}\left[N_+(\bar{r})-n(\bar{r},t)\right] \quad (4)$$

Equation (1) is the Euler's equation of motion. The operator is co-moving time derivative given by-

$$\frac{D}{Dt}=\frac{\partial}{\partial t}+V_x\frac{\partial}{\partial x}+V_y\frac{\partial}{\partial y}+V_z\frac{\partial}{\partial z} \quad (5)$$

Where are the components of velocity in x, y and z directions respectively. gives the acceleration of an electron in the fluid and may be written with the help of equation (5) as-

$$\frac{Dv}{Dt}=\frac{\partial v}{\partial t}+(v.\bar{\nabla})v \quad (6)$$

The dispersion relation for these modes can be obtained from required boundary conditions vacuum medium given as-

$$RX_l^{'}(\gamma kR)\left(\varepsilon_\infty(k\omega)\Omega^2-\varepsilon_0(k\omega)\frac{\omega_t^2}{\omega_p^2}\right)$$

$$\left[\left\{\bar{\varepsilon}(k\omega)\left(\Omega^2-\frac{\omega_t^2}{\omega_P^2}\right)-\left(\varepsilon_\infty(k\omega)\Omega^2-\varepsilon_0(k\omega)\frac{\omega_t^2}{\omega_P^2}\right)\Omega^2\right\}y_l(\alpha kR)RZ_l(\delta kR)^{'}+\left(\Omega^2-\frac{\omega_t^2}{\omega_P^2}\right)\Omega^2\varepsilon_B(k\omega)\left(Ry_l(\alpha kR)^{'}Z_l(\delta kR)\right)\right]$$
$$\left(\Omega^2-\frac{\omega_t^2}{\omega_p^2}\right)l(l+1)\bar{\varepsilon}(k\omega)\varepsilon_B(k\omega)\varepsilon_B(k\omega)X_l(\gamma kR)y_l(\alpha kR)y_l(\alpha kR).Z_l(\alpha kR)=0 \quad (7)$$

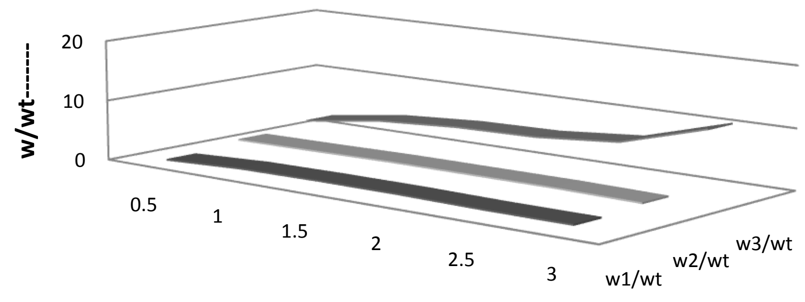
The equation (7) is the required dispersion relation for the surface Plasmon Phonon-Polaritons modes in the case of spatial dispersion relation polar semiconduc embedded in a bounding non-dispersion dielectric medium for dielectric constant .The effect of the magnetic field on the coupling of Phonon, Plasmon and Polaritons in a polar semiconducting sphere for k≠0 has been studied. The spatial dispersion relation of magneto Plasmon-phonon relation is derived as given

$$y^3-(x-az+b)y^2+(bx+czx+az)y-czx=0 \quad (8)$$

$$x=\left(\frac{\omega_c}{\omega_t}\right)^2, y=\left(\frac{\omega}{\omega_t}\right)^2, z=\left(\frac{\omega_p}{\omega_t}\right)^2 \quad (9)$$

$$a=\frac{B-2\bar{\varepsilon}A}{\varepsilon-\varepsilon_\infty A}; b=\frac{C-\varepsilon_0 A}{C-\varepsilon_\infty A}; c=\frac{B-\bar{\varepsilon}A}{C-\varepsilon_\infty A} \quad (10)$$

The graph is plotted for equation (8) or the substance NaF for different radius in vacuum dielectric medium as shown below figure.



	0.5	1	1.5	2	2.5	3
w1/wt	0.244323	0.854315	0.999795	0.999788	0.834796	0.834796
w2/wt	1.2659	1.41424	1.602071277	1.609127	1.6123	1.414214
w3/wt	2.307404	4.182	5.0349	5.308	6.4668	10.48595

Graph between K and w/wt of NaF tube in DC Magnetic field

The above figure shows the variation of the frequencies of surface Plasmon for shorter wavelength in presence of the applied DC magnetic field.

Conclusions

We observe that :

1. The frequency of surface Plasmon at the lower mode remains almost constant as well as high fields and is very close to the pure phonon frequency.
2. The frequency of surface Plasmon at the middle mode increases with the applied weak magnetic field but at strong field the frequency of surface Plasmon becomes almost constant, i.e. the frequency at this mode reaches the saturation stage. The frequency at this mode at saturation approaches very close to the bulk Plasmon frequency.

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3. The frequency of surface Plasmon at the upper mode increases and is proportional to the strength of applied DC magnetic fields.

The above conclusions are of great scientific and practical importance and may provide useful information for the study of the coupling between SP and SOP waves on surface of NaF. All the above dispersion relation and effect of D.C. magnetic field are reduced to the local limit case by neglecting spatial dispersion. The effect of spatial dispersion on the surface Polaritons has been derived.

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