East European Journal of Physics. 2. 141-152 (2022)
DOI:10.26565/2312-4334-2022-2-18 ISSN 2312-4334

ELECTRONIC CHIPS ACTING AS CAPACITORS OR INDUCTORS WHEN LASER ACT AS INFORMATION TRANSMITTER[†]

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Received March 12, 2022; revised March 28, 2022; accepted May 6, 2022

To increase the speed of information flow and storage capacity in electronic devices laser can be used to carry information instead of electric current. Since the photon is faster than electrons, one expects information to be transmitted very fast through the internet when photons replace electrons. This requires searching for chips that act as capacitors, inductors or resistors. To do this Maxwell's equation for the electric field intensity beside the electron equation of motion were used. The electron is assumed to vibrate naturally inside a frictional medium in the presence of a local electric and magnetic fields. These equations have been used to find a useful expression for the absorption coefficient. The absorption coefficient was found to be dependent on the laser and natural frequencies beside the coefficient of friction in addition to the internal electric and magnetic fields. These parameters can be fine-tuned to make the chip act as a capacitor, inductor or resistor. The laser intensity decreases when the absorption coefficient inecreases. Thus, the absorption coefficient acts as an electic resistor. Therefore, if the absorption coefficient inecreases upon decreasing the frequency the chip acts as a capacitor. But when the absorption coefficient inecreases when the laser frequency inreases the chip acts as an inductor. In the case that the absorption coefficient inecreases with the concentration of the carriers it acts in this situation as a resistor. For magnetic materials with magnetic flux density that cancels the frictional force, when the laser frequency is equal nearly to the atom's natural frequency the material acts as an inductor. But when the frictional force is low with the internal and external electric fields in phase, the material acts as a capacitor. However, it acts as a resistor for negligible natural frequency, when no electric dipoles exist and when the internal magnetic field force balance the frictional force.
Key words: laser; chip; capacitor; inductor; resistor.
PACS: 42.55.f

Electromagnetic waves (EMW) play an important role in our day life. They are oscillating electric and magnetic field propagating with the speed of light c in free space. The behavior of EMW is described by Maxwell's equations [1]. Light, laser, microwave, x-rays and gamma rays are electromagnetic waves used in a side variety of applications. Radio and laser EMW are used in telecommunication, where the transmit information through the internet to mobile phones and computers [2]. Laser is used also in medicine in surgery and curing some diseases, beside other biological applications [3].

The utilization of EMW in telecommunication is the most commercially important to people. The rapid increase of people using network encourages scientists to search enabling the electronic chips to strong very large number of bits and digits, beside fast transmission of information. These needs replacing electrons by faster particles to increase information flow. These particles also need to be smaller than electrons by many orders of magnitude to stove more information. The particles that satisfy such requirements are photons [4]. Laser rays, which are photon streams, is suitable to be used to transmit and store information [5].

Different attempts were made to utilize laser in storing and transmitting information [6,7,8].

The work done by Christopher Monroe [3] speak about using laser in quantum computer to control floating atoms. This will enable computers to perform many calculations within almost no time. One particle can store many pieces of information [9]. This means that the behavior of atoms is on the atomic scale. The quantum laws thus control their behavior. Therefore, the control of such computers become a formidable task due to the probabilistic nature of the quantum systems. This problem can be surpassed by utilizing laser but using classical systems on the scale of more than 300nm, say on the micro scale. These needs using classical laws like Maxwell equations for laser electronic systems. Monroe informs us that on 2016 that for quantum electronic system ytterbium – 17 was used for qubits for particular states. Error – corrected universal reconfigurable ion trap quantum archetype) EURIQA began operating autonomously in April 2019 [9]. The work done by Vishal, et al [10], is concerned with using quantum laws to show how to use them for quits and gates like Not and Xor gates.

The paper showed that the prablistic nature of quantum laws allows storing very large number of information pieces of information but at the same time make the control of computer behavior very difficult [109]. In the work done by Julie change, et al [11], the cost was minimized for convolutional neural networks (CNNS) by incorporating a layer of optical computing prior to electronic computing. This system improves the accuracies of the optical system. The modeling of neural dynamics can be done with the aid of nonlinear optics. When the task of producing non-linearity is gives to

[†] ***Cite as***: M.A.M. Yousef, A.S. Alsubaie, Z.A.A.A. Saad, and M.D. Abd-Alla, East Eur. J. Phys. **2**, 141 (2022), https://doi.org/10.26565/2312-4334-2022-2-18

electronic circuits in hybrid op to electronic circuit, the system will become more practical. This analogy is quite natural as far as the neuron cells functions are related to the electric pluses and bio photons [13,14,15]. The use of laser in electronic chips was realized by many researchers [16,17].

In the work done by Jin Li and others an optical gain op to electronic oscillator based on dual frequency integrated semiconductor laser was fabricated to generate high frequency micro and milli wave frequency. The device is dual semiconductor laser. The bandwidth was widened by introducing optical amplifier instead of electric one [18]. This means that laser electronic chips are now available. The rapid grow of topological photonics can give remarkable push to quantum computers. The discovery of quantum hall effect and topological insulators in condensed matter. The topological photonics using orbital angular momentum (OAM) can be used in optical quantum computer, routing and switching [19]. Many approaches and designs were suggested for quantum electronics [20,21,22]. However no intensive work or attention were played on designing laser capacitor or inductor although many researches were done for frequency dependent conductivity [23,24,25]. This paper is devoted for laser capacitors and inductor as shown in sections “Laser travelling in a resistive frictional medium” and “Laser electronic components for the electron equation of motion in the presence of local electric and magnetic fields beside thermal”. Sections “Discussion” and “Conclusion” are for discussion and conclusion.

LASER TRAVELLING IN A RESISTIVE FRICTIONAL MEDIUM

Maxwell's equations describe the behavior of moving and static charges as well as electromagnetic waves (EMW). The electric field intensity E for a medium with electric permittivity and conductivity ε and ε is given by

$$\nabla^2 E - \mu\varepsilon\frac{\partial^2 E}{\partial t^2} - \mu\sigma\frac{\partial E}{\partial t} = o, \quad (1)$$

where is the magnetic permeability of the medium. Consider a solution in the from

$$E = E_0 e^{i(wt-\gamma_a z)} \quad (2)$$

Differentiating equation (2) with respect to space and time yields

$$\nabla^2 E = \gamma_a^2 E$$

$$\frac{\partial^2 E}{\partial t^2} = -\omega^2 E$$

$$\frac{\partial E}{\partial t} = +i\omega E \quad (3)$$

Inserting equation (3) in (1) gives

$$(\gamma_a^2 + \mu\varepsilon\omega^2 - iw\mu\sigma)E = o \quad (4)$$

Rearranging equation (4) gives

$$\gamma_a^2 = i\omega\mu\sigma - \mu\varepsilon\omega^2 \quad (5)$$

For the electron moving with velocity v in aresistive medium of coefficient γ, under the action of the electric field E, the equation of motion of the electron is given by

$$m\frac{dv}{dt} = eE - \gamma v \quad (6)$$

Since E oscillater with time thus

$$E = E_o e^{iwt} \quad (7)$$

In this case the electron also oscillate with velocity

$$v = v_o e^{iwt} \quad (8)$$

Differentiating v in eqn (8) w.r.t time and inserting this result in equation (6) gives

$$imwv = eE - \gamma v$$

$$[imw + \gamma]v = eE \quad (9)$$

Thus, the electron velocity is given by

$$v = \frac{e \quad E}{imw+\gamma} = \frac{e(\gamma - imw)}{m^2w^2+\gamma^2} \quad (10)$$

For dielectric material the electric dipole moment (polarization) for n dielectric atoms por unit volume having distance x between the dipoles and charge q is given by

$$p = qnx \tag{11}$$

Thus, the current density J is given by [1]

$$\mathrm{J} = \frac{dp}{dt} = qn\frac{dx}{dt} = qnv \tag{12}$$

Inserting eqn (10) in (12) and using the definition of the conductivity ($\sigma = \sigma_1 + i\sigma_2$) yields

$$\mathrm{J} = qn\frac{e(\gamma - imw)}{m^2w^2+\gamma^2}E = \sigma E = (\sigma_1 + i\sigma_2)E \tag{13}$$

Thus, the real part σ_1 and the imaginary part σ_2 of the conductivity are given by

$$\sigma_1 = \frac{neq\gamma}{m^2w^2+\gamma^2} \qquad \sigma_2 = \frac{-mwneq}{m^2w^2+\gamma^2} \tag{14}$$

One can simplify the expressions for σ_1 and σ_2 by adopting some approximations. For instance let

$$\gamma < mw \qquad mw > \gamma \tag{15}$$

In this case equation (14) gives

$$\sigma_1 = \frac{neq\gamma}{m^2w^2} \qquad \sigma_2 = \frac{-neqmw}{m^2w^2} = \frac{neq}{mw} \tag{16}$$

Since $\gamma < mw$, thus $\sigma_1 < |\sigma_2|$
Numerically

$$neq\gamma \sim n \times 10^{-38}\gamma$$

$$mw \sim 10^{-30} \times 10^{15} \sim 10^{-15} \tag{17}$$

$$\gamma \sim \frac{m}{\tau} \sim \frac{10^{-30}}{10^{-14}} \sim 10^{-16}$$

$$neqmw \sim n \times 10^{-38} \times 10^{-15} \sim n \times 10^{-51} \tag{18}$$

$$\sigma_2 \sim 10^{-23}n \tag{19}$$

$$|\sigma_2| \quad > \quad \sigma_1 \tag{20}$$

Since for visible light $w \sim 10^{15}$ $\quad \mu\varepsilon \sim \frac{1}{c^2} \sim 10^{-17}$
Thus

$$\mu\varepsilon w^2 \sim 10^{-17} \times 10^{30} \sim 10^{13} \tag{21}$$

Clearly, the above estimations show that

$$mw \; > \; \gamma \tag{22}$$

According to equations (16) , (17) , (18) and (5) with the fact that [1 , 26]

$$\mu_o = 4\pi \times 10^{-7} \sim 10^{-6} \quad henry \;\; m^{-1}$$

$$n \sim 10^{20}$$

$$e \sim q \sim 10^{-19} \tag{23}$$

$$\sigma_1 \sim \frac{10^{20} \times 10^{-38} \times 10^{-16}}{10^{-30}} \sim 10^{-4}$$

$$\sigma_2 \sim \frac{10^{20} \times 10^{-38}}{10^{-15}} \sim 10^{-3} \tag{24}$$

$$w\mu\sigma = w\mu\sigma_1 + iw\mu\sigma_2 \sim 10^{15} \times 10^{-6} \times 10^{-4} + i\,10^{15} \times 10^{-6} \times 10^{-3} \sim 10^5 + i\,10^6 \tag{25}$$

But

$$\mu\varepsilon w^2 = \frac{w^2}{c^2} = \frac{10^{30}}{9 \times 10^{16}} \sim 10^{30} \times 10^{-17} \sim 10^{13} \tag{26}$$

Thus are can to a good approximation ignore both $w\mu\sigma_1$and $w\mu\sigma_2$ compared to $\mu\varepsilon w^2$ in equation (5) to get

$$\gamma_a^2 = -\mu\varepsilon w^2 = -\frac{w^2}{v^2} \tag{27}$$

$$\gamma_a \ = i\sqrt{\frac{w^2}{v^2}} = i\ \frac{w}{v} = i\ k \tag{28}$$

In view of eqn (2), one gets

$$E = E_o e^{i(wt-kz)} \tag{29}$$

Which were sent a pure travelling wave with attenuation.

LASER ELECTRONIC COMPONENTS FOR THE ELECTRON EQUATION OF MOTION IN THE PRESENCE OF LOCAL ELECTRIC AND MAGNETIC FIELDS BESIDE THERMAL

The local field E_L an be induced when the external electric field displace atoms to form electric dipoles having dipole moment p. the local field strength is thus by

$$E_L = \propto p = \propto qnx, \tag{30}$$

where $\propto$ is a constant of proportionality q is the dipole charge, x is the displacement n is the atomic concentration. Thus, the equation of motion is given by

$$m\frac{dv}{dt} = eE + E_L - \gamma v - k_0 x = eE + \propto qnx - \gamma_o v + Bev - mw_o^2 x \tag{31}$$

$$\gamma = \gamma_o - Be, \tag{32}$$

where B is the magnetic flux density of the internal field and $k_0 x$ is the thermal vibration force. Again the velocity can become.

$$v = v_o \qquad e^{iwt} \tag{33}$$

Integrating both sides yields

$$x = \int v dt = \frac{v}{iw} = -\frac{iv}{w}, \tag{34}$$

where x is the displacement. The differentiation gives

$$\frac{dv}{dt} = iwv \tag{35}$$

Inserting eqns (34) (35) in (31) gives

$$imw\ v = eE - \frac{\propto qn}{w} iv - \gamma v + \frac{imw_o^2 v}{w}$$

$$[i[m(w^2 - w_o^2) + \propto qn] + \gamma w]v = ewE \tag{36}$$

For simplicity and to gain time as well as ink and paper one can define

$$\beta = mw^2 + \propto qn - m\ w_o^2 = m(w^2 -\ w_o^2) + \propto qn \tag{37}$$

$$\gamma = \gamma_o - Be \tag{38}$$

Thus, eqn (36) becomes

$$[i\ \beta + w\ \gamma]v = e\ w\ E \tag{39}$$

Hence, the velocity v is given by

$$v = \frac{ew}{(w\gamma + i\beta)} E \tag{40}$$

The current density resulting from dipole oscillation is thus given by

$$\mathrm{J} = \frac{dp}{dt} = qn\frac{dx}{dt} = qnv \tag{41}$$

In view of equation (40) one gets

$$\mathrm{J} = \frac{eqnw(w\gamma - i\beta)}{w^2\gamma^2+\beta^2} E = \sigma E = (\sigma_1 + i\sigma_2)\, E \tag{42}$$

Thus the real and imaginary conductivities are given by

$$\sigma_1 = \frac{eqnw^2\gamma}{w^2\gamma^2+\beta^2} \tag{43}$$

$$\sigma_2 = \frac{-\beta\, e\, n\, q\, w}{w^2\gamma^2+\beta^2} \tag{44}$$

If we select a material with weak internal field, and when we consider the case when the frequency w equal to w_o . Thus

$$w\,\gamma > \beta \tag{45}$$

There fore

$$w^2\,\gamma^2 + \beta^2 \approx w^2\,\gamma^2 \tag{46}$$

One is concerned with dipole current according to eqn (41). Thus, the mass of vibrating atoms m and w for visible light have the orders

$$m{\sim}10^{-26} \qquad\qquad w{\sim}10^{15} \tag{47}$$

Hence

$$\beta{\sim}10^{-26} \times 10^{30}{\sim}10^{4} \tag{48}$$

Also

$$w\gamma{\sim}10^{15}\gamma \tag{49}$$

$$w\gamma > \beta \qquad\qquad \beta < w\gamma \tag{50}$$

This requires

$$\gamma > 10^{-11} \tag{51}$$

The value of $\gamma(\gamma = m/\tau)$ for the element Bi exceeds 10^{-11} [26]. Thus the oscillating dipole should have friction more than that of the element Bi. In this case

$$\sigma_1 = \frac{e\,q\,n}{\gamma} \tag{52}$$

$$\sigma_2 = -\frac{\beta\, e\, n\, q\, w}{\gamma^2\, w^2} = -e\,n\,q\,\frac{\beta}{w\gamma^2} = -\,\sigma_1\frac{\beta}{w\gamma} \tag{53}$$

$$|\sigma_2| < \sigma_1 \tag{54}$$

Thus one can neglect the imaginary conductivity to get

$$\sigma_2 \quad \sim \quad o$$

According to eqns (53), (54) and (5)

$$\gamma_a{}^2 = i\mu\frac{weqn}{\gamma} - \mu\varepsilon w^2 = \mu w\left(\frac{ieqn}{\gamma} - \varepsilon w\right) = \mu w(i \times 10^{-38} \times 10^{11} \times 10^{20} - 10^{15} \times 10^{-11}) = \mu w(10^{-7}i - 10^{4}) \tag{55}$$

Thus

$$\gamma_a^2 \approx -\mu\,\varepsilon\, w^2 = -\frac{w^2}{v^2} = -k^2$$

$$\gamma_a = i\,k \tag{56}$$

In view of eqn (2) is a travelling wave in the form

$$E = E_o\, e^{i(wt-kZ)} \tag{57}$$

This wave is un attenuated. Now consider the resonance condition with no local field, i.e

$$w = wo \qquad\qquad \propto\, = o \tag{58}$$

In this case eqn (37) gives

$$\beta = 0 \tag{59}$$

Thus eqns (43) and (44) gives

$$\sigma_1 = \frac{e\ n\ q}{\gamma} \tag{60}$$

$$\sigma_1 = 0 \tag{61}$$

In view of equation (38)

$$\gamma = \gamma_0 - B_e \tag{62}$$

If one make the internal magnetic field by doping the sample with magnetic dipoles such that

$$\gamma_0 - B_e \tag{63}$$

In order to make

$$\gamma\ \sim\ 10^{-60} \tag{64}$$

In this case equation (60) gives

$$\sigma_1\ \sim\ 10^{22}n \tag{65}$$

Since

$$\mu\,\varepsilon\, w^2\ \sim\ 10^{13} \tag{66}$$

Thus one can neglect the last term in eqn (5) to get [see eqns (61) , (65) , (66)]

$$\gamma_a^2 = i\ w\ \mu\ \sigma_1 = (e^{90})^i w\ \mu\ \sigma_1 \tag{66}$$

Thus

$$\gamma_a = e^{45i}\sqrt{w\mu\sigma_1}$$

$$\gamma_a = \left(\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}\right)\sqrt{w\mu\sigma_1} \tag{67}$$

A direct substitution of eqn (67) in eqn (2) gives

$$E = Eoe^{i\left(wt - \frac{\sqrt{w\mu\sigma_1}}{\sqrt{2}}Z\right)} e^{-\frac{\sqrt{w\mu\sigma_1}}{2}Z}$$

$$E = Eoe^{-\frac{\sqrt{w\mu\sigma_1}}{\sqrt{2}}Z} e^{i\left(wt - \frac{\sqrt{w\mu\sigma_1}}{\sqrt{2}}Z\right)} \tag{69}$$

Thus the attenuation (absorption) coefficient becomes

$$\propto\, = \frac{\sqrt{w\mu\sigma_1 w}}{\sqrt{2}} \tag{70}$$

Increases with the frequency. This means that the resistance of the medium to the radiation increases upon increasing frequency. This behavior resembles that of an inductor, which has resistance $(x_L = wL)$ increasing with frequency. This means that the medium behaves in this case as an inductor.

Another case can be considered by doping the chip with magnetic dipole atoms such that

$$\gamma = \gamma_o - Be = o \tag{71}$$

In this case eqns (43) and (44) gives

$$\sigma_1 = o \qquad\qquad \sigma_2 = \frac{-enqw}{\beta} \tag{72}$$

In view of equation (37)

$$\beta = m(w^2 - w_o^2) + \propto q\, n \tag{73}$$

β can also be adjusted by doping the chip with electric dipoles and selecting atoms having natural frequency w_o or alternatively when no electric dipole exist, with the laser frequency fine-tuned such that

$$\beta \sim 10^{-60} \tag{74}$$

In this case equation (72) gives

$$\sigma_2 \sim 10^{22}\, nw \tag{75}$$

Thus with the aid of equations (17) and (23)

$$w\mu\sigma_2 \sim 10^{30} \times 10^{-6} \times 10^{22} n \sim 10^{46}\, n \tag{76}$$

In view of equations (5), (21), (72) and (76), one can neglect all terms except the term (76) to get

$$\gamma_a^2 = -\, w\, \mu\, \sigma_2 = \frac{w^2\, \mu\, e\, n\, q}{\beta} = C_o^2\, w^2 \tag{77}$$

Therefore

$$\gamma_a = \, C_o\, w \tag{78}$$

Where

$$C_o^2 = \frac{\mu\, e\, n\, q}{\beta} \tag{79}$$

A direct substitution of eqn (79) in (2) gives

$$E = Eoe^{-Cowz} e^{i(wt)} \tag{80}$$

This equation represents an oscillating wave with amplitude diminishes with distance z and angular frequency w. Thus the resistance of the medium to the wave increases with frequency. Thus, this medium acts as an inductor. This medium also allows intalgenment as far as

$$K = \frac{2\pi}{\lambda} = 0 \tag{81}$$

Thus the wave speed is

$$v = \frac{w}{k} \to \infty \tag{82}$$

Another approach can be tackled using equation (5) by considering a travelling diminished wave. This requires defining γ_a to be in the form

$$\gamma_a = ik + \, \gamma_{oa} \tag{83}$$

Where conductivity σ and electric permittivity are complex

$$\sigma = \sigma_1 + \, i\sigma_2$$

$$\varepsilon = \varepsilon_1 + \, i\varepsilon_2 \tag{84}$$

Thus a direct substitution of equations (83) and (84) in eqn (5) gives

$$\gamma_a^2 = -k^2 + \gamma_{oa}^2 + 2k\gamma_{oa} i = iw\mu\sigma_1 - w\mu\sigma_2 - \mu\varepsilon_1 w^2 - i\mu\varepsilon_2 w^2$$

Since the wave number k is given by

$$k = \frac{w}{v} = w\sqrt{\mu\varepsilon_1} \tag{85}$$

Then the two terms cancel out on both sides. Equating real and imaginary parts give

$$\gamma_{oa}^2 = -w\mu\sigma_2 \qquad\qquad \gamma_{oa} = \sqrt{-w\mu\sigma_2} \tag{86}$$

$$2k\gamma_{oa} = w\mu\sigma_1 - \mu\varepsilon_2 w^2$$

$$\gamma_{oa} = \frac{w\mu\sigma_1 - \mu\varepsilon_2 w^2}{2k} \tag{87}$$

For elements like Ag and Cu with $\tau \sim 10^{-14}$ at 273 K [26]

$$m \sim 10^{-30} \qquad w \sim 10^{15} \qquad \gamma \sim \frac{m}{\tau} \sim 10^{-30} \times 10^{+14} \sim 10^{-16}$$

$$mw \sim 10^{-15} \tag{88}$$

Therefore

$$mw > \gamma \tag{89}$$

Thus equations (14) and (89) gives

$$\sigma_1 = \frac{n\,e\,q\,\gamma}{m^2\,w^2} \tag{90}$$

$$\sigma_2 = \frac{-m\,w\,e\,q}{m^2\,w^2} = -\frac{n\,e\,q}{m\,w} \tag{91}$$

Inserting eqn (91) in (86) gives

$$\gamma_{oa} = \sqrt{\frac{n\,e\,q\,\mu}{m}} \tag{92}$$

Inserting also eqn (90) in (87)

$$\gamma_{oa} = \frac{\left(\frac{n\,e\,q\,\gamma\,\mu\,w}{m^2\,w^2}\right) - \mu\,\varepsilon_2\,w^2}{2k} \tag{93}$$

When the internal local polarized field is in the same direction and in phase with the external field

$$\varepsilon = \varepsilon_1 \qquad\qquad \varepsilon_2 = o \tag{94}$$

$$\gamma_{oa} = \frac{n\,e\,q\,\gamma\,\mu}{2m^2kw} \tag{95}$$

The term in equation (92) can be made similar to that of eqn (95) by

$$\mu\varepsilon = \frac{1}{v^2} = \frac{k^2}{w^2} \tag{96}$$

Thus inserting equation (96) in (92) gives

$$\gamma_{oa} = \sqrt{\frac{n\,e\,q\,\mu\,\varepsilon}{m\,\varepsilon}} = \sqrt{\frac{n\,e\,q}{m\,\varepsilon\,v^2}} = \sqrt{\frac{n\,e\,q\,k^2}{m\,\varepsilon\,w^2}} = \frac{k}{w}\sqrt{\frac{n\,e\,q}{m\,\varepsilon}} \tag{97}$$

Therefore equations (97) and (83) inserted in (2) gives

$$E = Eoe^{-\frac{k}{w}\sqrt{\frac{neq}{m\varepsilon}}Z}\, e^{i(wt-kZ)} \tag{98}$$

Equation (98) represent a travelling wave attenuated with distance Z. the attenuation rate increases upon decreasing the frequency. This means that the medium resistance to the wave increases when the frequency decreases.

Therefore, the medium, which is doped with electric polarized atoms or molecules, with low mechanical resistance act as a capacitor for electric circuits, where the capacitor resistance $\left(xc = \frac{1}{wc}\right)$ increases when the frequency decreases.

However for elements like Bi with $\tau\sim10^{-16}$ [26], the friction coefficient takes the form

$$\gamma\sim\frac{m}{\tau}\sim10^{-30}\times10^{16}\sim10^{-14} \tag{99}$$

Thus

$$\gamma\ >mw \tag{100}$$

This since ($m\,w\sim10^{-15}$), in the case of copper the relaxation time [1] is of the order $\tau\sim10^{-19}$. Thus

$$\gamma\sim\frac{m}{\tau}\sim10^{-30}\times10^{19}\sim10^{-11}$$

The frictional term is thus much larger than the term mw, i .e

$$\gamma\gg mw \tag{101}$$

Thus equation (14) gives

$$\sigma_1=\frac{neq}{\gamma}\qquad\qquad\sigma_2=-\frac{meqmw}{\gamma^2} \tag{102}$$

In view of equation (86) the insertion of the imaginary conductivity gives

$$\gamma_{oa}=\frac{w}{\gamma}\sqrt{neqm\mu} \tag{103}$$

For real dielectric constant when the internal and external fields are in phase

$$\varepsilon_1=\varepsilon\qquad\qquad\varepsilon_2=o \tag{104}$$

Thus inserting the real conductivity in eqn (102), together with (104) in (87) gives

$$\gamma_{oa}=\frac{w}{\gamma}\ \frac{neq\mu}{2k} \tag{105}$$

Thus inserting eqns (105) and (83) in eqn (2) gives

$$E=E_oe^{-\frac{w}{\gamma}\frac{neq\mu}{2k}Z}e^{i(wt-kZ)} \tag{106}$$

This equation represent a travelling wave facing resistance proportional to the frequency. Thus this chip, doped with materials that polarize themselves in the direction of the external electric field, acts as an inductor.

The chip can acts as a resistor, when using equations (37), (38) and (39). When the internal field B is adjusted by doping the chip with magnetic material such that [see (38)]

$$\gamma=\gamma_o-Be=o \tag{107}$$

i.e

$$B=\frac{\gamma_o}{e} \tag{108}$$

When also electric dipoles that generate internal field are present

$$\propto=o \tag{109}$$

Neglecting also thermal agitation when one cool the thin film or dope it with very strong bond which prevents electrons and atoms vibrations. In this case

$$wo\approx o \tag{110}$$

Thus equation (37) gives

$$\beta = m\,w^2 \tag{111}$$

In view of equation (39) one gets

$$v = -\frac{iwe}{mw^2}E = -\frac{ie}{mw}E \tag{112}$$

Using the formal definition of the current density

$$\text{J}= nev = -\frac{ine^2}{mw}E = (\sigma_1 + i\sigma_2)E \tag{113}$$

Thus, the real and imaginary conductivities are given by

$$\sigma_1 = o \qquad\qquad \sigma_2 = -\frac{ne^2}{mw} \tag{114}$$

Using equation (86) yields

$$\gamma_{oa} = \sqrt{\frac{ne^2\mu}{m}} = e\sqrt{\frac{n\mu}{m}} \tag{115}$$

This equation represents an attenuated travelling wave with attenuation and resistance proportional to the concentration of the doped material n. This indicates that the chip acts here as an ordinary resistor.

DISCUSSION

The magnetic and electrical properties of the materials or the impurities added to the host substrate determine completely and affect the laser propagation inside electronic laser chips. Section (2) shows that for a medium which has only mechanical resistance, such that the atoms are in the form of dielectrics equations (10), (12), (14) and (15) beside equation (29) show that such dielectric material enables laser waves to travel without any attenuation. Thus this material act as a conducting wire which connect electronic components with each other.

The dream of scientists to use laser instead of electrons in integrated circuits and electronic chips can be realized if certain conditions are satisfied.

According to equation (5) the attenuation coefficient reflects the resistance of the medium to the laser or electromagnetic radiation. Large attenuation coefficient reflects high resistance, while low coefficients reflects low resistance. This means that also when the attenuation coefficient is directly proportional to the frequency the medium acts as an inductor, which has resistance$(X_L = WL)$. Nevertheless, when the attenuation coefficient is inversely proportional to the frequency the medium acts as a capacitor, which has resistance$(X_c = 1/(wc))$.

The dependence of the attenuation coefficient on the frequency is through the conductivity σ as shown by equations (5) and (14). The interaction of the medium with EMW manifests itself through the electron equation of motion (31), beside equations (37) and (38). This interaction manifests itself through conductivity as shown by eqns (43) and (44). The properties of the medium that affect the attenuation coefficient through the conductivity σ are the local magnetic field B beside the local electric field $\propto q\,n$ in an edition to the natural vibration frequency WO and friction coefficient γ. Equations (58 – 70) shows that when the laser frequency is equal to the natural medium frequency, and in the absence of a local electric field, by adjusting the magnetic internal field to can cell out (see (64)) and to be just less than the friction force, in this case the attenuation coefficient is directly proportional to the frequency. Thus, the medium act as an inductor in this situation (see eqn (70)). However, when the magnetic force exactly can cell out friction force as shown by eqn (71), with laser frequency equal to the natural frequency, for very low doping with dielectric or electric dipoles that having very weak local field, the medium acts again as an inductor as shown by eqn (80).

Another approach can be tried by assuming the laser as a travelling wave with attenuation coefficient γ_{oa} as shown by eqn (83).

When one has elements like Ag and cu with relaxation time $t{\sim}10^{-13}$ or more the attenuation coefficient is inversely proportional to the frequency (see (97)). The medium thus acts as a capacitor.

However, for elements like Bi with $t{\sim}10^{-16}$ or less (see eqn (99)), the medium doped with Bi acts as an inductor as shown by eqns (105, 106).

The chip acts also as a resistor for nonelectric, non-oscillating atoms medium having internal field force exactly cancelling the frictional force (see eqns (107 – 116).

CONCLUSION

Using Maxwell's equations and the electron and dipole equation of motion it was shown that chips fabricated from some materials act as conductor or capacitor or resistor. For laser or light frequency nearly equal to the natural frequency, such that the local magnetic force just cancels the frictional force, in this case the material act as an inductor. The chip acts as a capacitor for nonmagnetic material with negligible natural frequency and high mobility electric dipole, which align itself in the external electric field completely. The chip also acts as a resistor for non-dielectric, nonmagnetic material with negligible natural frequency when its relaxation time exceeds 10^{-14} second.

Acknowledgments

The authors would like to acknowledge the financial support of Taif University Researchers Supporting Project number (TURSP-2020/189), Taif University, Taif, Saudi Arabia

Authors Note. All authors contributed equally to this work
Conflicts of Interest. The authors declare no conflicts of interest regarding the publication of this paper.
Funding. The funding support of this paper is from the authors of this paper themselves.

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ЕЛЕКТРОННІ ЧІПИ, ЩО ДІЮТЬ ЯК КОНДЕНСАТОРИ АБО ИНДУКТОРИ, КОЛИ ЛАЗЕР ДІЄ ЯК ПЕРЕДАВАЧ ІНФОРМАЦІЇ

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Для збільшення швидкості потоку інформації і ємності пам’яті в електронних пристроях для перенесення інформації замість електричного струму можна використовувати лазер. Оскільки фотон швидший за електрони, очікується, що інформація буде передаватися дуже швидко через Інтернет, коли фотони замінять електрони. Це вимагає пошуку мікросхем, які діють як конденсатори, індуктори або резистори. Для цього було використано рівняння Максвелла для напруженості електричного поля поряд з електронним рівнянням руху. Вважається, що електрон вібрує природним чином всередині середовища з тертям в присутності локального електричного та магнітного полів. Ці рівняння були використані для пошуку корисного виразу для коефіцієнта поглинання. Було виявлено, що коефіцієнт поглинання залежить від частоти лазера та власних поряд з коефіцієнтом тертя на додаток до внутрішніх електричних та магнітних полів. Ці параметри можна точно налаштувати, щоб мікросхема діяла як конденсатор, індуктивність або резистор. Інтенсивність лазера зменшується при збільшенні коефіцієнта поглинання. Таким чином, коефіцієнт поглинання діє як електричний резистор. Отже, якщо коефіцієнт поглинання збільшується при зменшенні частоти, мікросхема діє як конденсатор. Але коли коефіцієнт поглинання збільшується при підвищенні частоти лазера, мікросхема діє як індуктор. У випадку, коли коефіцієнт поглинання зростає з концентрацією носіїв, він виступає в цій ситуації як резистор. Для магнітних матеріалів із щільністю магнітного потоку, яка скасовує силу тертя, коли частота лазера дорівнює майже власній частоті атома, матеріал діє як індуктор. Але коли сила тертя низька з внутрішнім і зовнішнім електричними полями в фазі, матеріал діє як конденсатор. Однак він діє як резистор для незначної власної частоти, коли не існує електричних диполів і коли сила внутрішнього магнітного поля врівноважує силу тертя.

Ключові слова: лазер, мікросхема, конденсатор, індуктор, резистор