حساب دالة التضمين لمغير التردد البصري الجزئي شبه الموصل

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الخلاصة

يتضمن البحث دراسة وحساب دالة التضمين لمغير التردد البصري الجزئي شبه الموصل(السيلكون) والتردد المكاني لقيم مختلفة من النسبة المئوية للنفاذية (58%و45%و35%و10%)،وجد أن علاقة دالة التضمين للسيلكون مع التردد المكاني هي علاقة أسية لجميع قيم النفاذية، وأفضل حالة لدالة التضمين عندما تكون النفاذية قيمتها T=58%.كذلك تضمن البحث دراسة علاقة النفاذية مع قيم مختلفة لمعامل الانكسار للسيلكون. تضمن البحث أيضا بناء برنامج حاسوبي للبيانات المستخرجة الخاصة بالتضمين البصري للمادة شبه الموصلة كما موضح في الشكل 1 .

Modulation Function Calculation For Optical Semiconductor Fractal Modulator

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Abstract

The research includes the study and calculation of the modulation function of Optical Semiconductor Fractal Modulator and spatial frequency for different values of Silicon modulator transmittance percentage(10%,35%,45%,58%),it found the relation between the modulation function of Silicon and spatial frequency, the exponential relation of all values of the transmittance , the best state of modulation function when the value of transmittance is T=58% ,also the research includes the study of the relation of transmittance with different values of refractive index of Silicon . So the research involves building a computer program of output data which would relate to fractal optical modulation made of semiconductor material as shown in Fig. (1).

Introduction

Optical modulator is used to generate opto-electronic signal, which depends on the modulator shape and rotation speed. In addition, it may be used (the modulator) as a filter of light for specific wavelength depending on the values of refractive index of the modulator material.

In this paper fractal, function was used to design update Fractal Optical Modulator made of semiconductor material such as [Germanium, Silicon…] .In present article a silicon was used as a material of the Fractal modulator for different values of transmittance percentage

Fractal Function

Euclidean geometry provides a first approximation to the structure of physical object. It describes objects of simple shapes point , line segments , ellipses , circles, boxes and cubes , they have a few characteristic sizes with dimensions of one , two and three .This geometry is mainly oriented a round liner integral system .Benoit Mondebort 2 mainly suggested the existence of geometries near to the geometry of nature ,known as fractal geometry [1,2].

The word fractal is referred to infinitely complex; in mathematics a fractal is a geometric object that satisfies a specific technical condition.

An alternative way to specify the dimension of self-similar pieces with magnification factor N into which the figure may be broken. Therefore, the dimensions of the sierpinski triangle need logarithms to find the exponent in this case in general [3].

$$N = \frac{L}{K} \ldots\ldots\ldots\ldots\ldots(1)$$ Where

N: number segment

L: length of segment

K: length of each piece in the segment

$$N = \left(\frac{L}{K}\right)^{D'} \ldots\ldots\ldots\ldots\ldots\ldots(2).$$ Where D' is fractal dimension

By taking logarithm for eq. (2)

$$LogN = Log\left(\frac{L}{K}\right)^{D'}.$$

$$LogN = D'Log\left(\frac{L}{K}\right).$$

$D' = [Log\,N / Log\,(L/K)]$ ……….. (3). [3]

Fractal Optical Modulator Design

Designing the optical modulator from semiconductor material by using fractal function is done during building a computer program , which consists of ten oblique sectors and ten transmittance sectors for light, each sector is divided by using fractal function to small elements of triangle shape and spread it randomly as shown in Fig.(1).

The area of each element (triangles) is calculated substrate from the total area of disc (size of modulator), to evaluate the total area of transparent by using mathematics:

$(h^2) + (a^2) = (1)^2$ .... (4). [4]

Suppose we have similar triangle which has equal side (a) =1mm

Therefor $h^2 + (0.5)^2 = (1)^2$

$\therefore \quad h = 0.866mm$

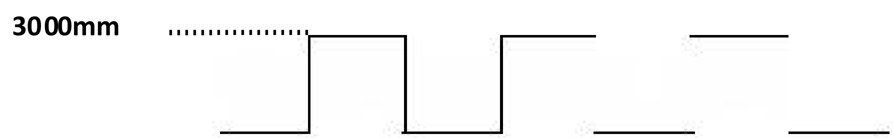
The area of triangle = (1/2) ah = (0.5)0.866 = 0.433mm^2

The summation of the total triangles area=46.76mm^2, but the total area of the disc (modulator) = $\pi r^2 = 3.14(30)^2 = 2826mm^2$

$\therefore$The total area of transparent =2779.24 mm^2

If we assume an incident, beam is perpendicular on the modulator disc and its shape is circular. By rotating the disc, the incident signal will be transmitted from the clear area while it is not transmitted from the oblique area. Therefor the output signal at maximum values (at arbitrary R_{max} = 3000mm will be maximum amplitude as shown below :-[4]

mm



But when the output signal is not minimum values of R_{min} =300mm there will be minimum width as shown below:-

That means the output signal will be equal to unit (1) when the incident beam transmitted from transparency part , while it is equal (0) when the beam would be on oblique part of disc . By continuing the rotation of the disc we will get a continuous signal with a frequency, that frequency depends on the number and shape of the sector as well as the speed of the disc rotation

Modulation Evaluation

In order to evaluate the modulation for stander ordinary modulator we supposed as following:-Refractive index of the modulation material =one (it means air refractive index) [4], which gave transmittance percentage 100%. N sequence number, R is radius of the modulator and S is spatial frequency (as shown in data tables 1, 2, 3 & 4), and by using the following relation :-[5]

$$M_i = (I_i max - I_i min) / (I_i max + I_i min) \quad \ldots\ldots\ldots\ldots(5)$$

Where: - Mi: Modulation of image.

$I_i max$: maximum Irradiance of the image.

$I_i min$: minimum Irradiance of the image.

Silicon (Si) Modulator

Silicon is used as an optical widow primarily for 3-5µm band as a substrate for optical filters. It has been used an optical fractal modulator made of silicon, which has the characteristic of refractive index with transmittance as shown in Fig. (2)

Calculations and Results

Four cases of silicon were taken with different transmittance (10%,35%,45% and 58%) , each case has the data displayed in a table and the output result shown by MF curve in Figs (3,4,5,6).

<u>CASE (1)</u> refractive index n=3.4975 with wavelength λ =1.357µm and the transmittance 10%, table (1) shows the data of (R, MF and S),the behave curve of MF results with spatial frequency shown in Fig(3)

<u>CASE (2)</u> refractive index n=3.4179 with wavelength λ =10.00 & 10.5µm and the transmittance 35%, table (2) shows the data of (R, MF and S) ,the behave curve of MF results with spatial frequency shown in Fig(4)

<u>CASE (3)</u> refractive index n=3.4975 with wavelength λ =3.432µm and the transmittance 45%, table (3) shows the data of (R, MF and S), the behave curve of MF results with spatial frequency shown in Fig (5)

<u>CASE (4)</u> refractive index n=3.4320 with wavelength λ =3.0000µm and the transmittance 58%, table (4) shows the data of (R, MF and S), the behave curve of MF resuls with spatial frequency shown in Fig. (6)

Conclusion

1- Using semiconductor material to make the modulator gives an advantage to get a specific output.
2- The best case of modulation by optical modulater made of Silicon (Si)when transmittance is T=58%
3- There is aclear relation between the intensity which increases by decreasing the spatial frequency for all cases.
4- It is very important that the optical fractal modulator, when it is designed from a specific material it will be special filter and frequency.

References

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3-Robert, E. Fisher and Biljana,T. Galeb, (2000), "Optical System Design ", The British Library Document Supply Centre.page36.

4-Peter, O, and Krister, F, (Optillion), (2000), "Optical Modulation Amplitude (OMA) Specifications", New Orleans , page 1.

5-Riedl, M.J., (2001),"Optical design Fundamentals for IR system" 2nd Edition, the society of photo-optical Instruments Engineers, p 155-163.

Table (1) Data of a clear aperture for silicon with transmittance 10%

S	1	2	3	4	5	6	7	8	9	10
R	300	600	900	1200	1500	1800	2100	2400	2700	3000
$Mx10^{-2}$	10	5	3.3333	2.5	2	1.6667	1.428	1.25	1.111	1

Table (2) Data of a clear aperture for silicon with transmittance 35%

S	1	2	3	4	5	6	7	8	9	10
R	300	600	900	1200	1500	1800	2100	2400	2700	3000
$Mx10^{-2}$	35	17.5	11.666	8.75	7	5.8333	5	4.375	3.88	3.5

Table (3) Data of a clear aperture for silicon with transmittance 45%

S	1	2	3	4	5	6	7	8	9	10
R	300	600	900	1200	1500	1800	2100	2400	2700	3000
$Mx10^{-2}$	45	22.5	15	11.25	9	7.5	6.428	5.625	5	4.4

Table (4) Data of a clear aperture for silicon with transmittance 58%

S	1	2	3	4	5	6	7	8	9	10
R	300	600	900	1200	1500	1800	2100	2400	2700	3000
$Mx10^{-2}$	58	29	19.333	14.5	11.6	9.6667	8.282	7.26	6.444	5.8

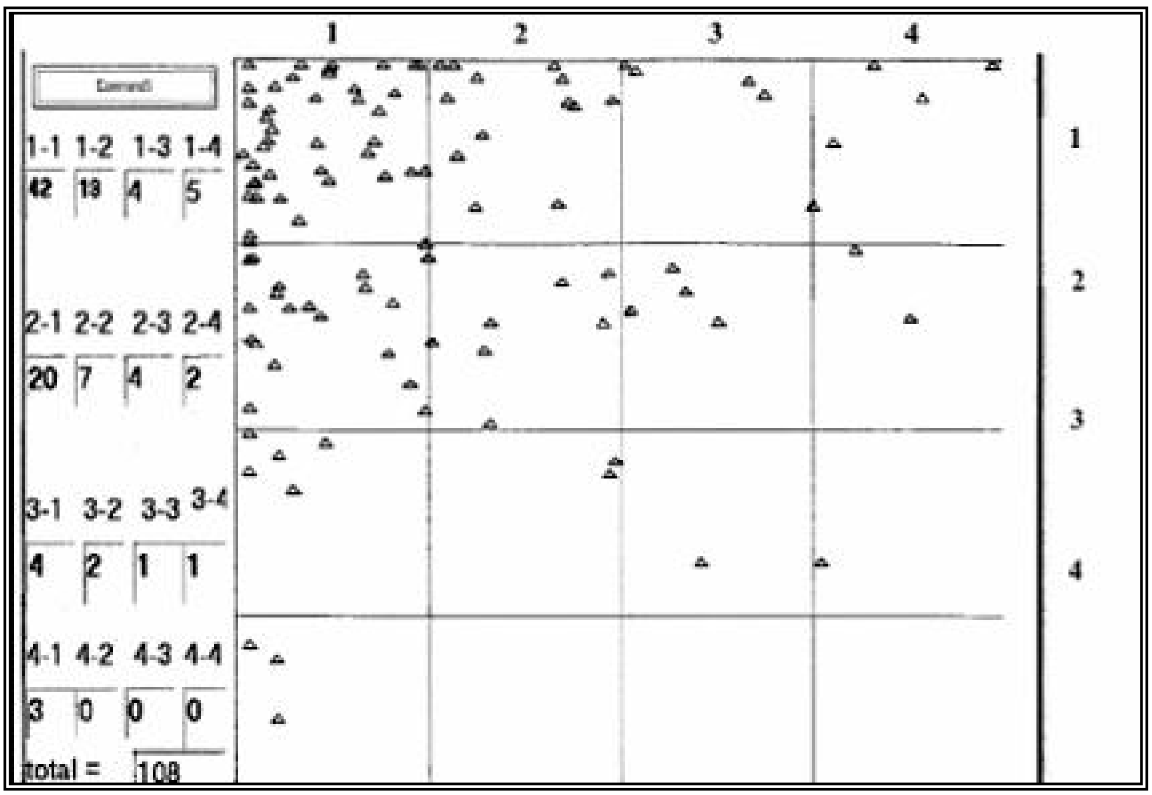

Fig.(1): The out put computer program of the Fractal optical modulation made of semiconductor material

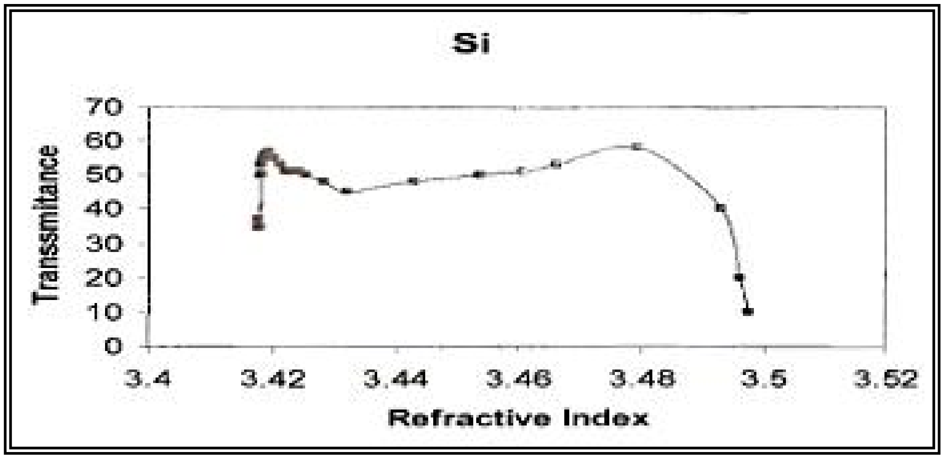

Fig. (2) The transmittance with refractive index for silicon

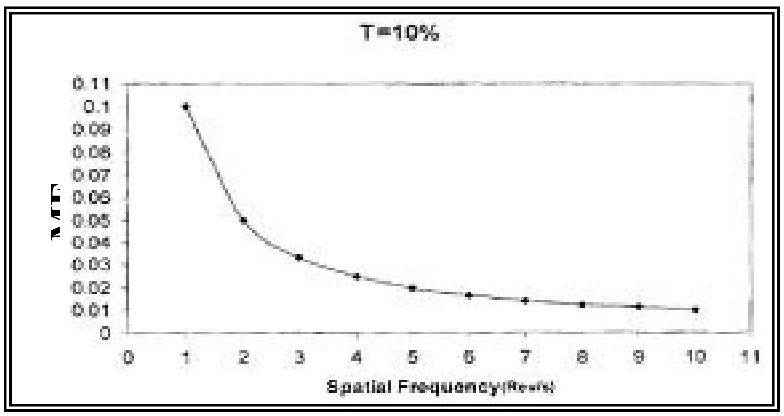

Fig. (3) The MF with the spatial frequency at transmittance 10%

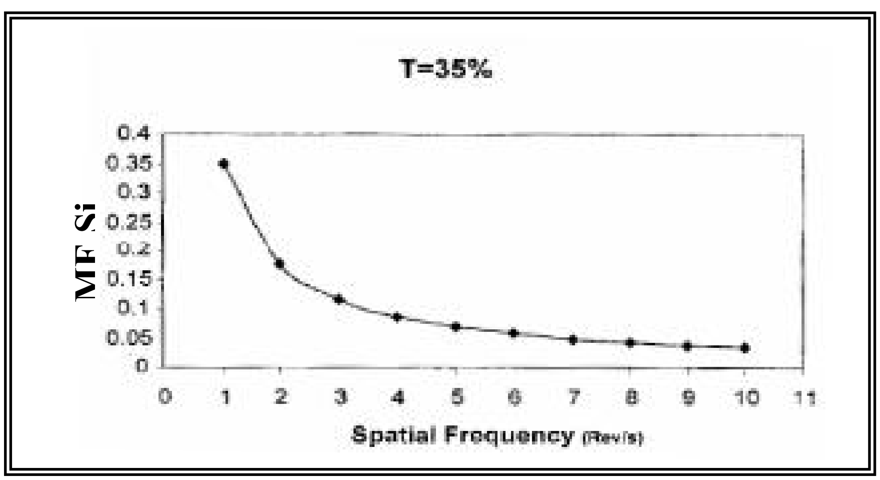

Fig. (4) The MF with the spatial frequency at transmittance 35%

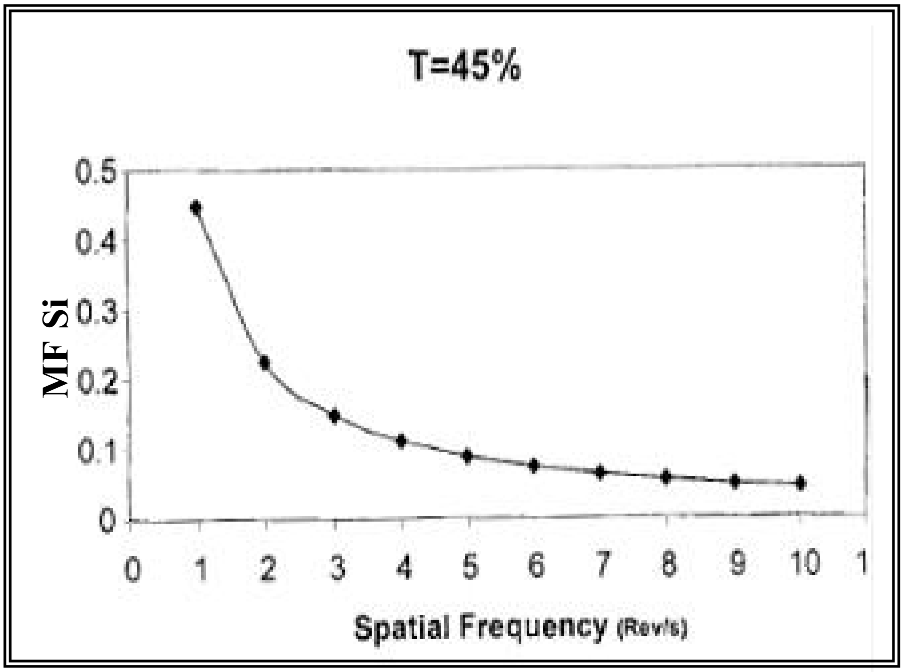

Fig. (5) The MF with the spatial frequency at transmittance 45%

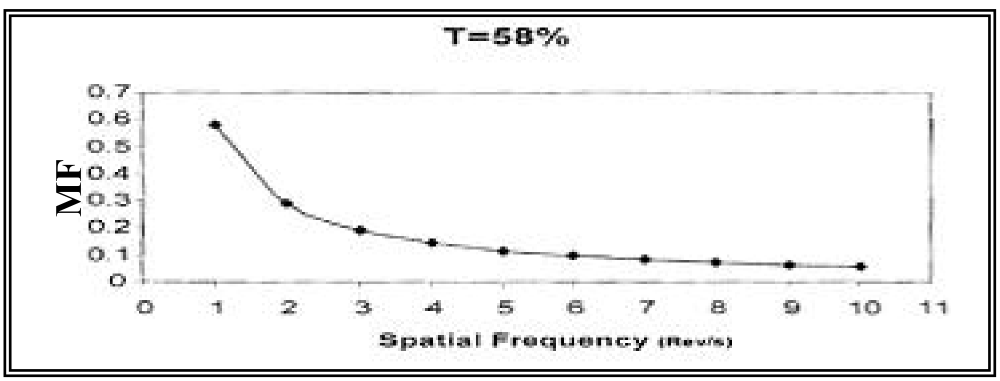

Fig. (6) The MF with the spatial frequency at transmittance 58%