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THEORETICAL STUDY OF HIGH REFLECTIVE OUTPUT COUPLER MIRROR

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ABSTRACT

In this research, a theoretical study to design high reflection mirrors which used as an output coupler for cw laser resonator have been established. The (open filter) program was used tostudy the reflectivity of multi-layers coating on (glass) substrate. From the results, the (maximum reflectivity was33%) for mirror with (five layers) form (InP+InGaAs).While the reflectivity become (93%) for mirror number of (InP+HfO2) with the same numberof layers. By use the MATLAB program, the reflectivity against the number of coating layers have been studied. Finally we can get the maximum reflectivity when the optical thickness of coating layers equal to quarter wave length".

INTRODUCTION

Theoretical concepts

When two or more light waves interact, they superimpose and form a resultant wave amplitude depends on the phase difference of the incoming waves. If the waves interfere constructively with a phase difference of the resultant wave has a maximum intensity. If the waves interfere destructively with a phase difference of , the resultant wave has a minimum intensity. Optical coatings manipulate this interference characteristic to control the reflected wave intensity an incident light reaches an air-film interface[1]. Some of reflecting waves back to the air and some of it transmission to the film. The transmitted part refracts in the film and reaches a film-substrate interface. Some of the other reflect back to the film and some of it transmits into the substrate. The two reflected waves which are generated at the film-air interface and the substrate-film interface interact and produce a resultant reflected light waves. The intensity of the net reflected light depends on the optical thickness of the film[2] these process are shown in figure (1) Optical thickness of a film is given by :-

$$(nd = \lambda/4) \qquad (1)$$

where (n) is the refractive index and(d) is the physical thickness of the film. If the optical thickness of the film is a quarter wave, the phase difference of the two reflected wave become out of phase and interfere destructively, then the net intensity of the reflected wave is at minimum[3] .

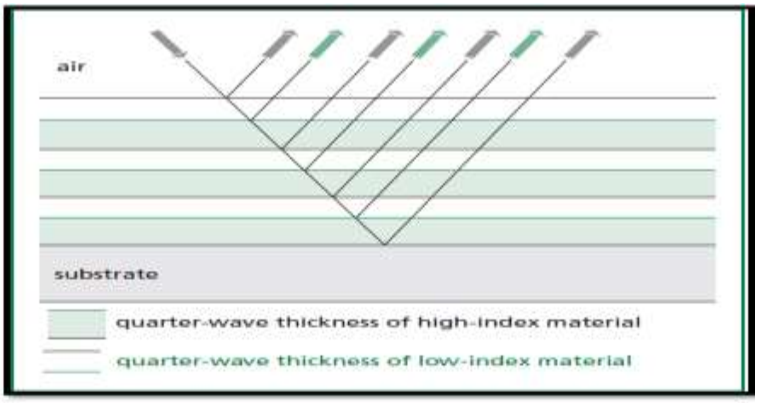

Figure (1) Aperiodic structure.

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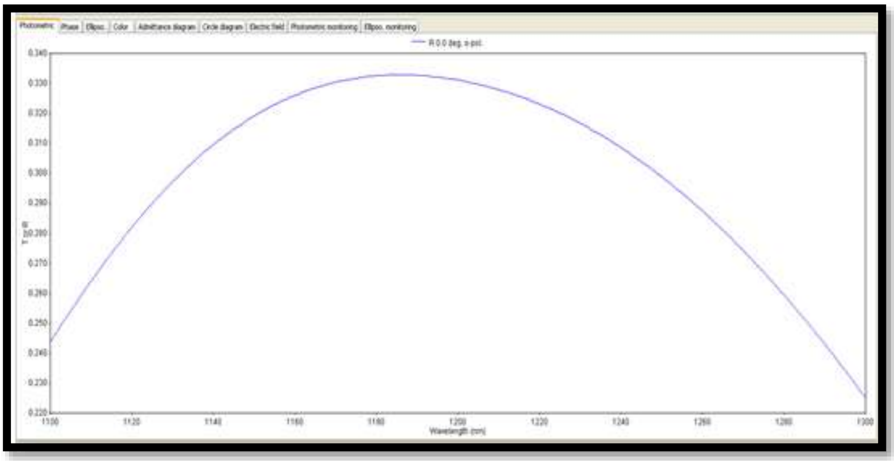
THE RESULTS AND DISCUSSION

The basic structure is a multi-layer stack of alternately high index and low index thin films, with thickness one-quarter at the design wave length. we used the two material (InP) and (InGaAs) as high and low index materials respectively deposited on glass substrate .Reflectivity when we calculated the reflectively as a function of wave length we obtain the figure(2.a)



Figure(2.a).shows the reflectivity characteristics of the multilayer stack with wave length

The arrangement of materials was**glass HL HLH**With H (InP) and L(InGaAs) layers being one quarter wave thick at 1200 nm .In figure (2. a) shows that reflectance is directly proportional with the wave length.In other word values of reflection decreasing with the wave length . From figure(2.b) we can see that the peaks represent the maximum value of reflectively correspond the wavelength value .

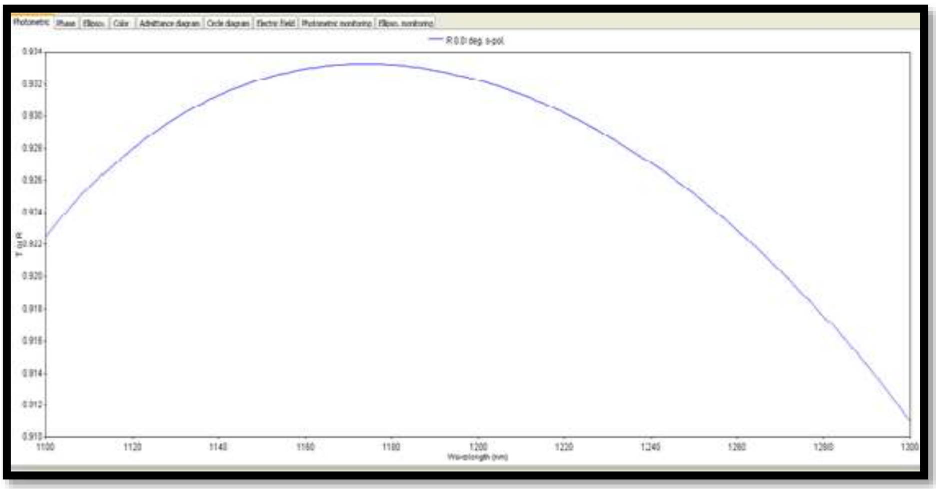


Figure (2.b)shows the reflectivity characteristics of the same multilayer stack with different wavelengths

Figure (2.b) Shows the reflectance characteristics of the multi –layer stack deposed
Glass HL HL H With the H(InP) and L (HfO2) layers being one quarter thick at 1200 nm **.**

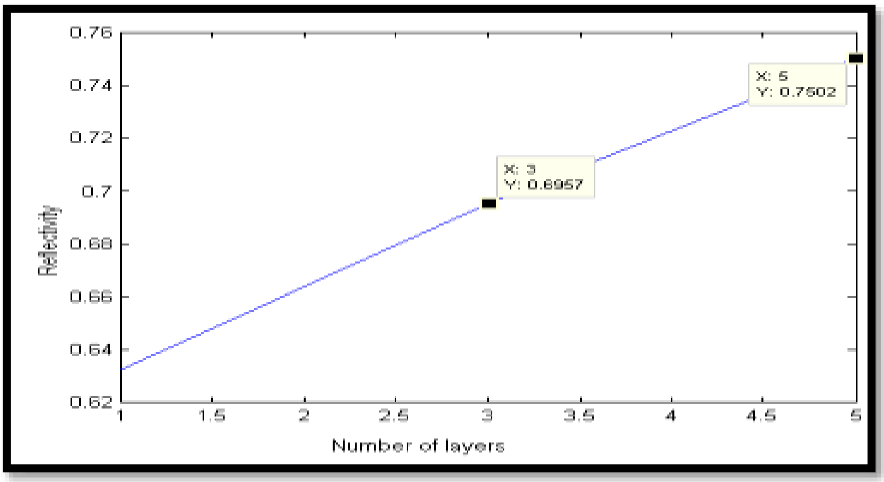


Figure (3) shows the number of layers for material (InP+InGaAs) proportional with reflectivity

From figure (3) and (4)we notice that the number of layers for materials (InP+HfO2) and (InP+InGaAs) proportional with reflectivity .In other Word the values of reflectivity increase with the number of layers as shown in this eq .

$$R = \left(\left(n_2^{(B+1)} - n_s n_1^{(B-1)}\right) / \left(n_2^{(B+1)} + n_s n_1^{(B-1)}\right)\right)^2 \qquad \dots\dots\dots (2)$$

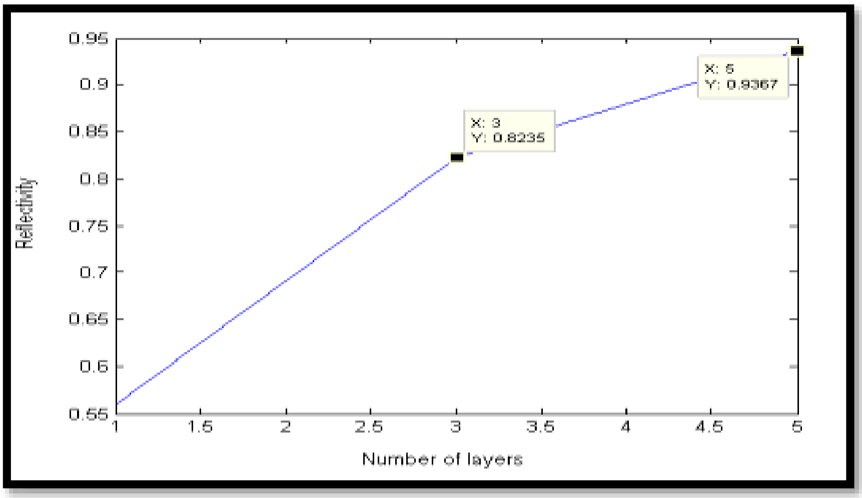


Figure (4) shows the number of layers for material (InP+HfO2) proportional with reflectivity

From the table(1), notice that the relation between the number of layers and the reflectivity for the materials that used for mirror (InP+InGaAs) and reflectivity for (InP+HfO2) .

Table (1)

InP+InGaAs	Inp+Hf02	Number of layer
69.57	82.35	3
75.02	93.67	5

From the table (1) show that the sample (InP+ HfO2)is prefer on the sample (InP+ InGaAs) because can get the required reflectivity with less number of coating layers. That is very important at the design and fabricate the laser mirrors The increasing of coating thickness(number of coating layers) exposed the films for the more stress and become more brittle from the films that have little thickness .

CONCLUSIONS

When we studied the effect of number of layer and the type of coating material on reflectivity we can conclude the following":

[1] The reflectivity increases with the incident of increasing wave length .

[2] Increasing the number of layers up to (5) notice that the reflectivity is sharply increases with the wave length for (InP+ InGaAs) increase and reaches to the maximum (33%) for wide range of wave length from (1100-1300)nm for the sample (Inp+HfO2),the reflectivity of five layers is (93.67) at the (1200nm) .

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