Fabrication reflection holographic grating

D.Khawla jemeal tahir
Kerbala university ,college of science,physics department

Abstract

In this work we fabrication a reflection holographic grating by using dichromated gelatin, To perform that we have to use the Nd-yaG laser doubling frequency of wavelenght (532)nm and its powers of (80)mWatt the diffraction grating of (3100)line/mm and diffraction efficiency of 74% have been obtained.we have studied the graduated effect in development processing and also, effect of a film thickness in the band width.

ألخلاصه

تم في هذا البحث تصنيع محزز حيود هولوكرافي عاكس بأستخدام دايكرومات الجلاتين وتم استخدام ليزر نديميوم –ياك مضاعف التردد بطول موجي532nm وقدره (80mWatt)وتم الحصول على محزز حيود بعدد خطوط line/mm (3100) وكفاءه حيود74% وتم دراسه اثر التدرج في عمليه الأنماء وكذلك اثر سمك الفلم على عرض الحزمه.

Introduction

Recentlly Dichromated gelatin is has been consider the best holographic material for (narrow band,reflection,holographic optical element use in an expanding range of other application) [1].Dichrom-ated gelatin has properties (simple to prepar and easy to control thickness of gelatin)[2].DCG recognized worldwide as an out standing recording material in deed,its properties are [3-6]

1-DCG can hold the uppermost refractive index modulation
2-Its absorption is neglible from the near U.Vto the I.R as far as 2.7 μm which enables its use over a very large spectral range.
When its properly processed,ther is no scattering-3
4-Its spatial resolution is dimensionally molecular DCG can store from a few hundred to several thousand lines per millimeter
5-Once gelatin is processed and properly scaled the properties of recorded grating are stable over tens of years and it has a excellent resistence to temperature changes
6-The recording process is holographic and its sensitivity is within the reach of common laser such as (argon)ions
7-Its mean reflective index is close to 1.5, so a common glass coating induces no interface reflection.
8-The raw materials are inexpensive and can be purchased in large quantities.
The holograms of interest to the designer of avionic head up displays are of the reflection type and depend upon refractive index variations within the volume of the holographic film.[7] we call them volume phase holograms. Unlike transmission holograms which are highly dispersive, reflection holograms will be non-dispersive provided their fringe planes run parallel to the surface of the material[8]. The reflection hologram grating can be made to reflect a narrow band of wave lengths very efficiently [9].

- A reflection hologram grating is made up of many layers of fluctuating refractive index in a thin film[10] such a hologram operates by Bragg diffraction and its reflectivity can be thought of the as the sum of the reflectance from each layer, which depend on the amplitude

of refractive index modulation the separation of the layers determines the wave length reflected at a particular angle, and the number of layers interacting with incident light[11].

Reflection hologram grating

During the recording a reflection hologram, the reference beam and the object beam illuminate the film plate on opposite sides. The resolution of film emulsion must be very high. The recording of a reflection holograms need 10 to 100 times as much power as for a transmission hologram. The result it that the exposure time will be long[12]. The interference fringes are formed by standing waves generated when two beams of coherent light travelling in opposite directions interact[13]. These gratings offer a number of advantages over other gratings including [14,15]:

1- Diffraction efficiencies approach 100%,.
2- The wave length of peak efficiency can be tuned by adjustment of the incidence angle.
3- Large grating sizes are feasibl.
4- High dispersion reflection grating with relatively low dependence on polarization angle.
5- Grating customization is relatively straightforward as each grating is an original rather than a replica of an expensively ruled master.

Method for producing reflection holograms grating

Film preparation

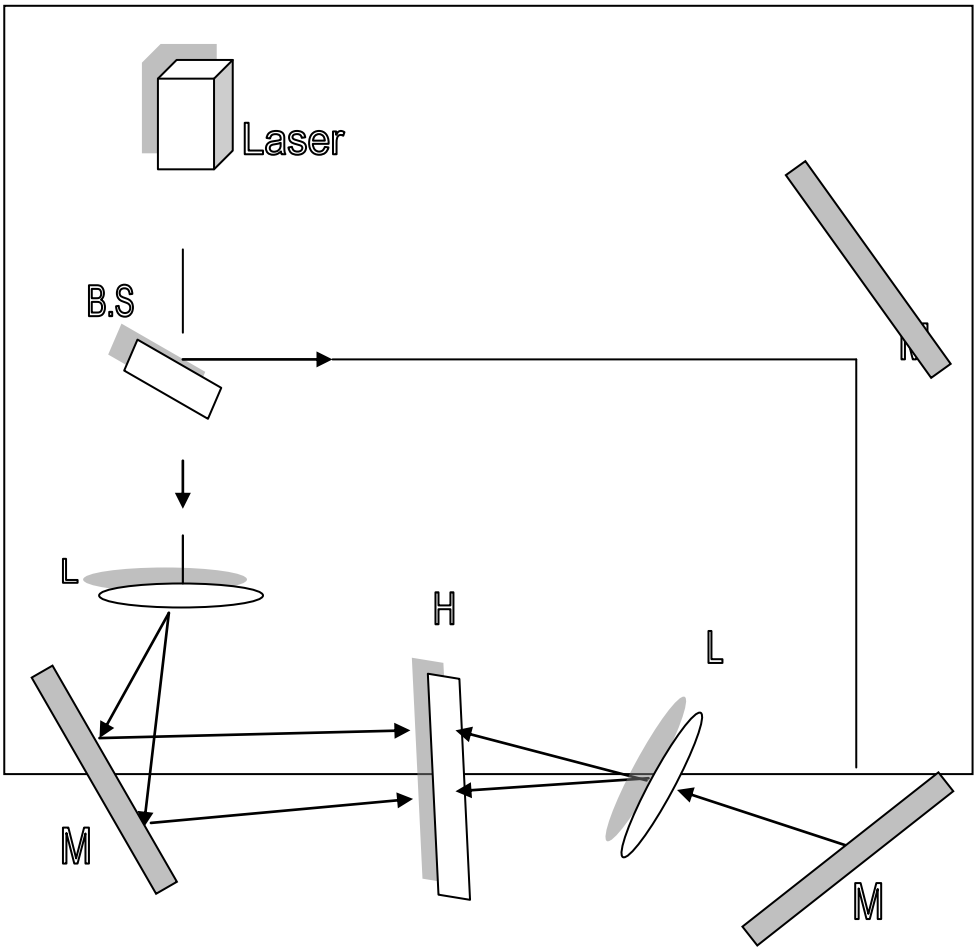
In this work we prepar film by adding 7%of gelatin to 10% formal dehyde solution at 45^0C . A measured quantity ,determined by the dry layer thickness required is poured on to a clean ,leveled glass plate in a dust free environment and allowed to dry for approximately 24 hours after that re processing another (multiple layers) became thickness of the film 40µm .

DCG plate preparation and processing

1. Soak the prepared gelatin film in a 6% ammonium dichromate solution at 20^0C (4mint).
2. Stand plates on edge upon an absorbent material to dry in the dark (15 hours)

Reflection grating fabrication

A thin film of sensitized gelatin is deposited on to a glass substrate and exposed in a holographic exposure system to record an inter ferometrically produced wave pattern of the desired fringe frequency and orientation . wet processing transforms the exposed fringes in to refractive index modulations within the gelatin .once during the recording a reflection hologram grating, the refrence beam and the object beam illuminate the film plate on opposite side as shown in figure(1)



Figure(1)recording Reflection grating fabrication

Using laser a green frequency-doubled Nd-YAG wave length(532 nm) and power (80mWatt) exposure time (2 mint)

Development

After recording the DCG processing is basically constituted of three steps.

First ,the dichromate is removed by wash in running water at(3 mint). Second, the gelatin is soaked in baths with increasing concentrate of isopropanol alcohol mixtures 20%, 50%, 80%, 100% and soak plate in each for(4 mint) .with agitation starting with pure water and ending with pure alcohol . finally the solvent is removed by heating the gelatin.

Result and discussion

The hologram formation mechanism in the dichromate gelatin is known to be a three step process .

First, an initial exposure records the interference pattern, which will reduce the cr^{+6}(yellowish)to cr^{+3} (reddish brown). This reaction will harden the complete layer and so reduce the refractive index modulation capacity of the gelatin (1-2)days . second, begin processing dehydration and complete dichromate gelatin film. Third, hologram formed by reconstructed after that resulting reflection hologram grating line frequency is around (3100 line/mm)and gelatin layer thickness is about (40µm) best result are obtained for recording at (80 mWatt) .

As could be seen from the above experimental the holographic reflection grating possess many outstanding features .

1- the effect of graduated processing of reflection efficiency .

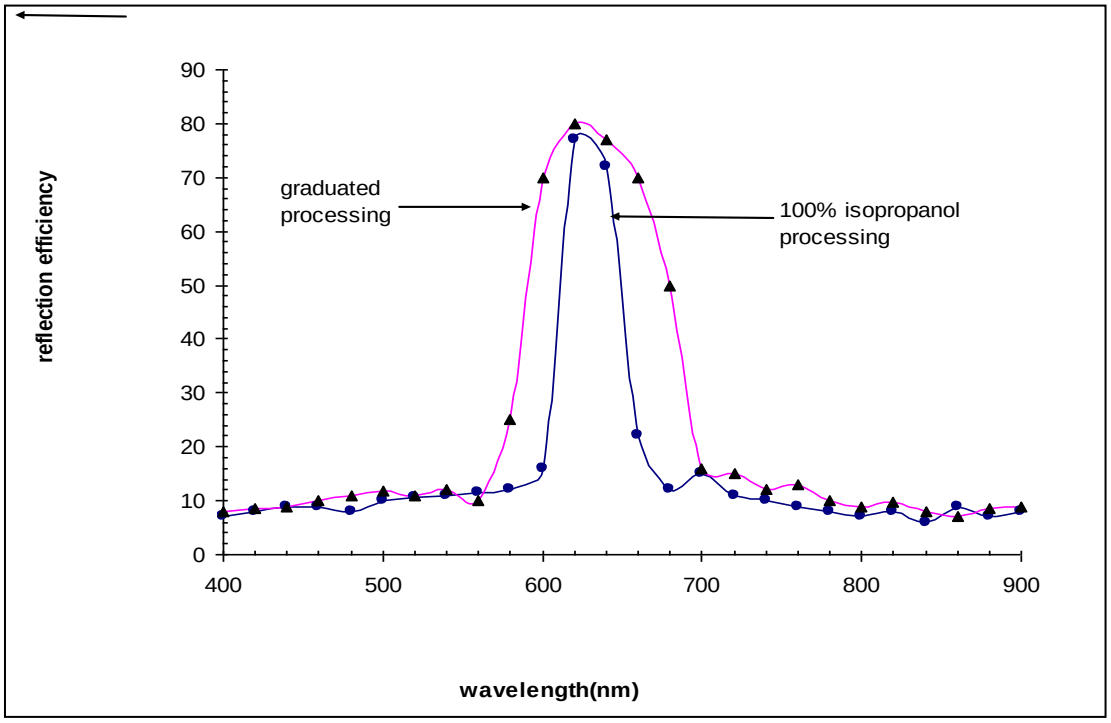


figure (2) the effect of graduated processing with reprocessing in 100% isopropanol of the reconstructin

The figure (2) showed that effect of graduated processing on band width . The graduated dry allows the water to gently escape from the gelatin layer this can be seen usually after the 50% stage by the gradual appearance of a uniform color a cross the hologram .
There appears to be better agreement between the final reconstruction wavelength and volume holographic models. Using 100% isopropanol , the dehydration occurs rapidly at the surface. The dehydrated surface layer traps water nearer the substrate which is unable to escape through the dry hardened surface layer . after several minutes a reconstruction color appears.

2- The relationship between bandwidth (Δλ) and media thickness (T)

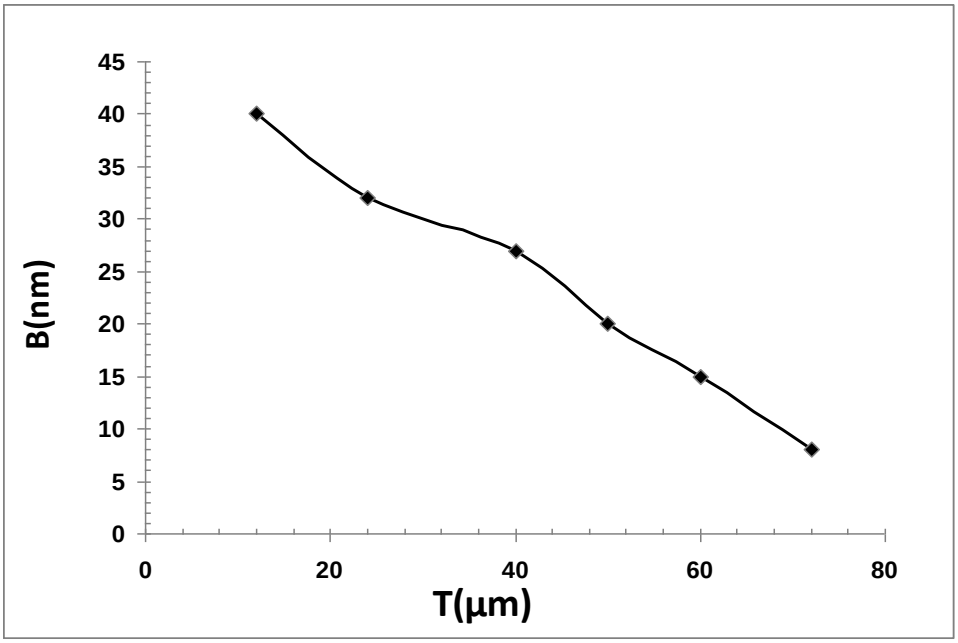


Figure (3) relationship between bandwidth and thickness

The curve in figure (3) showed that the bandwidth narrowed down with the increase of media thickness this is essentially in consistency with the formula

$$\Delta\lambda = c\frac{2nd^2 \sin\theta}{\pi T}$$

Which did not take into consideration the effect of absorption during construction this means that absorption by medium does not show an important in fluence on bandwidth during construction of reflection holographic grating .

In the present experiments , when the thickness of medium is (72 µm) ,the bandwidth at (532 nm) has reached (8nm) and the diffraction efficiency still reached 74%. These mean that the holographic grating can meet most of the requirements in many respects.

Conclusion

Dichromate gelatin is now established as the best material for current applications of high quality (HOEs) . Recent development work on thick films of (40µm) thickness in this paper the reflection holographic grating has been fabrication . Using Nd-YAG laser doubling frequency of wavelength (532 nm) and its powers of (80 mWatt) . After that the effect of graduated processing and relationship between bandwidth and thickness of medium.

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