Holograms preparation using commercial fluorescent benzyl

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Abstract We have been able to make holograms with substances such as fluorescence thought of light blue laser to make transmissions holograms, using ammonium dichromate as photosensitizer and polyvinyl alcohol (PVA) as matrix. Ammonium dichromate inhibit the fluorescence properties of inks, both mixed in a (PVA) matrix, but we avoid this chemical reaction and we show the results to use the method of painting hologram with fluorescents ink and we describe how the diffraction efficiency parameter changes as a function of the ink absorbed by the emulsion recorded with the gratings, we got good results, making holographic gratings with a blue light from laser diode 470 nm. And we later were painting with fluorescent ink, integrating fluorescence characteristics to the hologram.

1. Introduction
Fluorescence is a member of the ubiquitous luminescence family of processes in which susceptible molecules emit light from electronically excited states created by either a physical (for example, absorption of light), mechanical (friction), or chemical mechanism.

Generation of luminescence through excitation of a molecule by ultraviolet or visible light photons is a phenomenon termed photoluminescence, which is formally divided into two categories [1-4], fluorescence and phosphorescence, depending upon the electronic configuration of the excited state and the emission pathway. Fluorescence is the property of some atoms and molecules to absorb light at a particular wavelength and to subsequently emit light of longer wavelength after a brief interval, termed the fluorescence lifetime [3].

The fluorescence process is governed by three important events, all of which occur on timescales that are separated by several orders of magnitude [3, 4].

a) Excitation of a susceptible molecule by a photon happens in femtoseconds, while

b) Vibrational relaxation of excited state electrons to the lowest energy level is much slower and can be measured in picoseconds.

c) The final process, emission of a longer wavelength photon and return of the molecule to the ground state, occurs in the relatively long time period of nanoseconds.
Fluorescence is generally studied with highly conjugated polycyclic aromatic molecules that exist at any one of several energy levels in the ground state, each associated with a specific arrangement of electronic molecular orbitals. The electronic state of a molecule determines the distribution of negative charge and the overall molecular geometry [5].

The process of phosphorescence occurs in a manner similar to fluorescence, but with a much longer excited state lifetime [5, 6].

Fluorescence is important to make different kind of holograms, we find it in the ink of commercial text marker, but we consider benzoine as the main responsible of it in ink, therefore according with this supposition, when we put it in contact with a strong oxidant as dichromate solution, turn it to benzyl, according with equation shown in Figure 1.

![Figure 1](image)

But we evade this reaction, that is why we use the method of painting our matrix, in order to conserve the optic activity properties, we modify the crystalline molecular structure of a PVA matrix, but we also induce changing of oxidation number of chrome when it reacts with polyvinyl alcohol and chrome changes its oxidation number from +6 to +4 into the matrix, according with following chemical equation.

\[(\text{NH}_4)_2\text{Cr}_2\text{O}_7 + 2 \text{RHC}=\text{COH} \rightarrow 2 \text{RHC}=\text{O} + (\text{NH}_4)_2 \text{Cr}_2 \text{O}_5 + 2\text{H}_2\text{O}\]

It allows us to be able to make transmission holograms, as is described bellow.

2. Materials and methods
On the surface in the volume of holographic media we can have negative effects on the holographic register process [7]. These imperfections can produce noise or distortion of the beam to pass through the material. It is very important to ensure a high homogeneity of material both at the microscopic level.

There are two principal processes (in holography lab). One is by spinner (recreation from aqueous solution by centrifugation) and the other is the method of gravity.

By spinner method is based on centrifugal speed (revolutions per minute) that is provided with the instrument. Thus the solution will share on substrate (glass substrate) depending on the speed and therefore will be the final thickness obtained from the film, the film thickness depends on the holographic test and the type of hologram that you want to perform.

Method by gravity: basically we put the solution on the substrate, spread it evenly over it. However some problems that can occur in this method are that it must ensure meticulously the amount of the
solution on the glass, to get an homogeneous thickness. To evade this kind of errors, we place solution dropping and care to get a homogeneous film by this method. Here thicknesses will depend on the amount of solution that applies on the substrate and the type of hologram required record. One of the classifications of holograms is depending on their thickness and the angle between the two beams for holographic registers. Figure 2, [8,9].

![Optic arrangement used to make transmission holograms.](image)

The variation depends on the different concentrations of dichromate diffraction produce some changing in the efficiency parameters. With big concentrations of dichromate, the crystallization is stimulated largely in the emulsion film. But best results found 8% dichromate, i.e. the concentration 10:0.8

We prepare the matrix in the laboratory using an aqueous solution of PVA 10% and ammonium dichromate 8%, then by method of gravity; we share drops of solution on a two square inches glass.

We consider that fluorescent ink is mainly made with p-nitro benzyl which is fluorescent, but when and then we start periodically painting matrix with fluorescent ink, and we followed the diffraction efficiency

We have gotten good result to make transmission holograms, using the method by gravity, mainly with eosin ink because is more sensible to blue laser than text marker fluorescent ink. However in both cases we got excellent diffraction holograms, even when surrounding environment fluctuate continuously and difficult to make this process repetitive.
3. Results
Fluorescence is important to make different kind of holograms, for example we can used it to modify the crystalline molecular structure of a PVA matrix with fluorescent ink. There are many different kind of them in market but we are following the behavior study of the diffraction efficiency parameter from holographic gratings, with fluorescents inks such as eosin and benzyls.

We have been able to make holograms with substances such as fluorescence with blue light from laser to make transmissions holograms, using ammonium dichromate as photo-sensibilizer and polyvinyl alcohol (PVA) as matrix.

Ammonium dichromate inhibit the fluorescence properties of inks, mixed in a (PVA) matrix, but we show the results of painting hologram method with fluorescents inks and describe how the diffraction efficiency parameter changes as a function of the ink absorbed by the emulsion recorded with the gratings, we got good results, making holographic gratings with a blue light from laser diode at 470 nm. And we later were painting with fluorescent ink, integrating fluorescence characteristics to the hologram.

We also have focused our attention in finding the most favorable conditions to make this process repetitive, at different temperature and humidity of environment conditions.

4. Conclusion
Painting matrix with fluorescents ink, we modify diffraction efficiency parameters as a function of the quantity of ink absorbed by the emulsion film recorded, so, modifying the crystalline grids of PVA matrix, this method is good enough to prove it with other fluorescent inks, to make transmission holograms.

5. References
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