STUDY OF VOLUME PHASE HOLOGRAMS

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ABSTRACT

In this article we will employ two approaches , which can be employed widely for the manipulation and control of light. We will look at volume phase holographic (VPH)gratings and their application to direct light of a particular frequency in a desired direction as holographic solar concentrators. We will look at diffraction efficiency by varying concentration of polyvinyl alcohol with the concentrations 10gm, 16gm & 19gm keeping concentrations of other constituents constant (triethanolamine, arcrylamide, Bis-acrylamide and erythrosine-B).

I. INTRODUCTION

With the increasing energy demand there is an urgent need to shift to renewable sources of energy. Out of various renewable sources of energy, solar energy has been the most promising one. Our motivation was to increase the diffraction efficiency of volume phase holograms(VPH). The use of holograms in photovoltaic systems is due to its low cost and high efficiency. Holographic elements are able to disperse and to focus solar radiation at the same time. The hologram focuses light, spectrally splits it and diverts unwanted infrared heat away from the solar cell. It disperse white light or solar radiation into different spectral Bands, focused them onto spectrally matched solar cells.

Volume Phase Holograms

Volume phase hologram gratings diffract light by refractive index modulations within a thin layer of material.

• Diffraction is maximum when Bragg's condition is satisfied:

First condition: $(\delta\theta = 0)$

Second condition: Satisfy the grating equation,

$2\Lambda \sin\theta = \lambda$ (grating equation)

Where Λ , is the spacing of the hologram fringes.

Coupled Wave Theory:

Diffraction efficiency of VPH is given by:

$\eta = \sin^2\{(\xi^2+\nu^2)^{1/2}\}/(1+\xi^2/\nu^2)$

Where parameters ξ and ν defined by the relation

$\xi = (\delta\theta*2*pi*n*d \sin\theta)/\lambda$ and $\nu = (pi*n1*d)/\lambda * \cos\theta$

Where, n =average refractive index of the medium

λ = Wavelength of the incident light d =thickness of the emulsion

n1 =refractive index modulation θ =angle of incidence

$\delta\theta$ =angular deviation

The Bragg's condition is satisfied at $(\delta\theta = 0)$,the above formula reduces to the well known equation

$\eta = \sin^2\{\pi n1 d/\lambda \cos\theta)$

II. CONCLUSIONS

We synthesized Photopolymer, recorded VPH gratings for different concentration of polyvinyl alcohol for one of the most important application to optimize the diffraction efficiency of holographic solar concentrators . The model extends the Kogelnik theory for plane waves to include spherical waves. This has been validated experimentally on previously recorded grating and also on VPH gratings recorded during the course of the project.

III. FUTURE SCOPE OF THE TOPIC

The VPH gratings have only been analyzed for diffraction efficiency with different concentration of polyvinyl alcohol (PVA), keeping concentration of other constituents constant. There are many applications, we have not multiplexed holograms, angular sensitivity and wavelength sensitivity etc. It has tremendous potential in guiding and manipulating light and we believe there are in numerous applications which further work in this area will unfold.

IV. ADVANTAGES

By focusing different bands on spectrally matched photovoltaic cells we can increase the efficiency of the photovoltaic cells. Due to concentrating factor, absorbing area is reduced So it cuts the overall cost of the system.
We can design a hologram to diffract light in a desired direction.We don't require bulky and expensive tracking systems and By using technique of angular multiplexing we can concentrate solar radiation at different angles.

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