The Elimination Characteristics by Impressed Voltage of Holography Grating in Chacogenide Thin Film

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This paper discovers that there are some peculiar properties that can remove holography grating, which was made in chacogenide thin film by impressed voltage. The thin films were used are $As_{40}Ge_{10}Se_{15}S_{35}$, and we use He-Ne laser in order to form thin films. I-V curved line in a thin film before a lattice was made has the critical point, about 3.7 V. Moreover, the I-V curved line increased current intensity at over 4 V after it made thin film. In addition, while holography grating is being made, and when it has the highest diffraction efficiency, a lattice can be deleted if put more voltage into it.

Keywords : Holographic grating, Chalcogenide, Amorphous, I-V curve, Diffraction efficiency

1. INTRODUCTION

A holographic memory has received attention in recent years as a technology that can provide large storage density and high speed. Many applications of holography have been discussed and illustrated in the process of examining the different types of holograms, and the division between techniques and applications is not always clear.

Holographic diffraction gratings are currently widely used in various areas of science and engineering. Those based on both of the surface relief structure and refractive index modulation have potential applicability for displays, data storage, optical elements, and devices [1,2].

Holographic memories have held promise in the direction of high-density data storage. With the discovery of the photorefractive effect and its early realization of potential utility photorefractive materials are considerable of interest for the development of all optical, such as high density optical data storage and, image processing. Many different optical materials have been investigated in the field. Among these, amorphous As-Ge-Se-S is known to be a suitable material for optical recording. Because they have some unique advantages for the application of storage, such as large birefringence and dichroism, high spatial resolution. Its high resolution makes it suitable for high-density data recording and building nano-structures[3-6].

Chalcogenide Holographic memories have held promise in the direction of high-density data storage. With the discovery of the photorefractive effect and its early realization of potential utility photo-refractive materials are considerable of interest for the develop-ment of all optical, such as high-density optical data storage and image processing[7-8].

In addition, it has many problems when is used as a memory device because diffraction lattice can't be eliminated completely. Therefore this paper observes what the impressed voltage of lattice is after diffraction grating is established in As-Ge-Se-S amorphous chalcogenide thin film, which has excellent photoinduced anisotropy and safety. Moreover, we focus on how we can get rid of the record data by using electric changes of the feature.

2. EXPERIMENT

The amorphous As-Ge-Se-S systems exhibit good photorefractive effect useful for scalar hologram recording and especially the $As_{40}Ge_{10}Se_{15}S_{35}$ composition, selected in this work, shows the maximum change for reversible photo-structural transformation among $As_{40}Ge_{10}Se_{50-x}S_x$ (x = 0,25,35 at. %) thin films [9]. An $As_{40}Ge_{10}Se_{15}S_{35}$ bulk glass was fabricated by a conventional melt quenching technique. Films of amorphous As-Ge-Se-S were prepared by thermal evaporation of the bulk at a deposition rate of about 2 Å/s on ITO substrate. Film thickness was monitored to be approximately 2 μm of chalcogenide and 2000 Å of ITO films, respectively.

It is shown in Fig. 1 that is film structure. It is shown in Fig. 2 that is the schematic diagram of the experimental setup for grating formation, observing intensity of diffracted beam. A non-polarized He-Ne laser beam (h = 1.96 eV) was used as both recording beam and a probing beam. A He-Ne laser beam is split using beamsplitter. The two beams after reflection from mirror are allowed to interfere at the sample to form the holographic grating. The average intensity of the readout light (Io) was about 2.5 mW/cm^2 and incident angle was selected to be $\theta = 20$ °. The diffraction efficiency is define as η = Id/Io where Id is the intensity of the +1st order diffracted light (Id) from gratings in transmission mode was monitored as a function of time using an optical power-meter (Newport, 1815-C) with an electrical short pulse (4 V 1 cycle at 1 mSec).

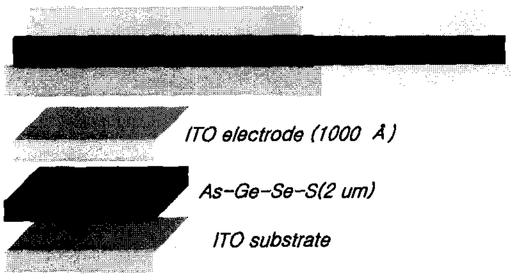

Fig. 1. Schematic view of multi-layer sample.

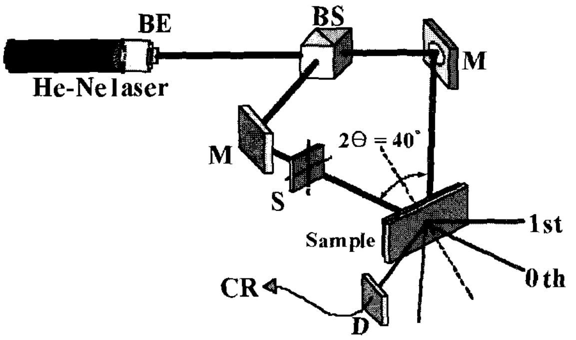

Fig. 2. Schematic diagram of the experimental setup in order to record the holographic gratings and observe diffraction efficiency: BE = beam expender, BS = beam splitter, M = mirror, S = shutter for probing, D = detector (optical powermeter), CR = chart recorder. The 0th and 1st present the orders of diffracted beams, respectively. An incident angle (θ) to record the holographic gratings and an average intensity of probing beam (I_o) to evaluate the diffraction efficiency (η) were 20 ° and about 2.5 mW/cm^2, respectively. The value of η is determined as a quantity I_d/I_o, where I_d is the intensity of 1st-order diffracted beam from grating.

3. RESULTS AND DISCUSSION

We have measured diffraction efficiency of chalcogenide thin film in incident beam He-Ne laser. Figure 3 shows that lattice forms in chalcogenide thin film and how diffraction efficiency changes in the course of time.

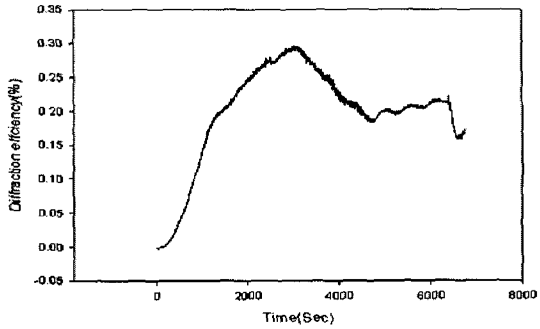

Fig. 3. Diffraction efficiency according to time in ITO/ $As_{40}Ge_{10}Se_{15}S_{35}$/ITO film.

As we see above, as soon as diffraction efficiency reaches the highest saturation point at about 2000 sec, it goes down. It implies that since atom's periodic disposition was developed by photoinduced phenomenon with forming lattice in amorphous thin film, the periodic disposition of atomic structure has been destroyed.

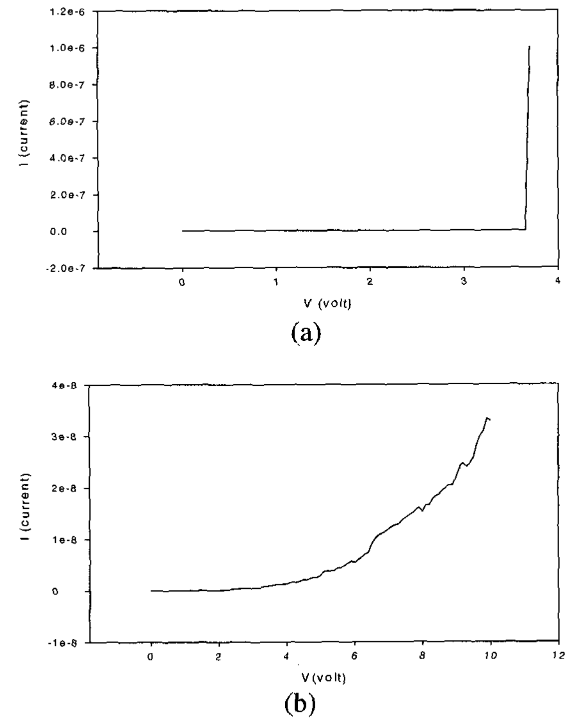

Fig. 4. I-V peculiar curved line has changed before (a) and after (b) holographic grating was made.

Figure 4 describes how I-V peculiar curved line has changed before (a) and after (b) grating was made. Before grating is formed, thin film possesses threshold voltage whose volt is about 3.7 V like Fig. 4(a). It reports that there has been no changes of electric current by voltage' impressed up to impressed voltage 0-3.7 V, which is called amorphous state, and after that if we put higher voltage into it, electric current is flowed by breakdown of film. Figure 4(b) indicates rise of electric current at about 4 V depending on impressed electromotive force. It is assumed that atomic non-periodic disposition, which is the characteristic of amorphous material, turns into the periodic one by forming lattice through optical irradiation in amorphous thin film, where atomic periodic structure is not settled. Therefore thin film is not destroyed at 3.7 V like Fig. 4(a). Even at higher voltage, similar I-V feature is shown without breaking out thin film. Figure 5 shows what has altered before and after voltage puts into chalcogenide.

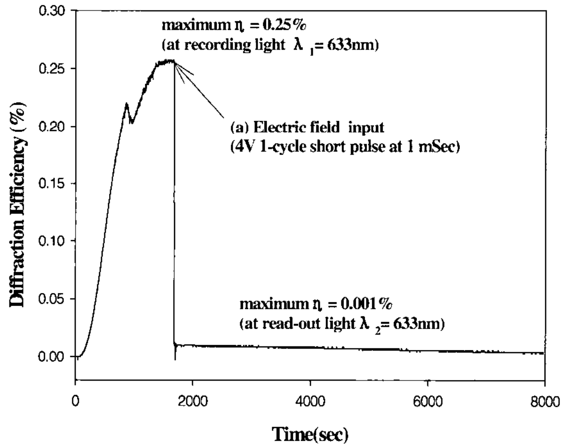

Fig. 5. Diffraction efficiencies of holographic gratings in $As_{40}Ge_{10}Se_{15}S_{35}$ (2-μm-thick) as functions of exposure time on the input of 4 V, 1 mSec short pulse(a).

To optimize the internal reflection and intensity variation within the depth of the recording medium, the holographic recording are performed in interaction between an optical wave (λ = 633 nm) and chalcogenide film thickness. The average penetration depth of recording light λ in the film depends on the value of the absorption coefficient (α) at this wavelength according to $d_p \approx 1.66$ μm. The chalcogenide $As_{40}Ge_{10}Se_{15}S_{35}$ films were prepared thicker in comparison with the penetration depth of recording light. In Fig. 5 are illuminated diffraction efficiencies vs. of exposure time in amorphous $As_{40}Ge_{10}Se_{15}S_{35}$ thin films. The diffraction efficiency (η) of the gratings for inducing light, shown in Fig. 5, reaches values within 0.25 % in the first transmitted diffraction order. That is, η increases relatively rapidly at the beginning of the recording process, reaches the maximum (η_{max}). Just after reaches the maximum (η_{max}), a short pulse (4 V 1 cycle at 1 mSec) was applied on the sample. A short pulse causes a remarkable decrease of η. For example, $\eta = 0.25\ \% \rightarrow \eta \ll 10^{-3}\ \%$. In this proceeding, we will present in details the electrical erasing effect of holographic data by electrical-bleaching in amorphous chacogenide films.

When the holographic recording is made at illumination and electrical fields two process, the direct optical transition and the electrical-bleaching, process. This leads to a shift of the equilibrium and establishment of a η value which depend on the electrical field after the recording. When it is plotted, with the illumination light and illumination time, more defects having configuration can gain more energy. The optical transition from the ground state to the metastable state is possible under the influence of light. Such a transition resulting in structural change is classified as scalar or vector effects of the inducing light and the electronic transition configurations. However, with applied electrical field, the defects occur to transition from the metastable state to ground state. Further detailed researches on the optimization of experimental conditions and re-writable recording are necessary to understand the mechanism of electrical-bleaching in chalcogenide films.

4. CONCLUSION

We observe how I-V curved line changes before and after it forms diffraction grating in chalcogenide thin film. It is measured that with I-V curved line which goes through forming grating, optical irradiation makes grating. It means that amorphous structure does not completely turn into crystalline structure, just it changes atomic periodic disposition more regularly. Erasure of diffraction efficiency in amorphous chal-cogenide thin film is achieved when investigating heat treatment and non polarization for a long time.

However, this way has a defect in that it is not perfect erasure, and it is hard to get rid of it absolutely. This can be a critical shortcoming. However, if we put more voltage, it can contribute to working out some matters, in particular getting rid of data.

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