

A Study on the Laser-Based Light Modulation System

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Abstract

Different techniques such as electro-optic, magneto-optic, acousto-optic methods have been utilized in the light modulation process. When they are compared each other, it is clear that each method has a different importance in the practical applications. In this work a study on the laser based light modulation technique has been concerned. For this purpose an opto-mechanical system has been designed and produced and at the end of the experimental study some typical results related to light modulation have been obtained.

Key words: Light Modulation, Modulator, Laser, Optics, Detector

1. Introduction

Some specific methods such as electro-optic, acousto-optic, magneto-optic modulation techniques have currently been used as light modulation methods. All of them are significant modulation methods and also each one has a different importance. Therefore each modulation technique is utilized properly for a specific purpose in practice. As known that light modulators are generally used for wideband analog optical communication systems, switching for digital information recording, information storage and processing, pulse shaping, beam deflection and scanning, and frequency stabilization and also switching of lasers [1]. For this purpose, different techniques related to electrooptic, acoustooptic, magneto optic and also mechanic systems are used specifically. Many studies [2] about electrooptic modulation have been done, particularly for this subject an electrically modulated silicon-on-insulator (SOI) submicrometer-size high-index-contrast waveguide has been studied, where the effect of the waveguide geometry on the device performance has been concerned. Meanwhile, it has been seen that an ultrashort pulse generation has been obtained by means of the electrooptic modulation method [3] and the modulation frequency has increased up to 40 GHz using a barium titanate thin film waveguide modulator [4]. Significant studies about magneto optic studies have been done, particularly for signal processing two-dimensional magneto optic spatial light modulator has been developed [5], switching and modulation of light in magneto optic waveguides have particularly been obtained [6]. Moreover, some specific studies about acoustooptic modulation [7-9] have been done, especially about this subject, Compact Mach-Zehnder acousto-optic modulator and Double-pass acousto-optic modulator system have been developed. In this work an opto-mechanical system has been produced, and also some typical results related to light modulation have been obtained.

2. Materials and Method

An opto-mechanical system based on the laser source was designed and produced in this work. He-Ne laser having $\lambda=675$ nm wavelength $P=1$ mW output power was chosen as a light source. As known that He-Ne lasers are in the Class of Atomic Lasers, the power output from

He-Ne lasers is quite low, generally it is around a few miliwatts, maximum power is up to 100 mW and also efficiency is also around 0.02%. But, nevertheless He-Ne laser source has some good properties, such as highly collimated, coherent, extremely narrow line width and also wide range of applications [1]. For the chopping process of incident laser beam a dc motor which has variable cycle, was used. A specific photodetector having visible range of electromagnetic spectrum given in Figure-1 were utilized for the light detection.

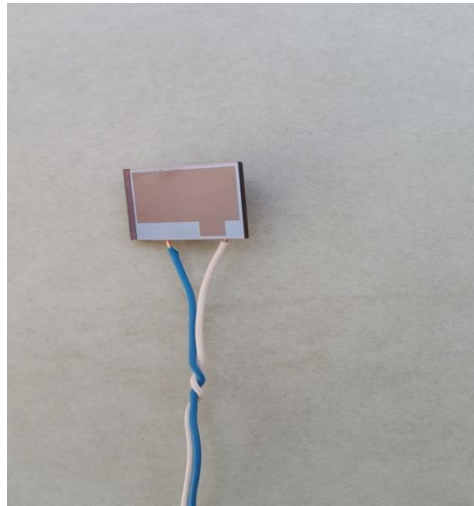


Figure-1. Illustrates the photodetector used for the experimental study.

For the output signals, an oscilloscope which has the model of ADS-3102 A was also utilized in the experimental setup. The schematic diagram of the experimental setup is given in Figure-2.

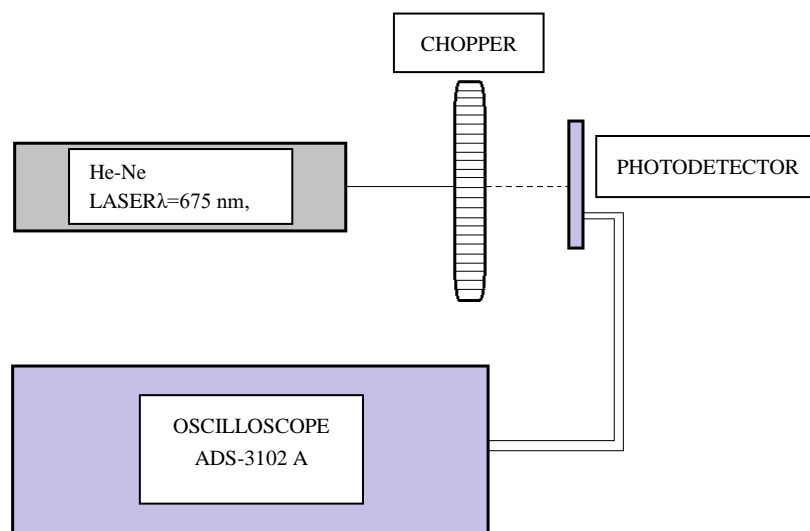


Figure-2. Illustrates the principle scheme of the experimental set up developed for the study of an opto-mechanical modulator.

The experimental arrangement seen in Figure-2 was used in this work, but using the piezoelectric crystal instead of chopper similar results can be obtained from another experimental set up. The figure of the piezoelectric crystal is seen in Figure-3.

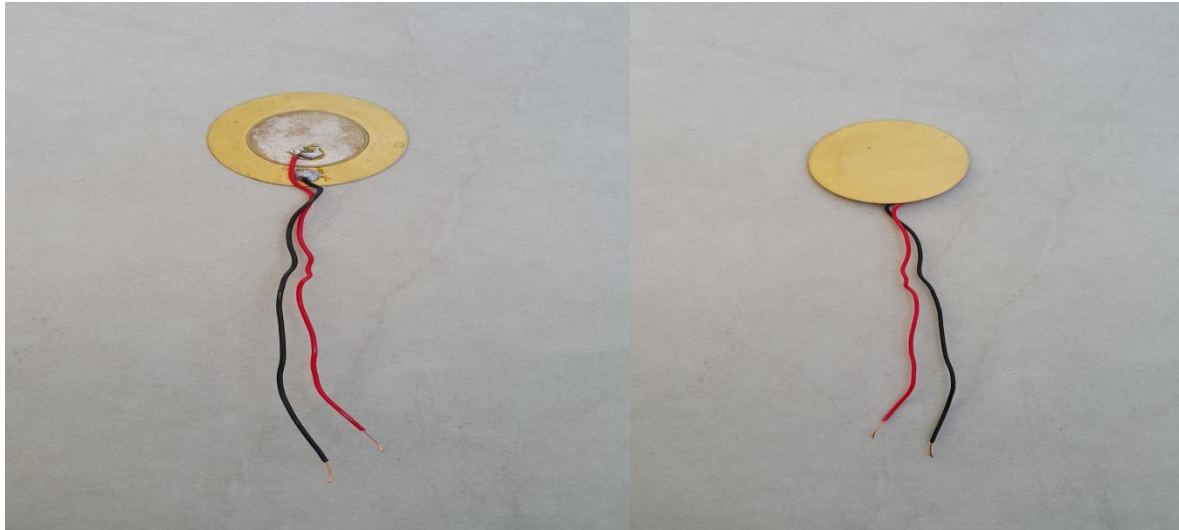


Figure-3. Illustrates the figures of the piezoelectric crystal which is used for the opto-mechanical modulator.

The needed arrangement for the opto-mechanical modulator with the piezoelectric crystals is given in Figure-4.

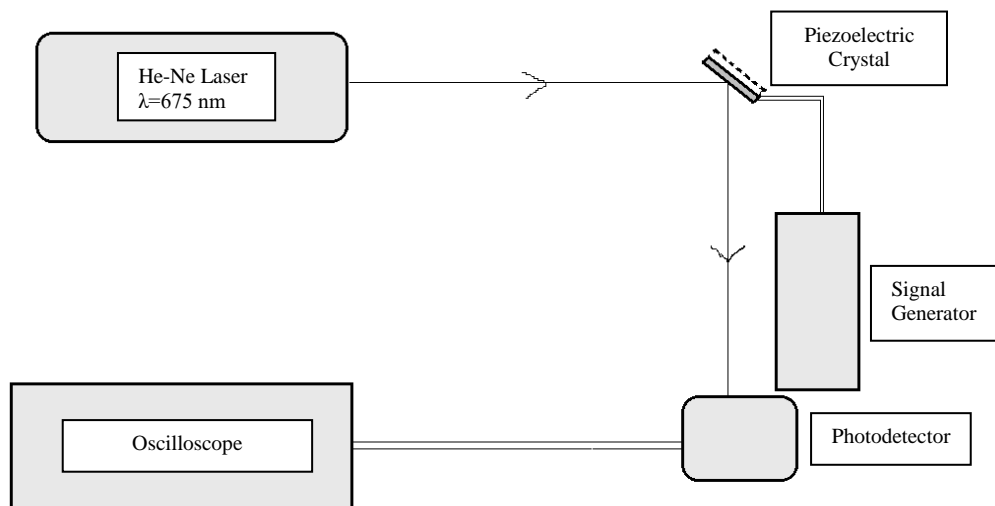


Figure 4. Illustrates the principle scheme of the experimental set up for the study of an opto-mechanical modulator with piezoelectric crystal.

If the behaviours of the both systems are compared, it is clear that the modulator system based on laser with the piezoelectric crystal is more effective for higher frequency.

3. Results

Utilizing the experimental arrangement as seen in Figure-2, the experimental results were obtained as seen in Figure-5.

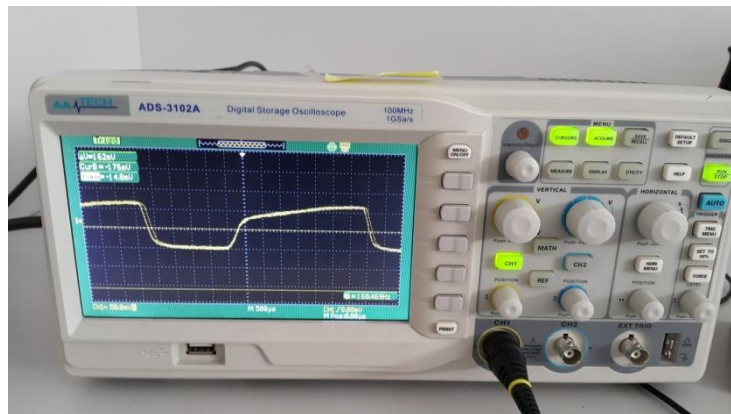


Figure-5. Gives the modulated light in the screen of oscilloscope used in the experiment.

The modulated light was obtained as seen in Figure-5 by means of experimental arrangement. As seen in the figure the shape of the wave is not good, but this negativity is due to the low operating frequency (where working frequency is about 160 Hz). Meanwhile, it is expected that the quality of wave is increased when working frequency is increased. If the output signals seen in Figure-5 are processed in the mode of digital form, digital data is obtained in the order of 101010101010....., relatively and these results can be used where necessary.

4. Discussion and Conclusions

In this work an opto-mechanical system was designed, produced and also some typical results related to light modulation were obtained. As seen in Figure-5, a modulated light with squared wave was produced but it was not in quality. It is thought that better quality shape of the squared wave is obtained in higher frequency. Moreover, if the second arrangement which is the opto-mechanical system with a piezoelectric crystal is utilized for the light modulation, in that case some physical properties such as cleanliness and brightness of the surface of piezoelectric crystal as seen in Figure-3 and also adjusting of the optimum distances between the components used in the experiment should be taken into account, carefully. Another significant point is also that adjusting the optimum angles of incidence and reflection is very important to get the desired exact results from the experiment. As a result of that concerning two experimental arrangements it can be said that while the experimental set up with chopper is more useful for lower frequencies, another system is also more effective for wider frequency range.

5. References

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