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Amplitude Modulation Laser Diode with swept Frequency analysis of samples

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Abstract: *This paper presents the design of a system with the ability to control the frequency with which they are stimulated laser diodes used to analyze samples in any physical states. It is common that the modulation of the laser diode is performed in amplitude, this for the analysis of samples using photothermal techniques. Our system was developed considering the electrical characteristics of each of the laser diodes such as current operating power, wavelength and operating voltage. We developed a kind of driver, with it is possible the amplitude modulation of the, but at the same time performing a frequency sweep of this, this without neglecting the optical power of each of the laser diodes used, and to ensure that the beam from each diode is suitable for this application. We take the design´s driver of the bipolar transistor configuration that allows the current flowing through the base of the transistor is that encourages each of the laser diodes, this applied separately to each diode used.*

Keywords: *Amplitude, Frequency, Laser, Modulation Photothermal.*

I. INTRODUCTION

The photothermal techniques allow analyzing various transport phenomena of temperature, charge and mass. Can be analyzed vibrations in solids, liquids and gases. Moreover they are useful in the study of photochemical reactions and phase transitions.

Another major advantage of photothermal techniques is that this phenomenon can be detected in many different ways. Depending on the detection system, the name given to the technique. When we use microphones or piezoelectric talk about photoacoustic techniques , if we use pyroelectric detectors we mean photopyroelectric techniques , when using beam test for sensing the temperature through the change of local refractive index, we have the mirage effect , temperature thermoreflective and the thermal lens. One of the most promising methods is using remote sensing and is known as infrared photothermal radiometry.

The infrared radiometry allows studying the optical and thermal properties of the materials, without requiring contact with the samples and in principle any sanding or polishing treatment for the samples is not necessary. In the infrared radiometry is incident light beam on a material, this as consequently emits infrared radiation and is recorded by an infrared detector, suited to the emitted wavelength. There are basically two experimental configurations known transmission and reflection. Also you can work in two ways using pulsed or modulated radiation.

Using these techniques, involves among other things, the modulation of a radiation source to which the sample is exposed for its characterization [1]. In most cases is chosen powerful lamps which are modulated by external devices. This set provides a more robust experiment, besides the price increase. Finding sources of modulated radiation involving a lower cost and also remain practical is the aim of this work. A laser diode with an appropriate modulation may be a viable substitute for such sources.

It will use a TTL signal, which will be generated by a PIC16F876 microcontroller medium scale. Making use of a driver enabling positive Laser Diode modulation to obtain the desired modulation results in a wide range of frequencies from its feed stream. It is important to note that this project is part of another system which is responsible for collecting the information through a photoacoustic chamber, which will be built-in microphone for obtaining data [2]. Later, this information will be amplified by a lock-in amplifiers, whose function is to amplify signals of very low amplitude, so that through a Graphical User Interface (GUI) will be displayed below the graphs (Amplitude vs Frequency and Phase vs Frequency) of the material response to the heat emitted by the beam of the Laser Diode.

Finally the photothermal prototype multipurpose analyzer presented in this paper consists of four modules:

The first module is the pyroelectric detection system for photothermal analyzer. The second module is the prototype of Lock-in Amplifier for photothermal analyzer. The third module is the photoacoustic detection system for photothermal analyzer. The last module that is discussed in this article is the prototype lighting system photothermal analyzer. This can be better understood by observing Figure 1.

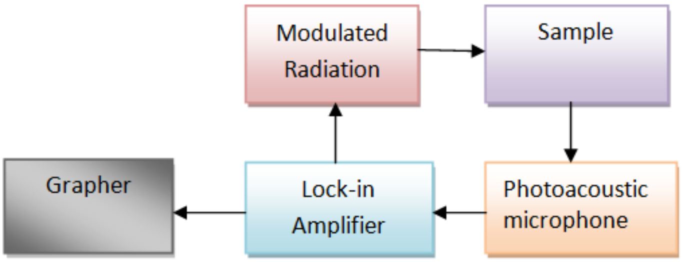

Figure 1. Basic configuration of the photoacoustic experiment.

II. DEVELOPMENT

To implement a light source is necessary to take various considerations. One is the type of sample is to characterize; because this determines, among other things, the necessary power source to generate photoacoustic signals optimal [3]. Also relevant is the experiment setup, sometimes space is limited, and a fix is looking to small.

For this work, different materials among these the experiment was conducted in a piezoelectric sensor were considered. For phase control and conditioning of our system. The circuit shown in Figure 2 shows the layout of the control stage which is responsible for manipulating the driver which is used primarily for 2N2222A transistor amplitude modulation of each laser diode, and in conjunction with the PIC16F876 microcontroller laser diode selection is made.

The sweep frequency of the system, consisted in the selection of different laser diode wavelength making the change to a frequency set in the JAVA program, this was feasible when selecting the button to change the type of sample to be analyzed, and primarily for each type of laser diode to the same driver amplitude modulation of said laser diode is used.

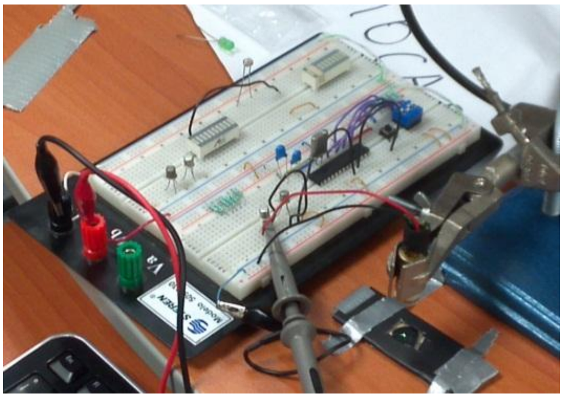

Figure 2. Prototype used for testing electronic

III. DESIGN AND CONSTRUCTION OF PROTOTYPE

In our project employ near-infrared laser diodes are shown in Table 1.

Table 1. List of laser diodes used for the tests of temperature change of a piezoelectric material.

Name	Long. Wave	Potency	Volt.
Laser Module D9mm	405nm	5mW	5VDC
Laser Module D8mm	532nm	10 mW	3VDC
Laser Module D4mm	635nm	5mW	3VDC
Laser Module D4mm	650nm	5mW	3VDC
Laser Module D6mm	780nm	5mW	3VDC

As the design and construction of the Electronic Prototype was developed according to the following parameters;

1. Power Laser Diode
2. Operating Temperature.
3. Wavelength.
4. Operating current.
5. Operating Voltage.

Each of these parameters is considered suitable for the amplitude modulation and frequency sweep applied to the laser diode described in Table 1.

In the case of controlling the optical power only enough to consider the following conditions; the current flowing through the laser diode is controlled by voltage source and driver configuration which is presented in Figure 3.

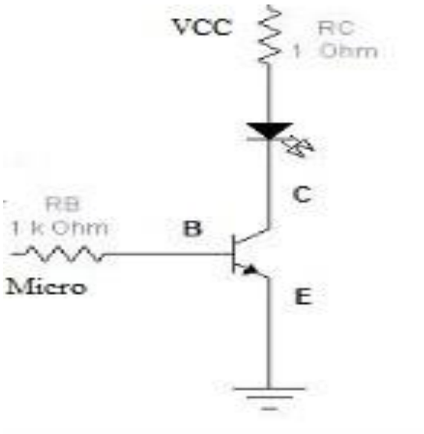

Figure 3. Configuring the Driver for photothermal applications.

Note that for controlling the power source industrial voltage is used, in order to reduce the noise that occurs in the prototype and foremost be in the future if it is necessary to control the optical power enough to implement a photodiode combined system which allows monitoring the optical energy being necessary for photothermal applications, particularly when used a photothermal microscope [4].

This situation is of great interest for those areas where the analysis of nanofluids is attractive for photothermal applications mentioned and controlling the optical power of each laser diode can see some interesting results, nondestructive testing and materials developed samples.

IV. SWEEP FREQUENCY OF LASER DIODES

In this case software developed in the object-oriented (Java), which aims to make a sweep frequency of each of the laser diodes used language was used as mentioned. View the interface in Figure 4.

Figure 4. Interface for frequency scanning Laser Diode.

V. RESULTS AND TESTING SYSTEM

The tests were performed using a piezoelectric sensor, with the aid of this see the stability of the driver developed, see Figures 5 and 6.

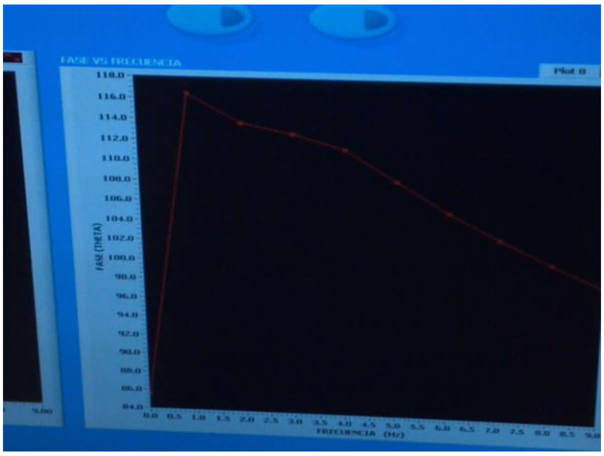

Figure 5. Exponential piezoelectric materials response

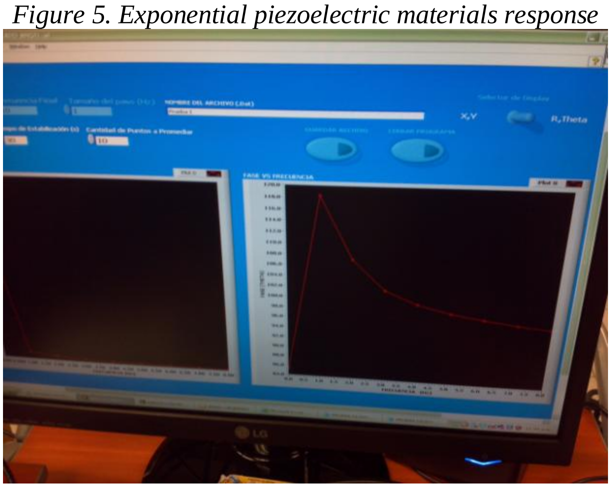

Figure 6. Amplitude and phase versus frequency of the diode laser.

Also we can see the graphics that were doing the tests in the laboratory, see Figures 7 and 8.

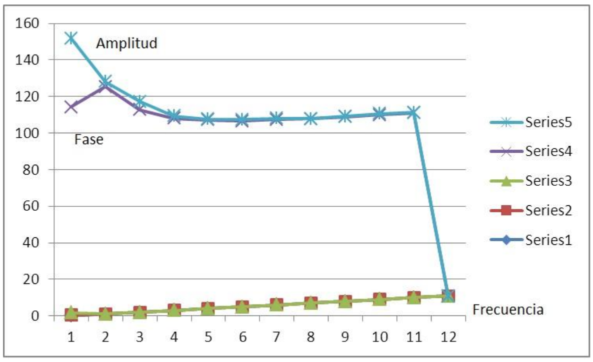

Figure 7. Response amplitude and phase vs. frequency, piezoelectric sensor. 635nm Diode.

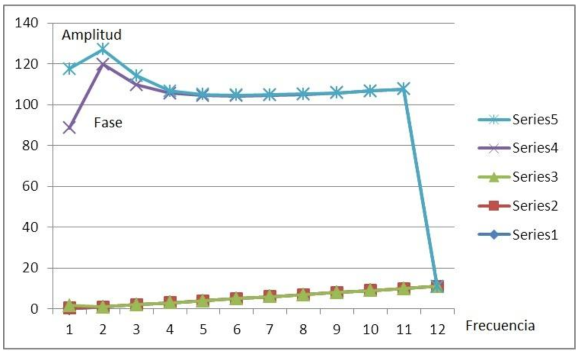

Figure 8. Response in amplitude and phase vs. frequency, piezoelectric sensor. 850nm Diode.

In the example we can see the frequency response of both the amplitude and phase for each laser diode, and its response is different, which means that the material responds differently as the case of photothermal technique [5].

VI. Conclusions

Implementing an NPN silicon transistor for modulation of a laser diode with complex arrangements can replace gas lasers or lamps coupled to other devices to sample radiation in photoacoustic techniques. Reducing cost and the need for this type of space experiments. Additionally the versatility of the prototype greatly improves the results in-live and in-situ, modular samples would not be possible to obtain results of these outside its fixed location.

With this we can say that the developed system is versatile because it does not require being in the place where you will find all the equipment to get the results of the photothermal techniques employed. So the obtained system satisfies the characteristics of a computer system with the ability to perform the analysis of samples of different materials in liquid, solid and gaseous states. Also its mechanical design allows you to adjust and select the Laser Diode to use, thanks to the programming of a microcontroller (PIC16F876) and in turn control the frequency sweep, to know the result of different materials radiate varying frequency.

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