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PHENOMENA OCCURRING IN ACHIEVING INTEGRATED CIRCUIT BOARDS USING ULTRAVIOLET LIGHT

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Abstract—To make a mechatronic prototype is essential to make firs a printed circuit board. Making a single board (prototype) in a factory would cost a lot, for this reason, it's needed to be found a method by which this can be done at home without any problems.

A highly precise method is presented in this project. With this method by applying a layer of photoresist on the board and by exposing it to ultraviolet radiation with a mask, printed circuit boards can be made at home easily. The same method is used in the production of printed circuit boards.

To make it possible to achieve printed circuit boards using this process, it is needed a source of UV (ultraviolet) radiation controlled by a countdown timer, named ultraviolet exposure box.

The project contains the exact description of the method and the manner of building an exposure system.

***Keywords*—**mechatronic**,** printed, circuit, boards, ultraviolet, lights, photoresist, programing.

I. INTRODUCTION

A printed circuit board (PCB) is a plate that is designed to support mechanical and electronic components to make electrical connections between these components. A circuit board is made of an insulating layer with variable thickness, which is a layer of copper on one side, both sides, or multiple layers. The insulating layer is a material generally known as FR4 (Flame Retardant stands for 4) and has a thickness of 1.6 (mm), but it is not the standard value. FR4 is a glass fiber material of printed wiring boards are manufactured with a thickness of 0.8 (mm) and 1.6 (mm). Also, in general, use FR408 materials and FR5. Flexibles circuit uses a plastic called polyamide with a high temperature melting. To start making a PSB, firs of all begins with design the operational circuit (schematic design) using a specialized software to design PCB, which will be transferred on the plate using more technologies. This can be chemically or mechanically. There are many methods to make a transfer a design on plate, a good example is the transfer chemical route which are using a photoresist material, irradiated with ultraviolet beams of a specific frequency [1]- [6].

II. EXISTING ULTRAVIOLET SOURCES

Ultraviolet radiation is electromagnetic radiation outside the visible light spectrum with wavelength of between 100 and 400 (nm). Ultraviolet radiation is divided into three categories:

1) *UV-A*
   a) *UV-A BLB*
   b) *UV-A BL*
2) *UV-B*
3) *UV-C*
   a) *UV-V*

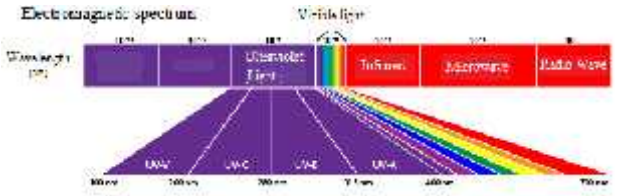

Fig. 1.1. Electromagnetic spectrum that defines where are the sources of radiation and ultraviolet radiation[5]

UV-A has a wavelength range between 315-400 nanometers. There are two types of UV - A ultraviolet sources:

1) UV-A BLB (black light blue) is a light source such as a fluorescent lamp having a color filter on the wall of the tube closed to prevent the passage of radiation of a certain wavelength. These types of radiation sources used most often at parties because certain materials shine like phosphorus from exposure to these types of radiation and visual effects occur.

2) UV -A light source BL (Black Light) not of said filter comprises, therefore emits a radiation with a wave length comprised in a range much higher than the BLB UV -A, visible light and transmitting right . BL UV

3) A radiation is used for the application of photosensitizing applications photochemical reaction and traps for catching insects. For tan skin are using fluorescent radiation of wavelength between 315 and 345 nm.

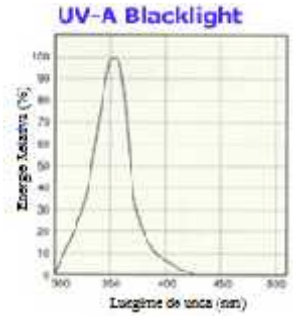

Fig. 1.2. Wavelength for UV-A BL [6]

UV-B radiation has wavelengths between 280-315 nanometers. These wavelengths are much more dangerous than the wavelengths present in the case of UV-A sources. This radiation does not penetrate deep into the skin as UV-A, but that can cause burns, cancer or other skin diseases. Ozone partial switching off of this radiation, UV-B radiation has a good side, helps the body to produce vitamin D. Sources of UV-B phototherapy are used in dermatological tests or inspections material resistance to UV radiation.

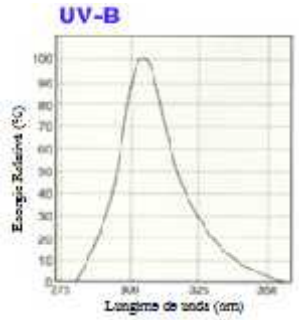

Fig. 1.3. Wavelength for UV-B BL [6]

UV-C radiation source of wavelength are typically between 200-280 nanometers. These sources are used for any infection, purify air, water, surfaces. There are sources of ultraviolet radiation in the wavelength range between 10 and 200 nm and are referred to as "Vacuum Ultraviolet" because this radiation is absorbed by air

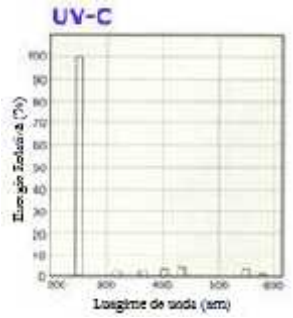

Fig. 1.4. Wavelength for UV-C [6]

III. METHOD FOR MAKING PCB'S AT HOME

There are two methods commonly used, which can be achieved using PCB's relatively simple:

1) The first method is the transfer of toner to the plate with raw wiring (thermal transfer);
2) The second method consists in depositing a photoresist layer wiring board raw and exposure to ultraviolet radiation plate.

In this project the focus is on the second method therefore still will briefly present the first method then describes in detail the second method. Regardless of which method is used for the first step is realizing plate printed circuit operating in specialized software for design the electronic circuits necessary to realization printed boards, in this case using EAGLE software.

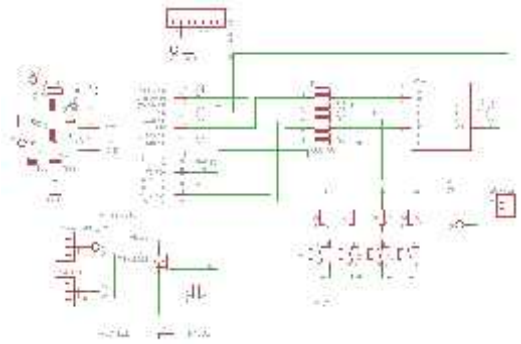
Fig. 1.5. Timer circuit diagram for count the exposure time on ultraviolet for making PCB's

Circuit diagram will be transformed into an electronic circuit to be transferred to PCB.

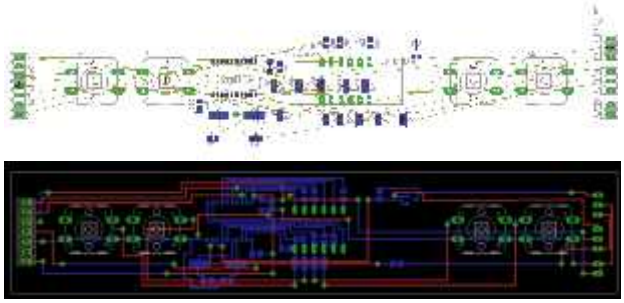
Fig. 1.6. Timer circuit diagram design with EAGLE software

Once completed the design of this electronic circuit will be printed using a laser printer and a semi-transparent sheet. It is important to use a laser printer for this kind of print and semi-transparent sheet because the ultraviolet lights works better. If the sheet is perfectly transparent and glossy the lights are reflected and the process will be degraded.

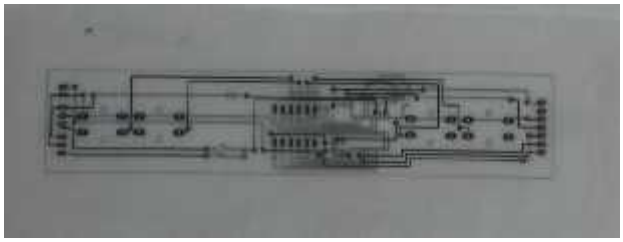
Fig. 1.7. Timer circuit diagram printed on a Semitransparent sheet

The circuits were printed on a sheet temperature resistant. It is very important that the film used to be resistant to temperature, not laser printer drum stick. There were problems transparencies, laser printer prints circuit faults (breaks) and therefore the plate is allowed more time exposed to ultraviolet light circuit lines that remain are broken plate broken sign that ultraviolet light penetrated through the imperfections printed circuit printer left, and if leave less time exposure is underexposed photoresist sign that it does not dissolve caustic soda solution later [2].

First cut the wiring to the desired size, rinse thoroughly with detergent. After washing, the plate does not catch your fingers copper layer. If oxidation copper layer is not going to wash the plate, it can polish with very fine sandpaper. It is not recommended to use a rough sandpaper that scratches visible copper surface for the application of photoresist substance is not distributed evenly on the plate. The positive photoresist bottle spray named "20" size 100 (ml) covering an area of 2(m^2) and bottle spray with size 200 (ml) covering an area of 4 (m^2) , and the range of sensitivity of the photoresist varnish is between 360-410 (nm) , is applied to the surface of the copper plate. Application is made in a room with very little light, the photoresist is sensitive to red light because of this is used for illumination, a red light source. After the photoresist is applied in a layer as thin as possible and as evenly distributed, the thickness of the photoresist layer greatly influences the time necessary for exposure to ultraviolet light. If the photoresist substance is not evenly distributed, it may happen that in some areas like to be under exposed. After applying photoresist substance must dry as dust quickly to block adhesion. For quick-drying plate can be inserted into an electric furnace where it is dried for 20 (min) by gradually increasing the temperature up to a maximum of 70 (°C). Above this temperature deteriorates the photoresist substance and not to be photoresist. Insert plate photoresist applied and dried between two sheets printed circuit semitransparent , stick the paper in several places so that the wiring does not move to paper.

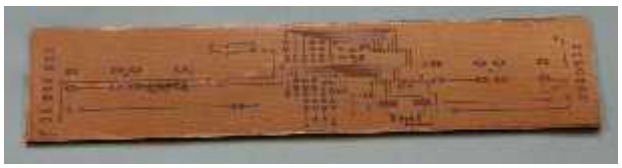

Fig. 1.8. Circuit diagram transferred on the plate - side one

Fig. 1.9. Circuit diagram transferred on the plate - side two

The whole set is introduced into the system with ultraviolet lights presented and exposed to a time - dependent radiation source , the radiation source distance from the plate , the thickness of the photoresist . After exposure the plates were placed in a solution containing 7(g) of sodium hydroxide (NaOH) dissolved in one liter of water, where the exposed photoresist material to be dissolved within 2 minutes. If dissolved means that plate was underexposed, if exposure time was too short. After this operation, the plate is placed in a solution of chloride where corrosion occurs (removal of copper which is useless)

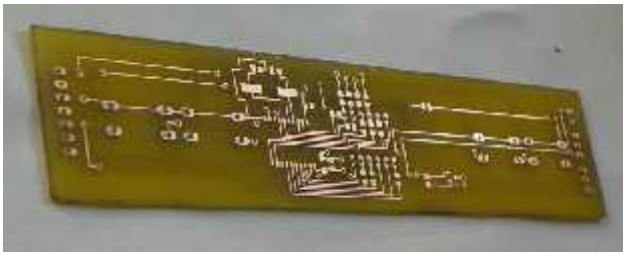

Fig. 1.10. Final circuit diagram result after corrosion(removal of copper which is useless) - side one

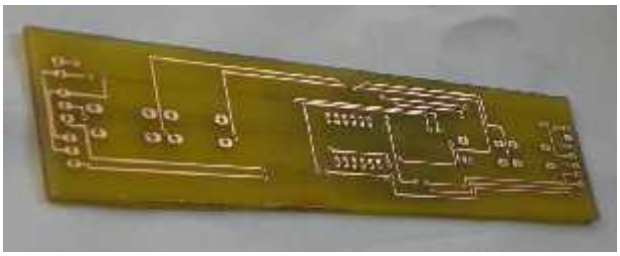

Fig. 1.11. al circuit diagram result after corrosion (removal of copper which is useless) - side one

Fig. 1.12. Final timer board with electronic components - front view -

Fig. 1.13. Final timer board with electronic components - back view -

IV. HOME-MADE SYSTEM FOR EXPOSURE TO ULTRAVIOLET LIGHT

To perform the tests were used a home-made system for exposure to ultraviolet light. The system begins with the dismantling of the old scanner inoperative. Manual exposure can be made of many things, for example in a bag or a box of pale, there are many possibilities. The scanner has the dimensions 450 x 260 x 48, and the glass

surface is 300 x 220 (mm).

Fig. 1.14. Scanner housing converted to ultraviolet light exposure system use for PCB-s technology

Fig. 1.15. Ultraviolet light exposure system
(a) without semitransparent sheet put on scanner glass – left;
(b) with semitransparent sheet put on scanner glass – right.

To see better the areas where UV radiation is lower compared to other areas, place a thin, transparent over the scanner glass. It is seen that at the edges, especially at the ends of the fluorescent tubes radiation is much lower than the middle area. Between the tubes are observed less enlightened areas to areas above the tubes. To minimize this undesirable effect is joined a matte film that disperses light to the inside of the bottle. Sticking foil as evenly and without bubbles is such a plastic card with a little detergent dissolved in water. It put some soapy water on the glass, because glass slide film, after which the card using air bubbles to disappear all pull out.

V. CONCLUSION

If the photoresist substance was not applied uniformly and therefore remained a spot of photoresist that leads to the deposition of dust particles in the photoresist substance causing those spots binding line circuit , which compromise the plate.

After etching plate in ferric chloride, places remaining photoresist copper spots on the plate does not corrode.

In places where they are glued to dust (dirt) the copper remaining points, in some cases the compact circuit is a critical operation problem. If the plate was polished with an abrasive belt hard enough to apply photoresist layer applied tapers where the plate was polished, it made after exposure, the photoresist area wiped, caustic soda bath so route electronic circuit has been compromised. Due to imperfections of printing on foil after etching slight interruption occurred route points.

After exposure it is difficult to see small defects on the trail, and after etching these defects increases exponentially.

To solve the problem with printing, on transparencies mistakes instead of foil to shall to use tracing paper, if on tracing paper appear not interrupt routing problem.

The plate was exposed to UV radiation for 45 (sec) on one side, and on the other side for 1 min and 15 (sec). The part that was exposed 45 (sec) track was full with lacquer discontinued route. If a face exposed 1 min and 15 (sec) the coating layer was very thin in some places even disappear altogether.

If the photoresist plate applied manually by industrial and not sprayed, the plate requires more exposure for 5-10 (sec) to Positive photoresist plates 20 hand applied, but has the advantage that the photoresist is applied uniformly and in a layer very thin.

After exposure and developing the photoresist remaining on the wiring is yellow and has a very similar color to the color of copper, then before corrosion can decide if the circuit is good or not. If the photoresist is applied to a clean plate without oxidations in a very thin layer , evenly and in a clean environment can be achieved pleasing compact and thin routes close to optimal results will not hide imperfections hard to see with the eye freely and so harmful in electronic circuits.

REFERENCES

[1] C. Alexandru, I.Barbu, „Modeling the Windshield Wiper Mechanisms as Multi-Body Systems” - Proceedings of the IX IFToMM International …, 2004, pp 29-34.
[2] D.M.Barbu, I.Barbu, „Dynamical model for an original mechatronical rehabilitation system” - The 8th WSEAS International Conference on System Science and Simulation in Engineering, Genova, Italy, pp. 626-273.
[3] C. Alexandru, I. Barbu „Functional Design of the Windshield Wiper Mechanisms using Virtual Models” - Proceedings of the 9th IFToMM Conference, Liberec, 2004, pp 23-28
[4] C. Alexandru, „The mechatronic model of a photovoltaic tracking system” - International Review on Modelling and Simulations, 2008, pp 64-74.
[5] http://chem-is-easy.blogspot.ro/2012/11/the-chemistry-of-skin-protection.html. – accessed on october 2013.
[6] http://www.topbulb.com/find/uv.asp – accessed on october 2013.