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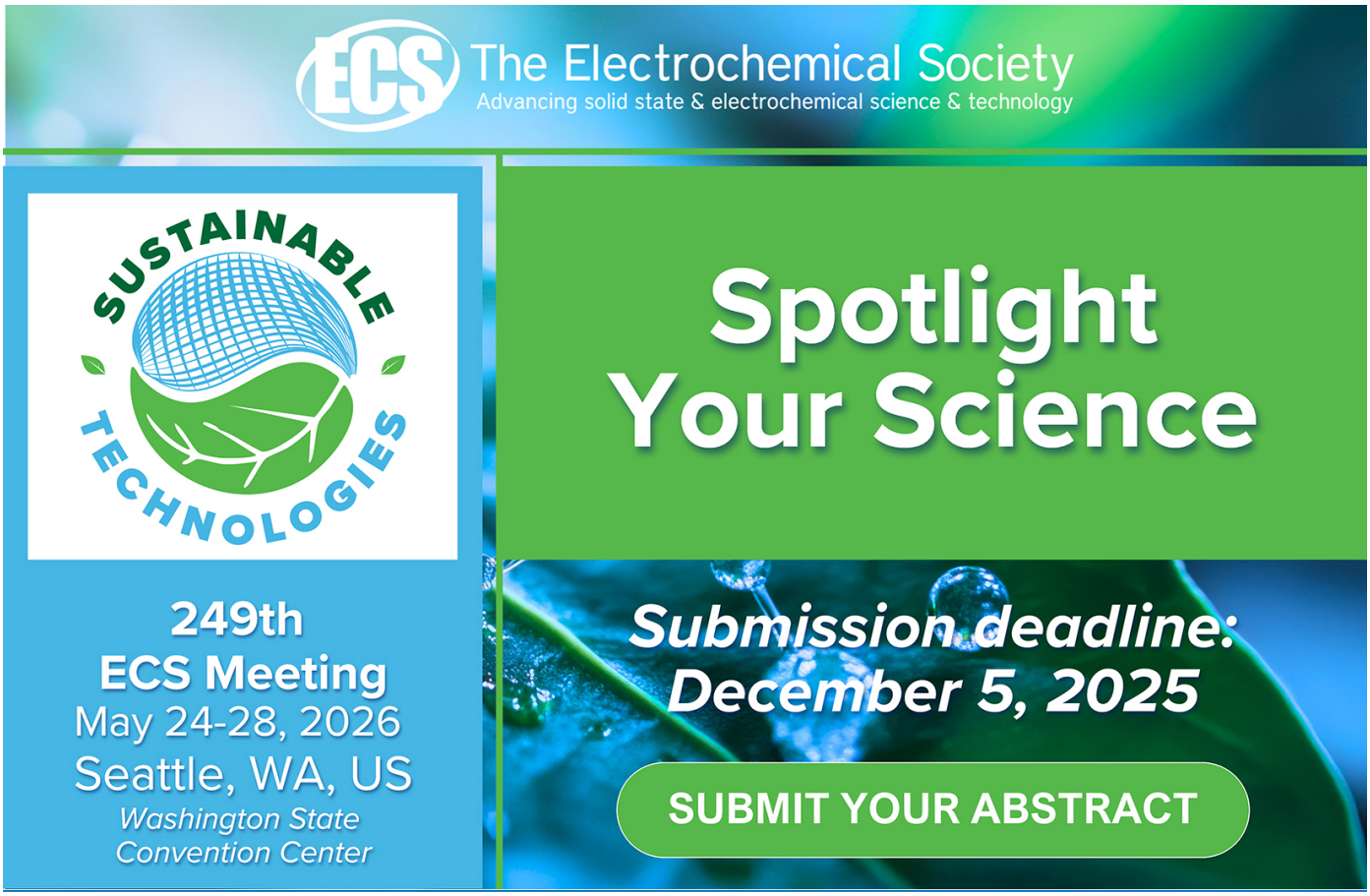

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Building a spin coater device for thin-film preparation

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Abstract

A low cost, simple design of the rotary spindle (spin-coater) is described in this research. This simple coating system is used as thin films deposition device for microscope slide (75*25) mm . The easily system can be built by electronics and machine. Designed with a brushless engine with Arduino Uno, designed for speed control. The rotational speed ranges from 350 to 10,000 rpm to give us many thickness according to the materials used. In our design, the rotational speed is controlled manually by the variable resistor.

Key words: low cost, spin coater, thin-film

1. Introduction

The technology of thin film plays an important role in high-tech industries [1]. The thin film technology has been enhanced mainly for the need of integrated circuits industry. Demand for the development of smaller, smaller, faster-speed devices, especially in the next generation of integrated circuits, requires sophisticated materials and new processing technologies suitable for integration technology [2]. In this regard, the technology and physics of thin films can play a chief part to reach this goal. Thin film production has been developed for the past 40 years. Thin film as a two-dimensional system is of unlimited importance to many problems of real world [3]. The costs of their materials are very small compared to the matching bulk material and achieve the same function when it arises to surface operations. Thus, knowledge and design can be used for the nature of films, their functions and their new features to develop new technologies for future applications [4].

Thin films are thin layers of materials ranging from parts of nanometers to several micrometers in thickness [5]. A thin film can be applied uniformly through various techniques: chemical vapor deposition (CVD) and PVD [Hussein, 2011]. Another way is rotational films (spin-coater). Spin-coater is a quick and easy way to create thin and homogeneous films [6].

Spin coating is the procedure used to apply thin films uniform on a flat substrate. The machine used to build thin film is called spin-coater, or simply rotor. In short, a limited amount of solution is deposit on the substrate, which is then rotated at high speed for propagation, liquid by centrifuge force. Manufacturing techniques are comparatively simple because equipment is available. One of the mainly important factors in rotational coatings is repetition. Several ways to develop composite inorganic semiconductors play vital roles in advancing technologies. For performance of thin films based on film, it is necessary to control film properties. Therefore, many advanced techniques are used, such as molecular beam epitaxy, laser assisted evaporation, sol-gel, ion beam radiation, thermal evaporation,

chemical vapor deposition, vacuum deposition, chemical bath deposition, etc. These processes are intensive of energy and include high temperature, pressure and vacuum. But spin coating is one of the most cost-effective, fast and simple ways to deposit thin films and the way to prepare single and heterogeneous films [7].
In general, the thickness of the spindle film is relative to the square root of rotation speed as in the equation below where t is the thickness and (ω) is the angular velocity:

$$t \propto \frac{1}{\sqrt{\omega}}$$

This means that the film, which is woven at a rate of four times the speed, will be half its thickness. The spin curve of this equation can also be calculated as shown below.

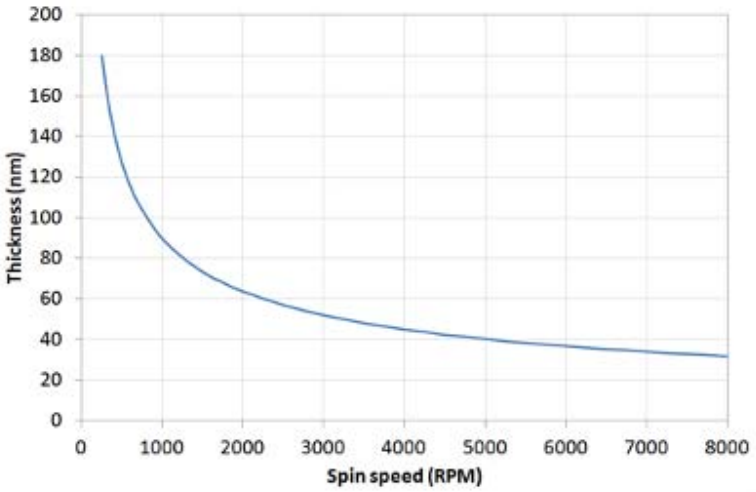

Figure 1. Example spin curve for a solution.

In this paper, a cost-effective and very easy spin coater has been planned with their modify base for spin holder. Our future design is approximately 75% cost-effective than the marketplace available spin coating system. There is no time extreme stay and the device is easy to clean after each process.

Furthermore, we use the basics of the physics in the design and construction of a low-cost spin-coater that can be programmed by computer using Arduino Uno card and brushless-motor.

2. Experimental

This part displays the hardware and software, adopted in this work, such as Arduino Uno brushless-motor and substrate holder.

2.1. Arduino Uno

Arduino UNO (Arduino, Italy)
Arduino UNO is a microcontroller based on ATmega328.For analog inputs, there are 6 very useful analog pins and for digital: It consists of 14 digital I / O pins where the number of PWM pins is 6. [10].

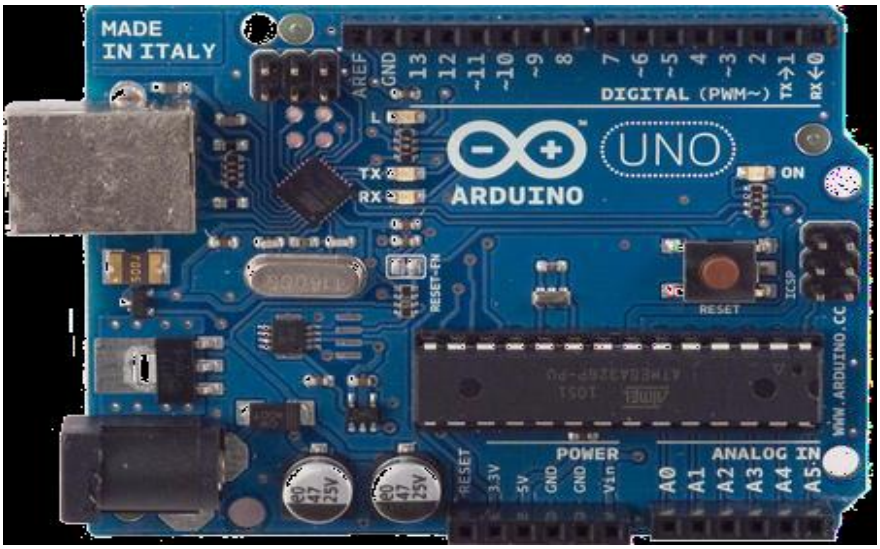

Figure 2. The Arduino UNO board

The stand for our device, a microcontroller needed to read data from our sensors and we work with Arduino because it is easy to utilize and has an dynamic community with lots of free codes and help to find when wanted [10]. In this project, we worked with the Arduino Uno board based on the 8-bitmica328p microcontroller. The panel has an internal clock frequency of 16 MHz and memory of 32 KB ashes and a number of analog and digital screws. It operates at a voltage of 5 volts and is easier to operate via USB, which also provides a serial line for communication and programming from a computer [11].
In the final product, the ATmega328p processor was used, which was flashed using an Arduino boot loader and an internal 8MHz oscillator rather than the entire motherboard, make the device smaller and easier to handle. For most programming and testing, the UNO board was used.

2.2. Brushless-Motor

In conventional DC motors, mechanical change is applied using brushes that lead to mechanical friction, noise, electric spark and wireless interference. These defects can be overcome by Brushless DC Motors (BLDC), as shown in fig.3. Due to the presence of permanent magnets in the rotor, they are also known as DC motors (PMBLDC) free of permanent magnet brushes. The (BLDC) engine was developed based on brushed DC motors.

Brushless motor controlled by 30A ESC controller in this work.

Figure 3. The brushless motor& 30A ESC Controller

2.3. Substrate holder:
The sample holder is made locally as shown in figure 4.

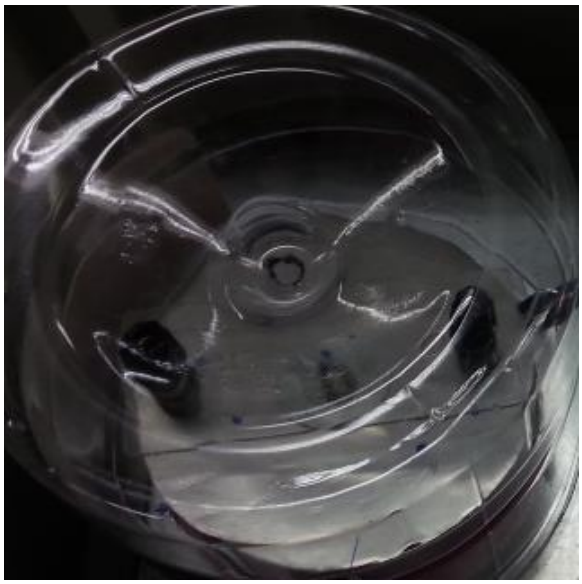

Figure 4. Substrate holder

2.4. Device assembly
Figure 5. illustrate the low-cost spin coating device after connecting the hardware and uploading the code.

Figure 5. Spin-coating device

2.5. The software

The following steps represent the used code with illustration each step after double slash .

```
#include <Servo.h>// servo library was used to control ESC

Servo esc; //Create of a servo class with name as esc

void setup()

{

esc.attach(8); //state the esc signal pin,Here as D8

esc.writeMicroseconds(1000); //initializing of the signal to 1000

Serial.begin(9600);

}

void loop()

{

intval; //Creating a variable val

val= analogRead(A0); // input Reading from analog pin a0 and store in val

val= map(val, 0, 1023,1000,2000); //mapping of val (adjust if desired)

esc.writeMicroseconds(val); //using of val as the signal to esc
```

}

3. Preparing of samples

Preparing samples that coated by manufactured device are shown in figure 6.

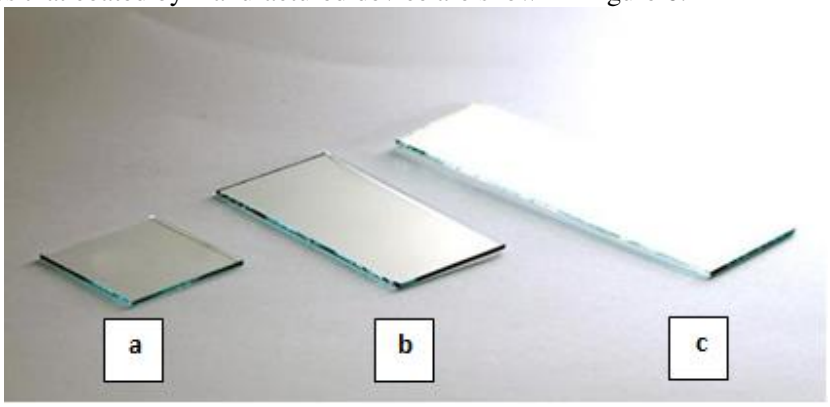

Figure 6. Prepared Samples with different thicknesses: a) 85 nm b)105 nm c)150nm.

4. Conclusion

Brushless motor is a good motor that we can use for build low cost spin coater.
High homogenized thin film is get by this manufactured device. Wide range spin-speed is gated by using brushless motor (350-10000) RPM giving us many thickness according to the materials used ,and in this work was about (1000,1500 and 2000)RBM.

5. References

[1] Ohring M 1992 *Academic Press limited*, 24-28 Oval Road, London, NW1, 7DX, UK, XIII.
[2] Kashyap S C and Wuttig M 2003 *World Scientific Publishing Co. Pvt Ltd.* **5** Toh Tuck Link, Singapore, 596224 *Tehran, Iran, IX.*
[3] Seshan K 2002 2nd ed Norwich, New York, U.S.A.: Noyes publications, William Andrew publishing.
[4] Aguilar R G and López J O 2011 *Latin American Journal of Physics Education*, 5 (**2**), 368-373.
[5] Smirnov M A Rambu P Baban, C and Rusu G I 2010 *Journal of Advanced Research in Physics*, 1 (**2**), 021011.
[6] P Claude Sevvanthi A Jayanthi C and Poiyamozhi A 2012 *Advances in Applied Science Research*, 3 (**6**), 3573-3580.
[7] Hussein H F Shabeeb G M and Hashim S S 2011 *J. Mater. Environ. Sci*. 2 (4), 423-426)."

[8] Dunbar P and Birnie III 1987 "The Key Stages in Spin Coating", *J. Imaging Technology*, 13, 122.

[9] Schubert D W and Dunkel T 2003 "Spin-Coating"*J. Appl. Phys*., 49 (**7**), 3993.

[10] M. Margolis 2011 "*Arduino cookbook*: O'Reilly Media, Inc.

[11] C Yi and F Bai *Journal of Changchun University of Science and Technology (Natural Science Edition)* **4** 016, 2011.