Spin Coater

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1 Introduction

A spin coater is a device that is used to apply thin films onto a substrate. The rotation speed of the spin coater is controlled by an Arduino microprocessor and a motor shield. The user interface for the spin coater is a remote control that communicates with a IR sensor which relays instructions to the Arduino. The speeds inputed into this device are not the revolutions per minute. The input speed is a digital speed that corresponds to a physical rate of revolutions.

The spin coater requires two power sources. The first is to power the Arduino, the second is to power the motor.

2 Operating Instructions

Prepare the sample first before completing any of the steps below.

To operate the spin coater plug in both power adapters. One is to power the Arduino and the other is to power the motor. (There is no power button on the device) Then follow these steps:

1. Adjust the variable resistor (silver knob below the LCD screen) to an optimal setting.
2. position the tachometer such that it will record a reading of the RPM.
3. To input the digital velocity, press the up arrow on the remote control. Then input the desired speed. The input must use all three digits, so if you want to imput a speed of 90, you must input 090. The maximum digital velocity is 254. Note: The inputs are not recorded unless the number pressed on the remote appears on the LCD screen. You may have to press a button multiple times before it is recognized by the Arduino.
4. To input the time press the down arrow on the remote control. Then input the desired time in seconds. Again you must use 3 digits to input the time, so if you want the spin coater to operate for 5 seconds you must input 005 or if you want it to run for 60 seconds you must input 060. The maximum time that the spin coater can operate is 999 seconds. Note: The inputs are not recorded unless the number pressed on the remote appears on the LCD screen. You may have to press a button multiple times before it is recognized by the Arduino.
5. **IF NEEDED:** To reset either the speed or the run time simply press the up arrow on the remote to reset the velocity or the down arrow on the remote to reset the time.
6. Press Enter/Save on the remote to start the spin coater
7. Before removing any sample, unplug the spin coater.

3 Instructions for changing the motor or the aluminum disk

Detach the motor shield from the motor. Use a screw driver to loosen the screws of port M1 on the motor shield. Then guide the motor out of the stainless steal holder.

Take a blow torch and from at least 6 inches away begin to heat the aluminum disk. After about a minute you should be able to use a pair of tweezers or tongs remove the disk from the motor.

If possible immediately position the aluminum disk onto the new motor shaft. Otherwise repeat the heating process and try again... The fewer times that the aluminum disk is heated the longer its life will be, so be good at stuff and don't fail more than a couple of times.

If you are changing the motor, new wires will need to be soldered to the leads on the motor. This is a very easy soldering job that anyone trained to use a soldering iron can accomplish.

Every time the aluminum disk is removed from the motor shaft and then replaced, it is necessary to test the "levelness" of the disk. To do this, turn the spin coater on and then shine a laser at the disk at a shallow angle. If the reflection is stable, then the aluminum disk is adequately level.

4 Parts

Excellent tutorials and diagrams for all Adafruit components can be found at *Adafruit.com*

1. Arduino Mega 2560: bought from Adafruit.com
2. Adafruit Motor Shied: bought from Adafruit.com, product number: 1438.

   It is likely that this motor shield will be discontinued if/when the current one needs to be replaced. This is not a problem, it will probably fit onto the Arduino Mega in the same manner. The one issue is that the code will likely need to be adjusted because the new motor shield will utilize a different library than the current shield. This should be straight forward with the help of Google and the Adafruit guides.
3. LCD screen: bought from Adafruit.com: any LCD screen will work but I suggest buying the adafruit product 772. This includes a shield as well as a LCD screen. You do not need the shield but the kit is quality and you only pay an extra $5 or so.
4. remote control: bought from adafruit.com product number 389: uses 3 volt lithium battery, CR2025
5. IR sensor bought from adafruit.com, product number : 157
6. 10 kΩ variable resistor: "borrowed" from electronics lab
7. red LED: "borrowed"" from electronics lab
8. Motor: 9V, 10,000 rpm (no load), Dimensions: casing diameter = 28mm; shaft diameter = 2.28 mm

5 circuit

There are really two circuits in the spin coater. One to power the Arduino and one to power the motor.

The circuit to power the motor is very simple. The power source is connected to the motor shield at the "power port." This is located along one of the "long" sides of the motor shield. **There are two prongs directly behind the power port labeled "VIN Jumper." It is essential that these two prongs are never connected while the power source is plugged into to the power port. If they become connected it will short out the Arduino, and a new Arduino and possibly a new motor shield**

will be required. (The VIN Jumper is used when the Arduino acts as the power source for the motor. However, the power output of the Arduino is insufficient for our needs)

Then the motor shield is connected to the motor via the M1 port on the motor shield.

The circuit that powers the Arduino is much more complicated. It incorporates, the Arduino, motor shield, LCD screen, IR sensor, Red LED, and variable resistor.

The Arduino is center of everything and all of the other components are connected to it. The motor shield fits onto the Arduino and occupies Arduino digital pins 1 through 13 as well as analog pins through A5. It should be obvious how the motor shield should fit onto the Arduino because there is only one configuration that utilizes all of the motor shield pins.

The LCD has 16 pins. The spin coater utilizes 12 of those pins. The pins are visable from the bread board on the underside of the LCD screen. Each pin is labeled through 16.

Pin 1 is connected to ground as well as the variable resistor. Pin 1 connects to the variable resistor using a blue wire.

Pin 2 is connected to a 5 volt pin on the Arduino. Pin 2 connects to the variable resistor using a red wire.

Pin 3 connects to the variable resistor using a white wire.

pin 4 connects to digital pin 22 on the Arduino.

pin 5 connects to ground.

pin 6 connects to digital pin 31 on the Arduino.

pin 11 connects to digital pin 35 on the Arduino.

pin 12 connects to digital pin 34 on the Arduino.

pin 13 connects to digital pin 43 on the Arduino.

pin 14 connects to digital pin 42 on the Arduino.

pin 15 connects to digital pin 48 on the Arduino.

pin 16 connects to ground.

The IR sensor and LED are integrated into the circuit in the following color coded manner. While facing the "bump" on the IR sensor:

The left most lead is connected to Arduino Pin 49 using a white wire.

The left most lead is also connected to the short red LED lead using a Yellow wire (Parallel).

The middle IR senor lead is connected to ground using a blue wire.

The right IR senor lead is connected to the long lead on the LED using an orange wire.

The Right IR senor lead is also connected to a 5 volt pin on the Arduino

6 trouble shooting

There is not a problem with the code, if there was, it never would have worked in the first place.

If the spin coater is malfunctioning, the first thing to check is if the senor is receiving a signal from the remote control. To test this, simply point the remote at the sensor and press any button, any time the sensor receives a signal (regardless of whether or not the Arduino reads it) the red LED should light up. If it does not it probably means that the battery in the remote needs to be changed. If a new battery does not do the trick then there may be a problem with the circuitry of the spin coater. The final possibility is that the circuitry of the remote is faulty and a new remote is required.

Another malfunction that I predict is that the wires that connect to the motor shield may become lose. If this happens reposition them so that the metal leads make solid contact with the motor shield.

If the spin coater is left on for a long period of time ($>$ 1 week) the timer will malfunction. Therefore, **unplug the spin coater after every use**.