Assessing the Effectiveness of a Microwave as a UV Exposure Unit for 3D Printed Materials

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ABSTRACT

3D printing antennas for weather measurements is a much more time efficient method than buying them. This project aims to make a quicker, more repeatable process for fast production antennas. Using a microwave oven, UV light strips, and adhesive mirror sheets, a low-cost alternative ultraviolet exposure unit was made. The construction process for the unit is detailed along with a comparison of the prototype work with a lab-grade exposure unit.

INTRODUCTION

Buying antennas or antenna parts can be very expensive and can take up to 8 weeks or more to arrive. A more time efficient and cost effective substitute would be to 3D print the antennas using stereolithography. [1]Stereolithography (SLA) is an additive manufacturing technology that uses a ultraviolet (UV) laser to cure liquid resin into hardened plastic. It can be used to produce visual prototypes and models of antennas. Taking the printed material and then copper plating it would allow the material to be used as an antenna.

An issue is that the hardened plastic would not be durable and solid enough for the copper plating to stick. This situation would require the hardened plastic to be put in a UV exposure unit. UV Exposure Unit is a post curing device that is used to further harden plastic material that has been 3D printed. This device would make the plastic durable enough for the copper plating to stick with no issue. Unfortunately, a lab grade exposure unit is very time consuming. It can take about 24 hours to a couple of days to reach the desired solidity for copper plating.

The purpose of this project is to transform a consumer microwave to a UV exposure unit, and to assess how much more effective it is based on time and performance. Both devices would essentially have the same components to cure plastic, a light source producing UV rays, a built-in timer, etc. However, a lab-grade exposure unit would not have a rotation platform that comes with a microwave. The rotation platform would allow the device to cure evenly all around the 3D printed material, especially spherical objects. With UV lights all around the inner cavity of the microwave, along with the rotation platform, the plastic could be cured within 30 minutes to an hour evenly. This would be a much more affordable and time efficient replacement for a lab-grade exposure box.

METHODS

The materials used to conduct this project were a Westinghouse 700-Watt Microwave, adhesive mirror sheets, and UV LED light strips. The microwave provides the chamber and the rotation platform that will hold the hardened plastic. The adhesive mirror sheets are to reflect the UV rays all around the inner chamber so that the whole material can be exposed better. The UV LED light strips will supply the UV rays that will cure the plastic. [3] The UV lights have to emit a wavelength of 365 or 395 nanometers in order to cure resin.

Before you get started you must make sure that the microwave is not plugged in. The first step is to unscrew the lid surrounding the sides and the top of the

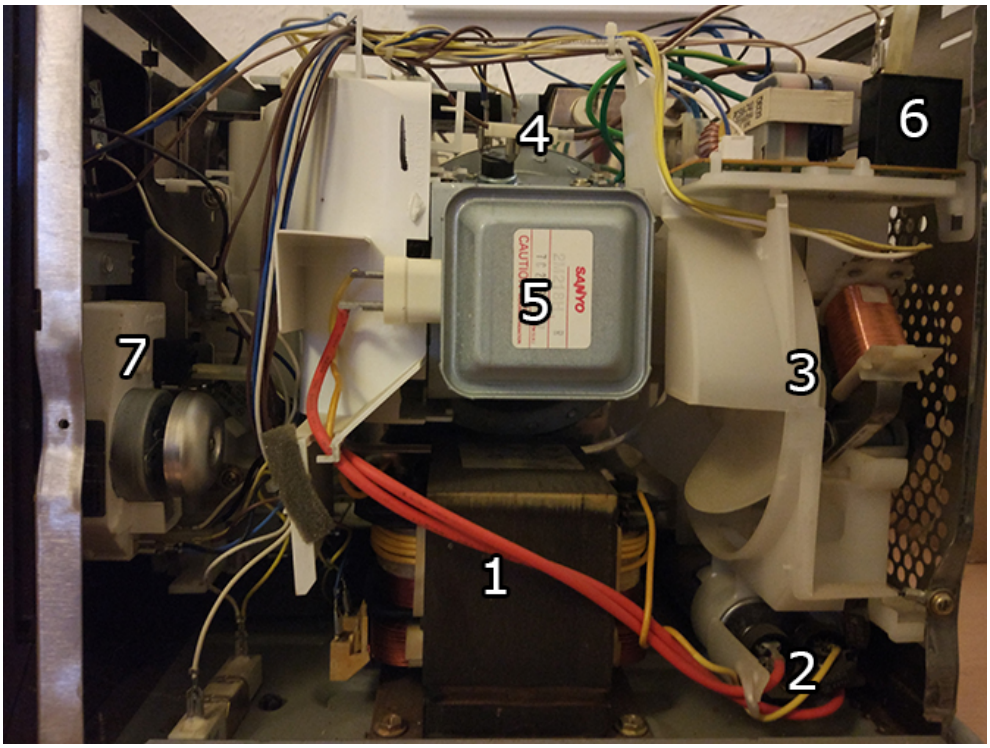

Fig. 1. [2]Microwave Oven Parts: (1)Transformer, (2) Capacitor, (3)Fan, (4) Thermostat, (5)Magnetron, (6)Relay, (7)Front Panel

microwave to get to all the main components. This will require a tool kit that can remove security torx screws.

The second step is to identify the magnetron, capacitor, and transformer and then take each one out. These are the components that will need to be taken out. The magnetron is the part that creates the microwaves that cook food. This will not be needed as a part for the UV exposure unit. Make sure to look to see where the screws are on the magnetron because you might have to take the transformer out first. The transformer is the part that generates the right voltage to power the magnetron. If this is the case, unscrew the transformer out and pull the two wires off so that you can access all the screws around the magnetron. After that, carefully unscrew the capacitor out, making sure that you do not touch anything else but that screw.

The third step is to take the oven lamp out and disconnect the wires that connect to it. The oven lamp will not be needed since UV LED lights will be used inside the microwave. Bend the two corner pieces holding the oven lamp in place so it can be removed. Then pull the two wires off of the oven lamp and wrap the ends with electric tape so that the current going through them will be contained.

The fourth step is to take out the fan, the fan motor, and to disconnect the wires. The fan is in the microwave to cool off the magnetron and since the magnetron won't be any use to the project, the fan will not be needed. Unscrew the fan motor out and pull the two wires off. These will also need to be wrapped with electric tape.

The fifth step is to make sure that the thermal fuses are still connected. The microwave will not come on correctly, once plugged in, if the thermal fuses are disconnected. When these are connected to the original wires they were connected to, the microwave should come on once plugged in.

The sixth step is to attach the AC adapter for the UV LED lights to the two wires that were connected to the transformer. These two wires have 120 volts AC, the same amount that the adapter would get from being plugged into the wall. Once the adapter is attached to the wires it should be able to convert the voltage to 12 volts DC. This will allow the lights to turn on.

The seventh step is to cut the adhesive mirror sheets

to fit inside the microwave. The left, right, back, and top parts of the inner chamber should be covered with a mirror sheet. A ruler can be used to get the dimensions and a 15-inch paper cutter can be used to cut the mirror sheets to the correct length and width. The glass turntable would also need to be covered so that the bottom of the material can cure as well. This can be done by taking the turntable out, setting it on top of a mirror sheet, and tracing around it with a marker. After this cut the circle out with a pair of regular scissors. Once all of this is done, apply all the mirror sheets inside the microwave.

The eighth step is to drill a hole into the sheet metal of the microwave. This needs to be at the top-right of where the magnetron was. This will be where the cord connecting the UV LEDs and the AC Adapter will go through. Get a drill bit that is better suited for cutting through sheet metal and make a hole size bigger than the size of output cord.

The ninth step is to cut and solder the UV LED lights. They should surround the inside of the microwave as much as possible. Starting from the top right side of the inner chamber, where the hole should be, the lights can go up to the top wall and down the left wall of the inner chamber. About an inch above the bottom of that wall, the lights should be cut. the next piece can be connected with two pieces of thin jumper wire; positive connecting to positive and negative connecting to negative. The lights should cover most of the side walls and the top wall. The back wall should also be covered.

The last step is to glue the UV LED strips to the mirror sheets. This can be done with an instant adhesive. Place the lights in the same order they were soldered.

Fig. 2. Inside of the Microwave Oven as an UV Exposure Unit

CONCLUSIONS AND FUTURE WORK

A scientific method to test the effectiveness of the microwave oven as a UV exposure unit would be to test how well it cures. This can be done by using different drops of liquid resin varying in thickness in the microwave oven and the lab-grade exposure unit. Evaluating the curing like this can give us results on the amount of energy that the UV LED strips are emanating in comparison to the UV bulbs in the lab-grade unit.

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