

The Operation Manual for  
**P $\mu$ SL 3D-Printer**  
in portable mode  
(McKay 304)

*Tianyu Gu  
Sicong Shan  
Bertoldi Group*

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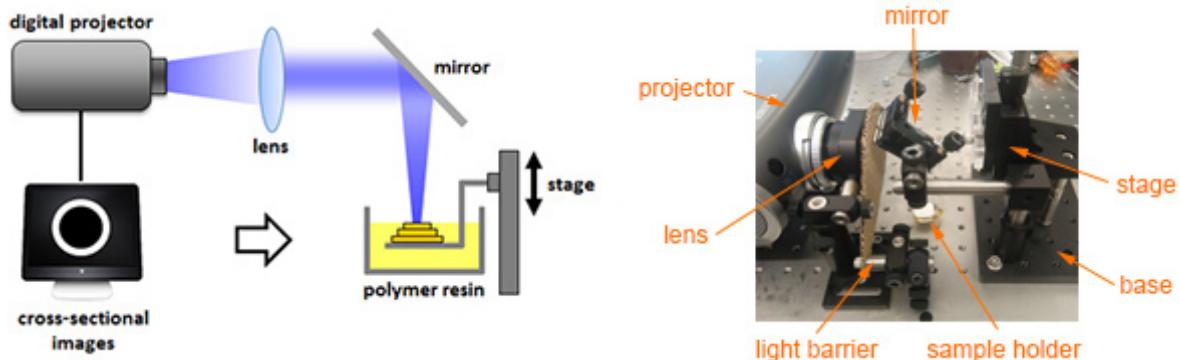


# 1 Device Introduction

The projection microstereolithography ( $\mu$ SL) a novel freeform 3D micro-fabrication technology which is capable of rapidly fabricating highly complex 3D microstructures in a layer-by-layer fashion. This device use a digital data projector and simple optical components like a convex lens and a mirror. Image will be projected on the photosensitive resin surface, polymerizing liquid resin into a desired 3D solid structure.

This device is a minimum system of projection micro stereolithography ( $\mu$ SL) 3D-printer, adopting the technology from Howon Jove<sup>1</sup>. The devcie is with low resolution (about 200 $\mu$ m) but very easy operation and large printing area. It's built for testing the characteristic of new materials like curing time, curing depth, fluidity and so on.

In this section, I will introduce the hardware, the software and the materials we used for the device.



## 1.1 Hardware

### 1.1.1 projector



The projector is core part of the device. It is connected to the computer and the desktop background will be projected out. Just change the background when you want to be project different images. **Push the power button** to turn on the projector and **double-push** to turn it off. **Rotating the ring** on the projector lens can adjusting the focal length and making the image sharper.

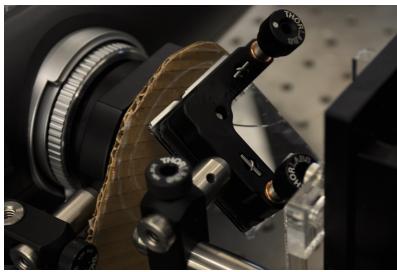
### 1.1.2 Convex Lens



The convex lens is used to decrease the projected image as well as shorten the image distance. Then image is able to projected on the sample holder fix on the linear stage next to the projector. A light barrier is set in front of the lens. It's used to block the optical path. As the convex lens is well adjusted, it's strongly adviced not to adjust it again in general use. But if you have to, please see the appendix at the end of this manual.

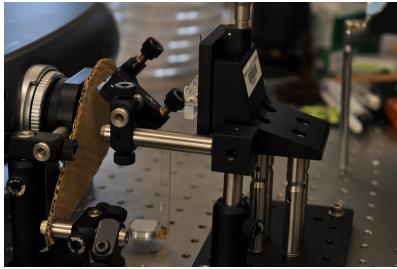
<sup>1</sup><http://www.jove.com/video/4457/micro-3d-printing-using-digital-projector-its-application-study-soft>

### 1.1.3 Mirror



The mirror rotates the main optical axis and lets the image be projected onto the sample holder. Note that the mirror should be placed in a specific distance in front of the lens. More details about this will be introduced in section 1.1.4. If you have to adjust the mirror, please see the appendix.

### 1.1.4 Linear Stage



The linear stage is also one of the most important parts. There's a sample holder fixed on it. Rotate the knob clockwise to lower the stage and counter-clockwise to raise the stage.

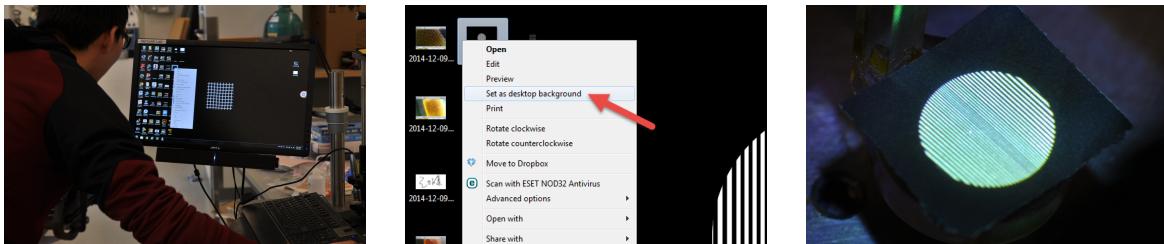
// TODO need to expand

The **stage assembly** is *stage + base + sample holder + mirror*.

## 1.2 Software

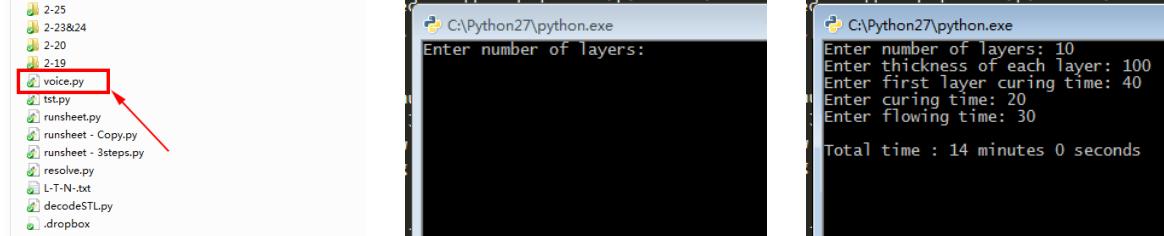
The portable projector actually does not need any softwares because it is meant to be operated manually. But there are still some works on computer.

- When you need to **change the projector's image output**, you should change the desktop background of the computer by **right click - set background**.



- An python program is written to help with the operation.** It can give out vocal instructions to assist you to do the right action at the right time. Four parameters should be set every time you open the program. The *number of layers* you need to print (depends on the height of sample and each layer), the *thickness of each layer*, the *first layer curing time*, the *other layers curing time* (both need to be tested with different materials and also depend on the cross-linking density you need) and the *fluid flowing time* (depends on the fluidity of the material, should be set long enough for the material liquid level covering the whole sample within this time).

After you finish inputting the parameters, the vocal assistance will start in 10 seconds.



## 1.3 Materials

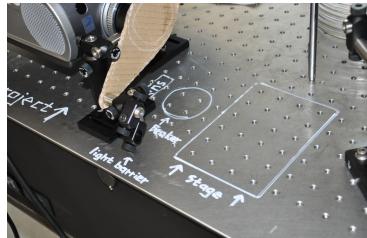
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## 2 Normal Operation Procedure

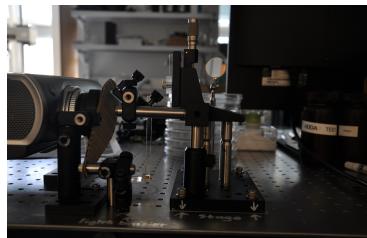
In this section, I will introduce the normal operation procedure for the 3d-printer. Just follow the steps. To your own safety, always wear gloves before doing anything and wash hands after experiments.

### 2.1 Preperation

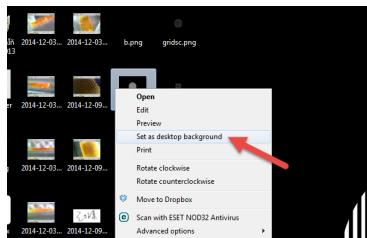
- **Step 1 :** Put the stage in right place. The mirror shall be about  $\sim \frac{1}{2}$  inch in front of the lens. Also make sure that the screws on corners are embedded into the holes on the table.



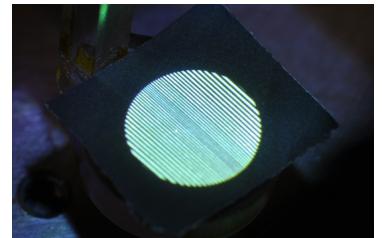
- **Step 2 :** Check the position of linear stage. Make sure that the initial position is 5mm as shown in picture.



- **Step 3 :** Now open the computer. Set 'tst.png' as desktop background. Turn on the projector and open the light barrier by rotating it.



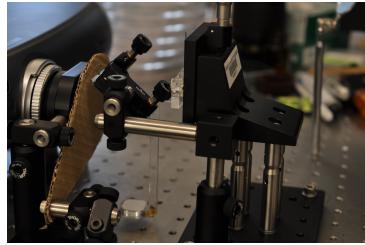
- **Step 4 :** Put a small piece of black paper on sample holder. Adjust the focal length by rotating the ring shown in picture until the image is sharp enough.



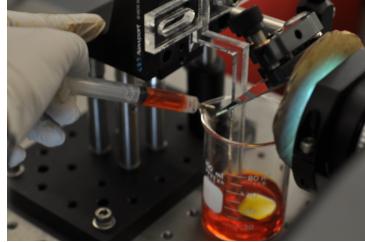
- **Step 5 :** Remove the black paper and close the light barrier, now the device is ready for printing.

## 2.2 Printing

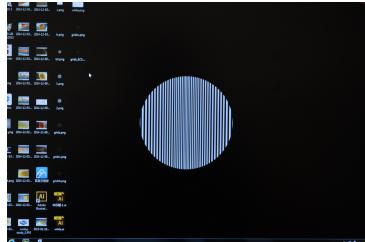
- **Step 1 :** Add about 20ml of material into a beaker outside. Take away the stage assembly so that the beaker can be put on the marker. Then put the stage assembly back carefully on the marker on table.



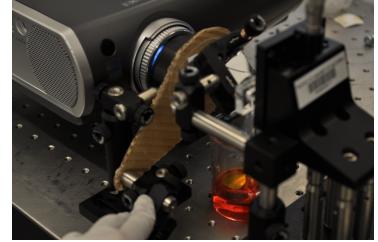
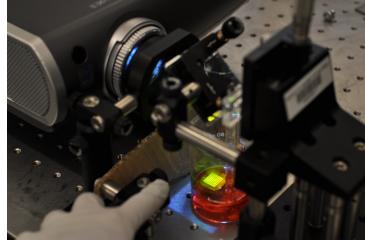
- **Step 2 :** Add material carefully with a small syringe. When the liquid level is just above the printing panel, it's ready to print.



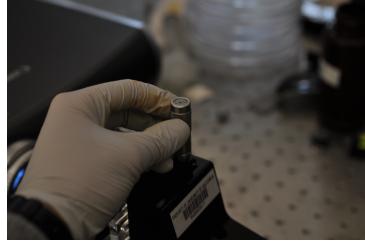
- **Step 3 :** Set the image you need to print as desktop background. Open 'voice.py' and input the parameters. Then Go back to the printer immediately. See more in Sec1.2.



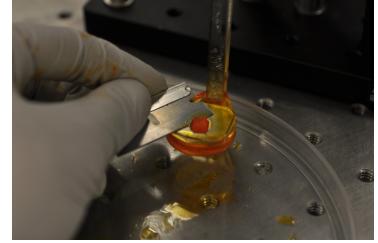
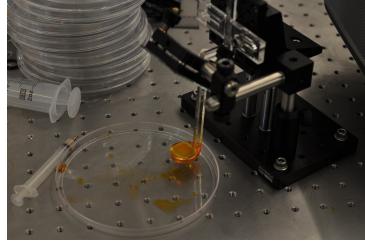
- **Step 4 :** Follow the voice instruction. When hearing 'Projecting', open the light barrier. After several seconds set in step 1, you will hear 'finish' which means you should close the barrier.



- **Step 5 :** When hearing 'lower the stage', lower the linear stage. The distance depends on the layer height of you sample.



- **Step 6 :** Repeat step 2 & 3. When hearing 'Fabrication finish', the sample is done. Take away the stage and cut the sample off carefully with a blade.



- **Step 7 :** Clean up the sample holder with isopropanol then put the stage back.