Intel Ohio One – The Silicon Heartland

Automated Patterning System Challenge

Challenge Abstract (Authored by E-Club)

Photolithography is a crucial step in the chip manufacturing process, which consists of projecting patterns of light on coated silicon to etch conductive patterns into it.

In some methods of photolithography, such as step and repeat photolithography, only a portion of the silicon is projected on at a time. In situations like this, a moving platform with precise X and Y movement (called an "XY stage") is necessary to step the silicon automatically and continuously etch a full pattern.

This challenge prompts teams to take an existing motorized XY stage and implement alignment. A USB microscope and alignment slide with micrometer divisions is provided along with the motorized XY stage. Creativity in this challenge is encouraged, and the goal is to maximize precision.

Background

A key step in manufacturing semiconductors is the photolithography process where patterns are printed on a wafer to manufacture devices like transistors, resistors, capacitors etc. This usually requires very expensive equipment and facilities to print these devices during the manufacturing process. Recently, DIY maker community has invented less expensive methods, which could be a great benefit to educate students about semiconductor device manufacturing and an opportunity for schools that cannot afford expensive photolithography equipment. A great example is the Hackerfab (https://docs.hackerfab.org/hacker-fab-space). In addition, a hackerfab facility provides more student access than an expensive nanotechnology facility. Currently, the Hackerfab organization consists of Carnegie Mellon University (CMU), University of Waterloo, The Ohio State University and University of California, Irvine, as well as industry professionals and other enthusiasts. Finally, setting up a semiconductor manufacturing DIY facility would be a great student organization community activity where students can further explore with other students.

Challenge

Explore the Hackerfab website as a resource to innovate & demo initial hardware and software components for micro-making. The focus of this challenge is a photo-patterning equipment stage. Design and develop parts of the photo-patterning such as microcontroller closed loop feedback for positioning a DIY stage. Teams are welcome to explore other additional components to further improve their patterning stage. The primary goal of this challenge is to deliver an automated photo-patterning stage with statistical data showing alignment position

accuracy on a given sample and from one sample to the next. Each team will be provided with the below devices to design and develop their automated photo-patterning stage.

Guidelines and Tips

1. After developing and calibrating your automated stage a validation measurement would be performed using a calibration slide to check for accuracy.

2. Explore the Hackerfab website Drive, Github (https://github.com/hacker-fab), and Gitbooks areas for ideas to develop components helpful for micro-making. Prototype your device for later transfer to a micro-making facility.

3. Explore developing a hardware plus experiments kit that can be used by students in their home setting for micro-making processes that can lead to technology learning and transfer to a micro-making facility.

Judging Criteria

1. **Innovation and Creativity** – Does the solution bring new ideas and improvements to DIY stage accurate movement?
2. **Design & Build Quality** – Is the design well thought out? How polished is the prototype? Is the prototype especially transferable to a micro-making facility?
3. **Solution Completeness** – Does it work? Is there a roadmap for future enhancements and automation?
4. **Cost Effectiveness** – How does the solution address the cost needed to scale and used by all students to learn about technology and semiconductor manufacturing?

Challenge Prizes

1st Place -

2nd Place -

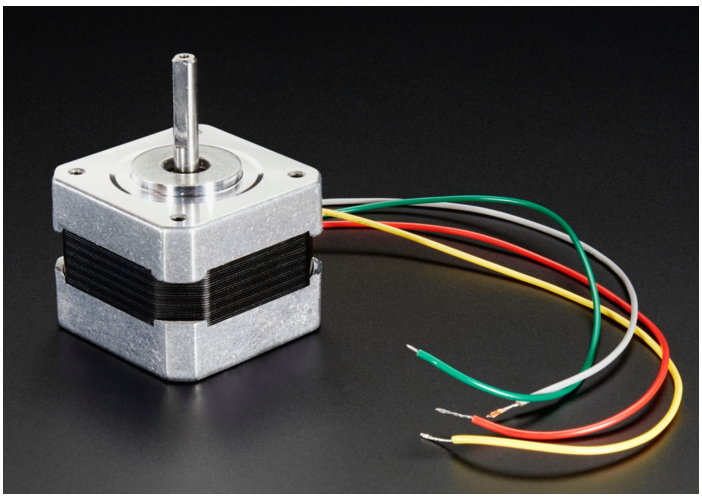
Honorable Mention -

Devices and Components Students Will Receive

1. **XY Linear Stage**

2. **USB Microscope**

3. **Two Stepper motors per stage – NEMA 17 200 steps/rev, 12V 350mA**

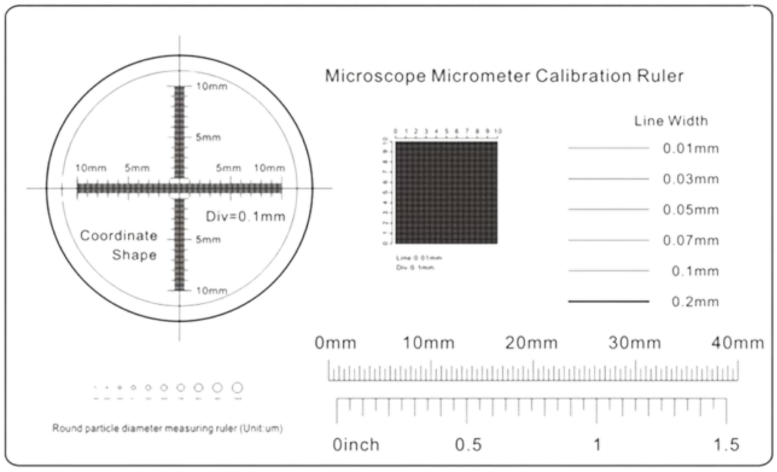


4. **Arduino microcontroller**

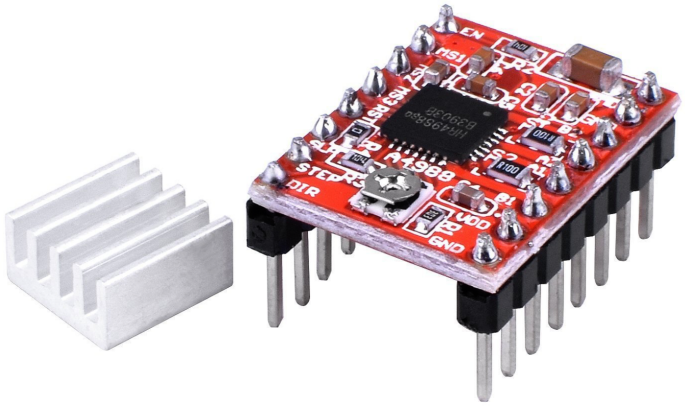
   An arduino pro micro is provided.

5. **Measurement sample**

   Provided calibration slides have multiple micrometer sized features that can be used.



6. **Stepper Motor Drivers – A4998 Stepper Motor Drivers 35V +/- 1.2A**



7. **3D printed components**

   3D printed parts to couple the stepper motors to the XY stage micrometer heads (the adjustment knobs).

Links and Other Resources

- Breaking Taps video on photolithography and maskless lithosteppers (https://www.youtube.com/watch?v=RuVS7MsQk4Y&t=1230s)
- Hackerfab Gitbooks (https://docs.hackerfab.org/hacker-fab-space)
- Hackerfab Lithostepper V2 Docs (https://docs.hackerfab.org/hacker-fab-space/fab-toolkit/patterning/lithography-stepper-v2-build-work-in-progress)
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Image of Prototype Stage