ME 363 LAB #9: SOFT LITHOGRAPHY PART I

Photographic mask-making

Meet in Potter 333

Introduction: Recent advances in micrometer-scale patterning and molding of "soft" materials, typically polymers, have allowed the efficient and inexpensive production of intricate microstructures with feature sizes of order 10 micron. At this size scale, many useful features can be incorporated into prototypes for micro fluidic elements and other MEMs structures. The distinguishing feature of a soft lithography manufacturing system is the replacement of expensive and complex sub-micron lithography tools, which are necessary for solid-state electronic devices, with a vastly simplified and time-saving process that involves the use of standard office printers and 35mm photography for the production of lithographic masks. These masks, which can be produced in a matter of minutes, are used to pattern photoresist materials, which become masters for the creation of molded MEMs structures and devices. The process steps learned in this laboratory are identical to those used in solid-state electronics.

Purpose: To be familiar with facilities used in soft lithography processes and to design and make a photographic mask. The mask will be used in the next lab (lab#10).

Instruments: Computer&printer, 8"x4" Lightbox, Nikon FM3A with 105mm Micro Nikkor lens.

Materials: 3M transparency film, Kodak Ektagraphic 36mm B&W Film, B&W film developing chemicals, film cover.

Procedures:

1. Pattern Design:

Figure 1 shows two pattern examples that were used in this lab. These patterns were designed by using Adobe Illustrator or AutoCAD and print onto transparency films. In preparation of this lab, you must design your own micro pattern before the lab. The patterns you design must be **different** from the examples shown in Figure 1 and it is preferred that they also have potential engineering applications. You can use the Adobe Illustrator software (or some other software) to draw your own pattern and upload this file (*.jpg or *.pdf) to Brightspace so that your TA can print them transparency films.

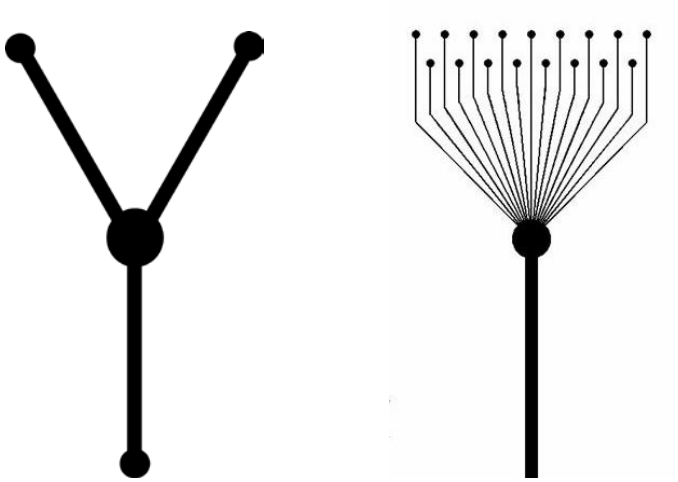

Figure 1. Basic example patterns for soft lithography lab. (illustration purpose only)

2. Calculate the distance of the film plane from the object (D):

After the pattern is printed onto a transparency it will be photographed with a 35mm camera. This process reduces the size of the image and exposes it onto a high-contrast black-and-white 35mm film. The distance of the film plane from the object, D is a function of optical reduction ratio, RR, and is given by

$$D = 0.0556*RR + 0.101 \text{ (meters)} \quad (1)$$

The optical ratio is about 7.7 when photographing the pattern from a standard transparency to a 35 mm film. Substitute the value of RR and calculate the distance D.

3. Mount Transparency onto Lightbox:

Tape the four corners of the transparency. Try to ensure that the transparency is flat and wrinkle-free.

4. Photograph the Pattern:

Position the camera and ensure that the camera is viewing perpendicular to the surface of the lightbox. After proper camera alignment the keys to success are (a) focus, (b) exposure.

(a) Focus is achieved by looking at the pattern through the viewfinder and moving the focus bezel back and forth until the image is sharpest.
(b) The optimal image is achieved with an f-stop of 11 and 1 second shutter speed (exposure time). The f-stop represents the size of the iris opening. Small and large f-stop numbers represent large and small openings, respectively. Therefore, as the f-stop number is decreased more light is transmitted to the film.

Each group should take **FOUR** photographs of their pattern at different exposures near the nominal value and different distance D. Let each group member practice focusing and adjusting the exposure. After every

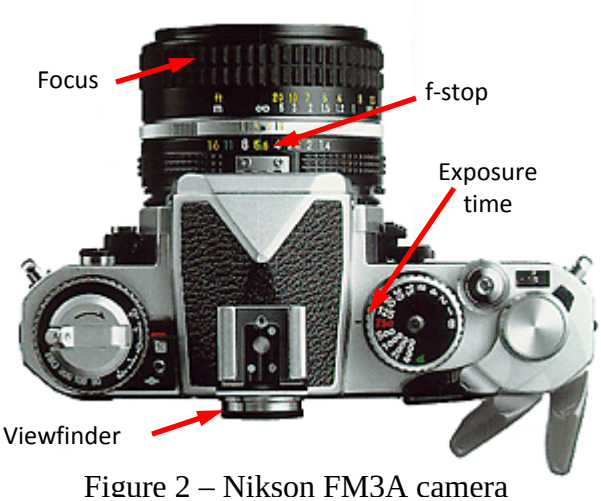

Figure 2 – Nikson FM3A camera

group takes the picture, TA will collect the film and develop in dark room.

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5. Introduction to facilities used in soft lithography processes

After taking the photograph, TA will brief the facilities used in soft lithography. These facilities include:

- 144 sq. ft. class 10,000 clean room (in Potter 333)
- Class 10 solvent hood
- Suss MA1006 mask aligner
- Delta-10 spin coaters
- Hot plate and convection oven for soft and hard baking

<u>The items to be included in the report: (one final report for lab#9 and lab#10)</u>

1. Your own pattern printed in paper, with dimensions labeled
2. Pattern on transparency
3. Optical microscope image(s) of the micro pattern made by the soft lithography

Group number:

Image #	f-stop	Shutter speed (sec)
1	11	1/250
2	8	1/250
3	5.6	1/250