

## **1. Using the High Magnification Optical Inspection Microscope**

The optical microscopes within the cleanroom are used for optical characterization of device wafers at various points in the microfabrication process. Several contrast mechanisms and a range of magnifications are available. Additionally, the microscopes are equipped with a camera that can take instant pictures. This feature should be used heavily to document various stages of work in a routine manner. Within the cleanroom, there are two microscopes: a standard 4-objective, high magnification microscope, and a stereo zoom microscope for lower power magnification and larger depth of field.

### **1.1. CAUTIONS**

There are several ways in which to damage the microscopy equipment. These actions should be avoided, and the equipment should be treated with care and concentration. Specifically, four errors should be studiously avoided.

#### **1.1.1. Crashing the nosepiece**

When looking through the eyepieces, always turn the focusing knobs such that the stage is moving away from the objectives (i.e. down). Start with the stage close to the optics and then move it away. This avoids the lens touching the work piece and scratching it or getting debris on it.

#### **1.1.2. Jamming the camera**

When working with film, make sure to operate the camera properly, setting the levers in the correct positions to introduce and remove the films. The sequence of actions is detailed below, and is straightforward but it is possible to become confused. Additionally, a firm pull is necessary at certain points in the process, and it is important to pull only when appropriate. Doing otherwise can jam the camera.

#### **1.1.3. Lamp misuse**

Only cycle the power on the microscope lamps when they are on their lowest settings. Do not leave them on when you are not using them. This will prevent premature bulb burn-out.

#### **1.1.4. Dropping or mishandling optics**

Optics are fragile, and must be handled with care. It is particularly important not to drop them or allow them to roll off the table onto the floor, or to become scratched or damaged.

### **1.2. Viewing Images**

#### **1.2.1. Obtaining a low magnification image in reflection**

- 1.2.1.1.** Make sure that the illuminator knob on the back right of the microscope base is on its lowest setting
- 1.2.1.2.** Turn on the illuminator power switch at the left rear of the microscope base
- 1.2.1.3.** Turn up the illuminator to the desired level
- 1.2.1.4.** Position the nose piece so that the 5x objective is pointing at the work piece.
- 1.2.1.5.** Raise the stage with the focus knob so that the work piece is 1-2 mm below the objective
- 1.2.1.6.** Make sure that something in the field of view can produce contrast
- 1.2.1.7.** Lower the stage with the focus knob, until the image comes into focus

#### **1.2.2. Changing magnifications**

- 1.2.2.1.** Rotate the nose piece ring, to which all four objectives mount until the desired objective is in the proper location
- 1.2.2.2.** DO NOT grab individual objectives to rotate the assembly
- 1.2.2.3.** When moving objectives always go in increasing order, stopping to focus at each magnification setting
- 1.2.2.4.** Take special care not to crash the higher power objectives, as they will be very close to the work piece.

1.2.2.5. Always move the stage down to focus

1.2.2.6. The microscope is configured such that all of the objective focus in approximately the same plane s, so it should only be necessary to adjust fine focus when moving form one magnification to another.

### 1.2.3. Dark field mode

1.2.3.1. On the lower power objectives (5x and 20x), a dark field image may be constructed by pulling on the rod on the side of the microscope labeled “Pull B.F.”

1.2.3.2. Note there are a number of rods on the right side of the microscope that can be adjusted. Refer to Figure 1 for a guide about which ones can be adjusted.

### 1.2.4. Phase contrast mode

1.2.4.1. Insert the polarizer in the optical path. It is usually situated near the microscope.

1.2.4.2. Insert the analyzer in the optical path. It is located below the eyepieces, and can be slid in and out with modest pressure. It has a lever to adjust the angle between the analyzer and polarizer from 0 to 45degree.

### 1.2.5. Wavelength filters

1.2.5.1. There is a green filter, that is usually situated to the right of the microscope that can be placed in the optical path to avoid exposing photoresist, if this is desired.

## 1.3. Taking photographs

Taking photographs of work pieces is a common practice for documenting work, and recording steps in the fabrication process.

### 1.3.1. Activating the exposure control unit (PM-10AD)

1.3.1.1. Turn on the switch on the right side of the unit

1.3.1.2. Check settings to make sure they are set to standard values.

1.3.1.3. Refer to the manual on the unit with any questions. It is usually situated on top of the box.

### 1.3.2. Configuring the illumination for photography

1.3.2.1. Select an image to be captured on film, by examining the work piece through the eyepieces.

1.3.2.2. Increase the amount of light hitting the sample to a the maximum tolerable value. This includes removing any filters or polarizers from the optical path that are not necessary to the photograph.

1.3.2.3. Set the light path selector knob to the appropriate value. This knob can be seen in Fig 1 on page 3 of the instruction manual for the PM-10AD.

1.3.2.3.1. All the way out sends all light to the monocular telescope on the PM-10AD body. Photographs cannot be taken in this mode.

1.3.2.3.2. Half way out sends some of the light to the film, while using the rest to form an image in the telescope. Images can be photographed in this mode.

1.3.2.3.3. All the way in sends all of the light to the film, thus minimizing the exposure time for photos taken in this mode.

However,. the image cannot viewed before photographing.

### 1.3.3. Selecting the camera eye-piece

1.3.3.1. Remove the camera from the camera mount by loosening the appropriate thumb screw, and lift the body of the camera. Be extremely careful to support the camera throughout this process.

1.3.3.2. The camera eye-piece can be seen in the optical hole exposed when the camera is removed.

1.3.3.3. A 2.5x and a 6.7x camera eye-piece are available.

1.3.3.4. The 6.7x one is typically kept in the high magnification microscope, while the 2.5 x is typically kept in the stereoscope. Neither eye-piece should

ever be left out of either microscope.

**1.3.3.5.** Always re-install both eye-pieces after switching them, and make sure both are covered. There is a plastic cover for this purpose, for one eye-piece and the camera covers the other, depending on which microscope it is mounted on.

**1.3.3.6.** Page 26 in the PM-10AD manual details the magnification that each of these camera eye-pieces result in.

#### **1.3.4. Selecting film**

**1.3.4.1.** Choose film that will allow for a reasonably short exposure time, given the available light. Short is less than a second or two.

**1.3.4.2.** Exposure time for a given film can be determined by setting the PM-10AD to ASA corresponding to film, and noting the calculated exposure time on the right display.

**1.3.4.3.** Type 52 film has an ASA number of 400, while type 57 is much “faster” film and has an ASA number of 3000.

**1.3.4.4.** For low light conditions, use the type 57 film to minimize long exposures.

#### **1.3.5. Loading film**

**1.3.5.1.** Note the side of the film that must be facing toward the camera, and observe that convention.

**1.3.5.2.** Move the camera lever to the L-position, for load.

**1.3.5.3.** Slide the film into the film holder, taking care to support the film and not wrinkle it on insertion. A firm touch must be used here.

**1.3.5.4.** Slide the film in until a click is observed

**1.3.5.5.** Slide the film cover out until a stop is encountered. The film is now exposed inside the camera waiting for the shutter to be opened.

#### **1.3.6. Exposing**

**1.3.6.1.** Check the focus through the telescope on the PM-10AD body. The focus is often slightly different from the position appropriate for the eyepieces. Furthermore the focus can be disrupted by manipulating the film, and should always be checked after loading the film.

**1.3.6.2.** When image is focused and framed properly in the telescope, press expose on the PM-10AD unit, and wait for exposure to complete. For longer exposures, the display counts down while the shutter is open.

#### **1.3.7. Removing film and developing**

**1.3.7.1.** Slide the cover back into the film holder unit

**1.3.7.2.** Slide the film holder lever to the “R” position

**1.3.7.3.** Grasp the film with the right hand, while bracing the camera with the left. This bracing is crucial to making sure the microscope does not tip over.

**1.3.7.4.** In a firm smooth motion, pull the film all the way out of the film holder. You may meet some normal resistance as the thicker end of the film passes through the rollers within the film holder body near the lever location

**1.3.7.5.** Always make sure the lever is in the correct position for the task at hand.

#### **1.3.8. Logging film charges**

**1.3.8.1.** After taking all photographs in one session, log the number of photos of each type taken.

### **1.4. Shut down**

#### **1.4.1. Stage position**

**1.4.1.1.** Position the stage at its lowest point of travel

**1.4.1.2.** Center the stage in x and y

#### **1.4.2. Objective position**

**1.4.2.1.** Set the active objective to the lowest power (5x)

### **1.4.3. Lamp power down**

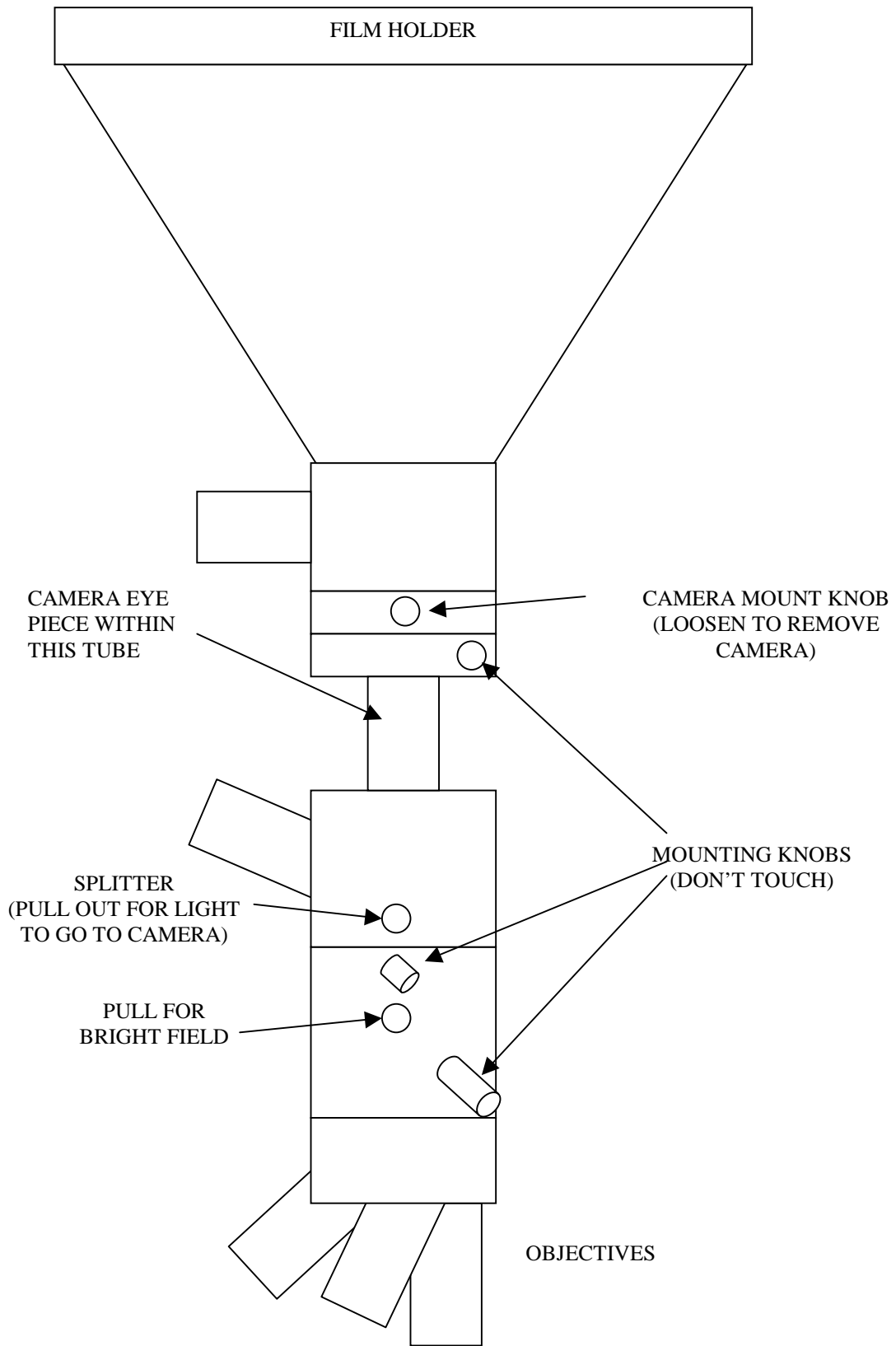
**1.4.3.1.** Turn all illuminators to their lowest setting

**1.4.3.2.** Turn off all illuminators

## **2. Using the Stereo Microscope**

### **2.1. Viewing Images**

Viewing images in the stereo microscope is somewhat simpler than the high power microscope. It is simply necessary to turn on the illuminator, and focus the images. This document will not go into detail about the operation of the stereoscope at this time. A future version of this documents will cover these issues.



**Figure 1: A side-view schematic of the high magnification microscope, showing the different working parts, and the function of various knobs.**