

# University of Minnesota Nano Fabrication Center

## Standard Operating Procedure

**Equipment Name:** KARL SUSS MJB3

**Coral Name:** mjb-3

**Revision Number:** 1

**Model:** MJB3

**Revisionist:** Tony Whipple

**Location:** Bay 2

**Date:** 21 Jan 2004

### 1 Description

The Karl Suss MJB3 exposure system is an optical contact aligner which transfers a pattern from a glass mask to a photoresist coated wafer by exposing it to ultraviolet light with wavelengths of 365 um or 320 um.

### 2 Safety

The only safety concern is the system uses electricity and has a UV light source.

### 3 Restrictions/Requirements

Must be a qualified user on mjb3.

The imitations for the substrate is that it must not damage the system.

### 4 Required Facilities

Nitrogen gas

House vacuum

### 5 Definitions

#### FRONT CONTROL PANEL

**POWER Button** - Pressing the POWER button switches on the mask aligner. When the machine is powered, the POWER button is illuminated. Do not every touch this, as it should always be ON.

**CONTACT Indicator** - The CONTACT Indicator is illuminated whenever both the contact lever and the separation lever are in the contact position. The substrate is then in contact with the mask. It is not possible to perform alignment when the contact Indicator is lit.

**SEPARATION Indicator** - This indicator is illuminated when the contact lever is in the contact position and the separation lever is in the separation position. The substrate is then separated from the mask by a small distance to allow alignment to be performed.

**EXPOSURE Button**- Pressing the EXPOSURE button initiates exposure and illuminates the button until exposure has been completed. The exposure time is determined by the setting on the exposure timer.

**VACUUM MASK Button**. Pressing the VACUUM MASK button switches on the mask vacuum at the mask holder and illuminates the button. In order to avoid damage to masks which may inadvertently be left in the machine, the mask vacuum is always on whenever the machine power is OFF.

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**VACUUM CHAMBER Button-** In the vacuum contact (HP) mode, the vacuum between mask and substrate is automatically pulled immediately prior to exposure. However, it is possible to check the alignment with the mask and substrate in vacuum contact prior to making an exposure. This feature is particularly useful when using high magnification objectives with restricted depth of focus. Simply press the VACUUM CHAMBER button after moving the substrate to the contact position using the separation lever (CONTACT Indicator Illuminated), and the vacuum will be pulled. You may release the vacuum by moving the separation lever to the separation position. If you press the EXPOSURE button while the VACUUM CHAMBER button is illuminated, the VACUUM CHAMBER button will go out but the vacuum between mask and substrate will be preserved and exposure will take place in normal fashion

**HP/ST Button-** Used to select either vacuum chamber exposure mode (HP) or standard exposure mode (ST). The appropriate Indicator light illuminated to indicate the exposure mode selected.

**SOFT CONTACT Button** Used to select soft contact exposure mode. In this mode the substrate is pressed against the mask only by mechanical pressure during exposure. The vacuum under the substrate remains on. To select soft contact exposure mode, the HP/ST button must be in the ST position.

**Exposure Timer-** The exposure timer is located on the right side of the front panel. In order to set the timer, two controls are used: an inner knob marked "s", "10s", "m", "10m", "h", and "10h" which is used to set the multiplier and an outer ring which is used to move the timer pointer. The scale for the timer pointer is graduated from 0 to 3. The exposure time is determined by multiplying the pointer setting by the multiplier set on the inner knob.

Example 1 to obtain an exposure time of 2 seconds set the timer to 2 and the multiplier to "s"

Example 2 To obtain an exposure time of 8 minutes set the timer pointer to 0.8 and the multiplier to "10m"

The *timer* therefore range of 0.1 seconds to 30 hours. When the EXPOSURE button is pressed, the timer pointer rotates counterclockwise to 0 during the exposure.

**NITROGEN LOSS Button and Alarm -** This button is a latching type pushbutton that contains an indicator lamp, and the alarm emits pulsating tone. The system monitors the flow of nitrogen used to cool the expose lamp base. If that flow rate falls below a preset level, the *system* will be activated. If the NITROGEN LOSS button is at the out position, the button will flash and the alarm will sound. If the NITROGEN LOSS button is in the depressed position, the button will flash but the alarm will be defeated. In either case, if nitrogen is not returned within approximately 3 minutes, the exposure lamp power supply will be turned off, thereby significantly reducing the possibility of a lamp explosion due to overheating.

### **ALIGNMENT STAGE**

**Transport SLIDE -** The transport slide is located near the top of the stage at the right side and is used to transport the chuck and substrate from the loading position into the stage

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Alignment Micrometers (X, Y, and Theta) the Y and Theta alignment micrometers are located on the front of the alignment stage while the X micrometer is mounted on the right side. They are used during alignment to move the substrate in relation to the mask. The X and Y micrometers have both coarse and fine adjustment. The range of adjustment in X and Y is 6.0 mm and the pitch of the micrometer lead screws is 1.0 mm (coarse adjustment) and 0.05 mm (fine adjustment). The Theta (rotation) micrometer has a range of 30 with a pitch of 0.25 mm.

Contact Lever- The contact lever, which controls the Z-axis movement of the chuck, is located at the lower left side of the stage. After inserting a chuck and substrate into the stage using the transport slide, the contact lever is used to bring the substrate in to contact with the mask for parallelity compensation.

Separation lever- The separation lever is also located at the lower left side of the stage. This lever is used to move the substrate in and out of contact with the mask in order to perform alignment, once the contact lever has been engaged. Exposure can only be initiated when the separation lever is in the contact position.

Maskholder- The maskholder is securely clamped in the mask holder frame on the top of the stage using two knurled knobs. It is removed and reinserted into the maskholder frame from the left side of the stage.

Variable Thickness Adjustment- The, variable thickness adjustment is located on the front of the stage immediately below the Y-micrometer. If substrates or masks of different thicknesses are to be used, this thickness difference must be compensated for, using the variable thickness adjustment.

### 6 Setup

Coat the substrate with the needed material before using the system.  
Reserve the time needed for this equipment using the online system.

### 7 Operating Instructions

#### **POWER ON**

1. Make sure the air pressure and nitrogen on the front of the manometer box are on and the vacuum in back is on. Always make sure the nitrogen is on when the lamp is on because this is what cools the lamp!
2. Make sure the power on the main machine is on and the lamp controller power is on. This is easy to confirm that the lamp is running by looking at the lamp housing and see the light from lamp.

#### **LOADING**

3. Blow any unwanted particles off your mask with the nitrogen gun.
4. Loosen the knurled knobs on the main unit and slide out the mask holder. Turn over

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the mask holder so the vacuum ring faces up. Place the mask completely over the vacuum ring with the emulsion/chrome side up.

5. Now press the MASK VACUUM button to activate the vacuum.
6. Reinsert the mask holder into the stage assembly and tighten the knurled knobs.
7. Slide out the chuck platform. Place the substrate on the chuck and gently slide it back in.
8. Raise the chuck by pushing the contact lever away from you making sure the separation lever is in its rear most position. Watch and make sure the wafer won't come in contact with the mask before the lever is pulled all the way back. If you think it will, bring the chuck back toward you and lower the chuck by turning the variable thickness adjustment knob. Then raise the chuck again, watching the wafer. If it doesn't come in contact this time, push the contact lever all the way back, and the contact button on the control panel will become illuminated. This does not mean that your wafer and mask are in contact, however, because this button will light whenever the lever is all the way back. With the contact lever forward, turn the variable thickness knob to the left and then try to move it to the rear again until you feel it tighten just a little. There is no need to force it! You want the contact lever to have a slight amount of extra resistance just as it is being pushed to its rear most position.

### **ALIGNMENT**

9. Pull the separation lever toward you to separate the wafer and mask. The maximum separation stroke is 30 microns.
10. Turn on the microscope. Focus on the mask/wafer using the focus knob located behind the eyepieces.
11. Microscope movement is controlled by the swing on the side of the unit. To move it, push top or bottom button located on the arm, and direct the microscope. The top button is front/back, and the bottom button is right / left.
12. To align the wafer to the mask, use the silver X, Y, and theta knobs.

### **EXPOSURE**

13. Exposure time will vary according to numerous factors. To set the time, turn the black knob to the desired time. Check to make sure you have the desired units marked on the middle of the knob. ("s", "10s", "m", "10m", "h", and "10h")
14. Select exposure mode – select : **Vacuum Contact (HP) Mode** or **Standard Mode**

### **Vacuum Contact (HP) Mode**

In the HP mode, a vacuum is pulled between the mask and the substrate immediately prior to exposure. The Highest resolution is obtained in this mode, since the gap between substrate and mask due to flatness variations, dust particles etc., is as small as possible. When printing in the vacuum contact mode, the sequence of events after the EXPOSURE button is pressed is as follows:

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1. The vacuum under the substrate is switched off.
2. The vacuum between the substrate and the mask is switched on through the vacuum chamber hole located at the outer edge of the chuck.
3. The shutter opens, exposure takes place for the length of time set on the exposure timer, and the shutter closes, completing the exposure.
4. The vacuum between the substrate and the mask is switched off.
5. The vacuum under the substrate is switched on.
6. A nitrogen burst is introduced through the vacuum chamber hole breaking the vacuum between the substrate and the mask.

### Standard Mode

In the ST mode, you have the opportunity to select one of the two exposure programs.

#### •Hard Contact

If the ST button is illuminated, and the SOFT CONTACT is not, exposure will be performed with nitrogen pressure pressing the substrate against the mask. The sequence of events after the EXPOSURE button is pushed is as follows:

- 1.) The vacuum under the substrate is removed.
- 2.) Nitrogen pressure under the substrate is applied.
- 3.) The shutter opens, exposure takes place for the length of time selected on the exposure timer, and the shutter closes, completing the exposure.
- 4.) The nitrogen pressure under the substrate is removed.
- 5.) Vacuum is reapplied under the substrate.

#### •Soft Contact

If the ST and SOFT CONTACT buttons are illuminated, then exposures will be performed with only mechanical pressure pressing the substrate against the mask. During exposure, the vacuum securing the substrate to the exposure remains, and nitrogen is applied.

15. Push EXPOSURE to begin. The lamp will automatically come forward and the exposure timer will countdown, and then the lamp will retreat.
16. After exposure, lower chuck and remove substrate. Use caution as the sample might stick to the mask for a few seconds.

### Finishing up

17. Remove the mask holder. Turn off the mask vacuum and remove your mask. Replace the mask holder. Turn off the microscope illuminator!

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### 1. Problems/Troubleshooting

Bad image?

Check that the mask has the Chrome side down.

Are you using correct guideline expose times and develop times?

Is the sample in contact with the mask or is there a gap?

The image not bright enough?

The brightness on the lamp is controlled by the knob besides the lamp on/off switch, just turn the knob to a higher level. Beware not to turn it too high as the bulb might burn out if it is turned beyond the 3<sup>rd</sup> click.

Can not turn theta enough?

Make sure the stage is straight before loading your sample and check that your sample is close to being straight if you can see tell if it is before loading it under the mask.

The sample is stuck to the mask?

If the sample is stuck on the mask, carefully return the chuck under the mask, as it might release ( fall ) from the mask in a few seconds. If it stays on the mask carefully remove the mask holder with the wafer. Have your hand under this as the wafer might drop free. If the wafer is still on the mask turn the mask holder upside down to have the wafer and mask on top and slowly remove the wafer from the mask. Be carefully so as to not scratch the mask.

After removing the wafer, check the amount of pressure forcing the wafer into the mask. Was the wafer soft baked correctly?

Using MASK CLEANER on your mask to clean it will help in reducing the resist from sticking to your mask. To do this, ally a small amount of the MASK CLEANER chemical to your mask, chrome side and then rinse off with DI and dry the mask. To remove resist particles on the mask you can rinse off the mask with a solvent like acetone and rinse with DI before applying the MASK CLEANER.