GENERAL PROCESS AND OPERATION SPECIFICATION

EVG 610 Mask Aligner

I. SCOPE
   a. The purpose of this document is to describe requirements and basic operating instructions for the EVG 610 Mask Aligner. This tool is intended to be used for both topside and backside alignment and lithography. Use of this tool is limited to only approved substrates and <100mm wafers.

II. SAFETY
   a. Be sure that you are trained and signed off to use this equipment per AggieFab policy.
   b. Read Section 2: Safety in the EVG User Manual.
   c. If you are unsure about any procedure or indication while operating this equipment, contact a staff member or trainer for assistance.
   d. The tooling for this tool is extremely expensive. Use extreme caution when installing/uninstalling any tooling. Store extra mask holders and chucks in containers or shelves provided by AggieFab. Avoid scraping or moving anything across smooth surfaces used for vacuum or sealing.

III. APPLICABLE DOCUMENTS, MATERIALS AND REQUIREMENTS
   a. For more information about the detailed operation of this tool refer to the EVG 610 Operation Manual, available on the home screen below the Framework application. This has much more information about the various options this tool provides.
   b. This tool is intended to be used with a restricted selection of substrate materials.
   c. Approved substrate materials: Any approved wafer material and photoresist.
   d. Appendix A: Creating and modifying recipes.
   e. Appendix B: Backside alignment methods.
   f. Appendix C: Changing objectives.

IV. OPERATION (topside only, go to step (V) for bottomside alignment procedure)
   a. <u>Note: Steps (a)-(g), (i)-(k) are the same for both topside and bottomside alignment. Step (h) and its sub-steps are the only differences.</u>
   b. Turn on the vacuum pump located behind the PC.
   c. Turn on the tool by turning the red switch clockwise to the “1” position.
   d. Navigate to the EVG 6Series software by clicking on the icon on the bottom to access the main graphical user interface (GUI).
   e. Log in using your username and password.
   f. Allow the machine to initialize.
      i. You will have to move the top optics up and pull the tray out (both shown on the screen) to continue the initialization. The top optics may need to be brought down a bit then back up for the system to recognize the movement.
      ii. If the initialization gets stuck on a step, shut down the PC and tool (see the last step of the OPERATION section) and try again.
   g. Create new recipe or open existing recipe.
      i. To open an existing recipe, click on “Open Recipe” on the top left of the GUI and navigate to your folder.
      ii. To create a new recipe, please see Appendix A.

h. On the main recipe window, click “Run” on the bottom left and follow all instructions as presented on the screen. There are animations on the bottom left to help guide you. Click “Continue” when finished with a step. Please note that the following steps are an example, and not the same for all methods.
    i. Warning: The tooling (maskholder, wafer chuck, loading frame) is very expensive. Use extreme caution when handling the tooling, especially the maskholder. If you need help, please contact a staff member.
    ii. Choose the correct optics by clicking on the pictures until the one you are using is selected.
    iii. Move tray out until you hear a small click in the machine.
    iv. Insert the correct maskholder (4 inch or 5 inch) without hitting the optics or scraping along the bottom. See Figure 1 for correct handling and insertion.
    v. Fix maskholder by using the two clamps on either side.
    vi. Insert the correct wafer chuck (pieces-size, 3 inch, or 4 inch, at least 1 inch less than the maskholder size), and connect the vacuum line. See Figure 2.
    vii. Insert loading frame (same size as maskholder). Make sure the small spikes go into the holes on the wafer chuck. See Figure 2.
    viii. Place mask onto loading frame and move the frame in.
    ix. Move the stage to the center position by adjusting the X-knob to 5mm-0, Y-knob to 5mm-0, and theta-knob to 7.5-50. It is important to get these as close as possible to the correct value, else your mask will not be aligned correctly and the vacuum hold will not work, possibly breaking your mask. See Figure 3.
    x. Adjust the microscope to the features on your mask, then move the optics straight up.
    xi. Align the substrate to the mask. You can click the red button on the screen labeled “Sep/Cont” to check the alignment when the substrate and mask are in separation/contact. A small blue light will be lit when substrate and mask are separated and not lit when the substrate and mask are in contact.
    xii. Double-check the alignment is correct. If you want to adjust, click “Undo” to go back a step.
    xiii. Move the lamphouse over the substrate and wait for exposure. See Figure 4 for correct positioning.
i. Choose either “Continue” or “Exit” when “End of Process” is reached and follow the steps.
    i. “Continue” will allow for another substrate to be exposed using the same recipe.
    ii. “Exit” will quit the recipe.
j. Remove all tooling.
    i. Remove wafer chuck and loading frame and place back in sleeve inside box.
    ii. Remove the maskholder and place bottom-side/vacuum lines up with the sleeve under it and a large cleanroom wipe over it. Nothing else should be on top of it. See Figure 5.
    iii. Push tray back in.
k. Log off and turn off the tool.
    i. To log off, click on your username in the upper right-hand corner of the GUI and select “Logout”.

ii. To power off the PC, move your cursor to the very bottom left-hand corner of the screen, click the "EVG" logo, and then click the red power button and choose the "Shut Down" option.
iii. To power off the tool, turn the red switch counter-clockwise so it points to the "0".
iv. Turn off the vacuum pump.

V. OPERATION (bottomside alignment using the recommended "Crosshair" method)
a. Follow steps (a)-(g) in the topside alignment procedure.
b. On the main recipe window, click "Run" on the bottom left and follow all instructions as presented on the screen. There are animations on the bottom left to help guide you. Click "Continue" when finished with a step. Please note that the following steps are an example, and not the same for all methods.
i. Warning: The tooling (maskholder, wafer chuck, loading frame) is very expensive. Use extreme caution when handling the tooling, especially the maskholder. If you need help, please contact a staff member.
ii. Choose the correct optics by clicking on the pictures until the one you are using is selected.
iii. Move tray out until you hear a small click in the machine.
iv. Insert the correct maskholder (4 inch or 5 inch) without hitting the optics or scraping along the bottom. See Figure 1 for correct handling and insertion.
v. Insert chuck and loading frame (same size as maskholder). Make sure the small spikes go into the holes on the wafer chuck. See Figure 2.
vi. Place mask onto loading frame and move the frame in.
vii. Move the stage to the center position by adjusting the X-knob to 5mm-0, Y-knob to 5mm-0, and theta-knob to 7.5-0. It is important to get these as close as possible to the correct value, else your mask will not be aligned correctly and the vacuum hold will not work, possibly breaking your mask. See Figure 3.
viii. Adjust the microscope to the features on your mask.
ix. Set the crosshairs to alignment marks on your mask. Once these crosshairs are set and you press "Continue", **<u>you cannot move the bottomside optics or misalignment will occur.</u>**
x. By only moving the stage and not the bottomside optics, align the patterns on the substrate to the crosshairs on the screen.
xi. Double-check the alignment is correct. If you want to adjust, click "Undo" to go back a step.
xii. Move the lamphouse over the substrate and wait for exposure. See Figure 4 for correct positioning.
xiii. Follow steps (i)-(k) in the topside alignment procedure.

VI. SIGNATURES AND REVISION HISTORY

a. Author of this document: Ethan Morse, Larry Rehn
b. Author Title or Role: Student Technician, Lab Manager
c. Date: 14 August 2018
d. Revision: A

Approvals:

Technical Manager Signature:_____

Date: _____

Revision History:

Revision	**Author**	**Date**
Original Issue	Ethan Morse	08/06/2018
Rev A	Ethan Morse, Larry Rehn	08/14/2018
Rev B		
Rev C		
Rev D		
Rev E		

Figures

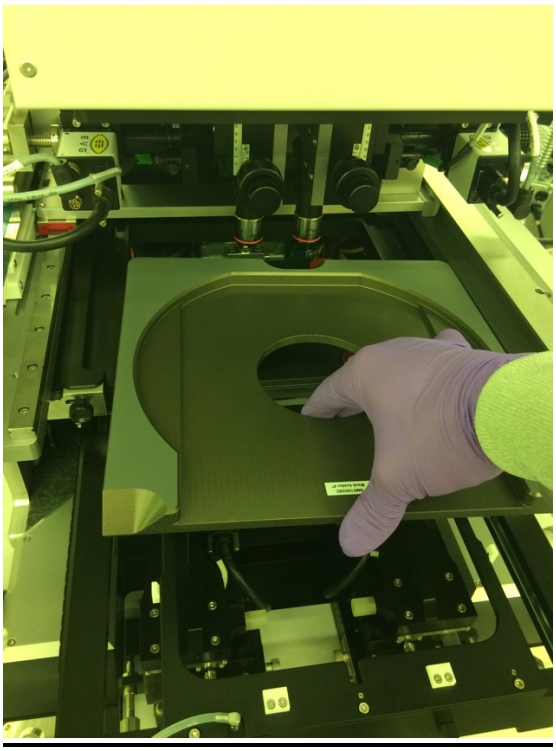

Figure 1: Correct handling and insert of the maskholder.

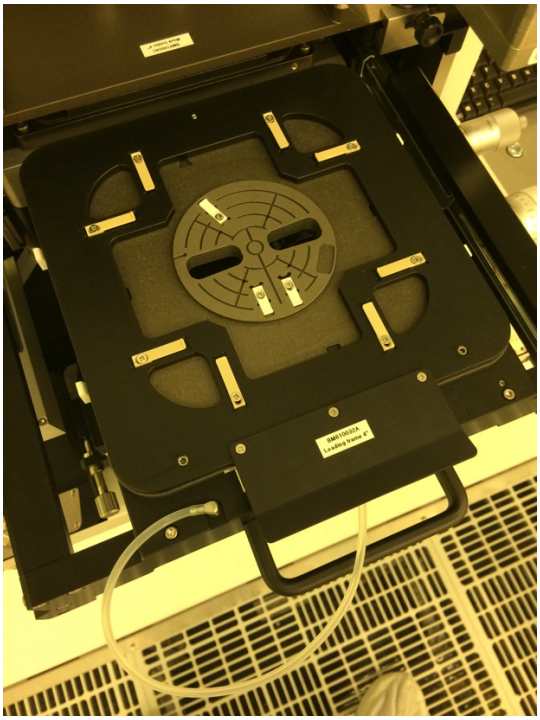

Figure 2: Position of loadframe on wafer chuck with vacuum line connected.

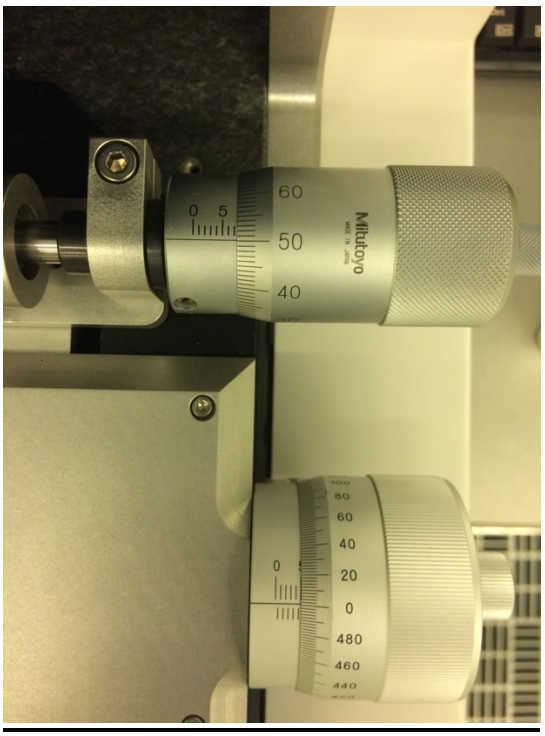

Figure 3: Middle position for the X-know and theta-knob. Notice the X-knob is covering half the 5 and is on the 0 mark and the theta-knob is between 7 and 8 and on the 50 mark.

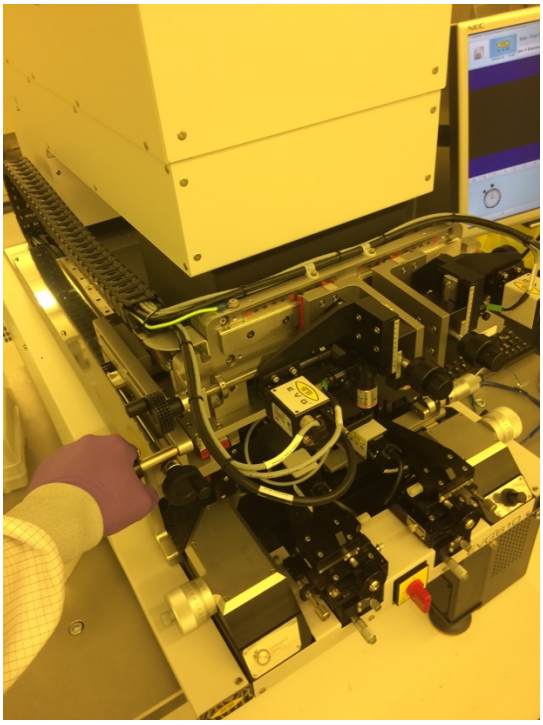

Figure 4: Lamphouse in exposure position (pulled all the way towards the user).

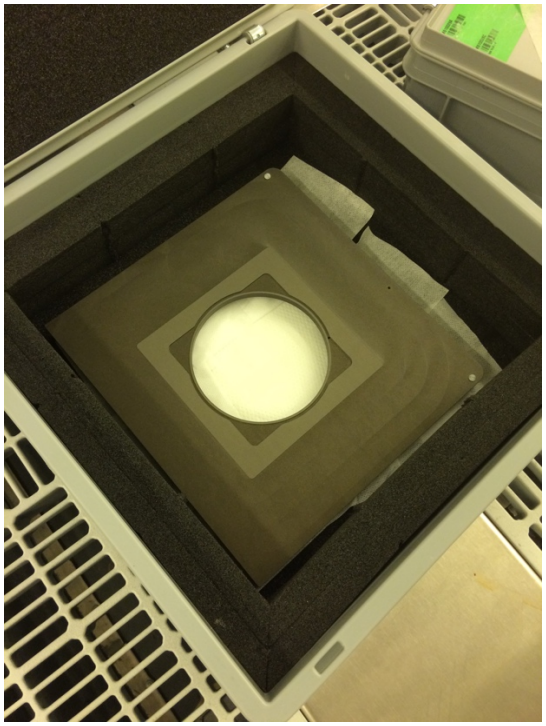

Figure 5: Correct placement of maskholder in storage container. Notice the vacuum lines are facing up.

Appendix A – Creating and modifying recipes

1. To create a new recipe, click on "New Recipe" in the upper left-hand corner of the "Recipes" tab.
2. Change the parameters to fit your needs.
3. General (1st column):
    a. Process:
        i. Man. Anodic Bond: N/A
        ii. Man. Bottom Side: To align the backside of the substrate using the bottom-side objectives.
        iii. Man. First Print – Top: Used when there are no patterns on your substrate, only bare photoresist.
        iv. Man. SD Bond: N/A
        v. Man. Top Side: To align patterns currently on substrate to mask.
    b. Process Mode:
        i. For "Man. First Print – Top" and "Man. Top Side", use "Transparent."
        ii. For "Man. Bottom Side", see Appendix B ("Backside Alignment Methods") to learn more more about these methods. "Crosshair" is recommended.
    c. Exposure Mode:
        i. Constant Dose (suggested): The dosage needed for the specific photoresist. Ex: AZ5214E calls for 100 mJ/cm^2. This is better than "Constant Time", as the machine will do all the calculations necessary.
        ii. Constant Time: Substrate is exposed for a constant amount of time with a constant intensity (set on the lamphouse).
    d. Contact Mode:
        i. Note: All "Proximity" modes require a special seal on the chuck. Please contact a staff member to install the seal.
        ii. Hard Contact: Presses substrate and mask together with a large amount of force. Adjusted with the valve on bottom right of machine. Resolution: ~1-2 μm.
        iii. Proximity: No contact between substrate and mask during exposure, but very close distance together. Resolution: ~2-4+ μm.
        iv. Proximity Purge: Same as Proximity, but the space between substrate and mask is purged with N2. Resolution: ~1-2 μm.
        v. Soft Contact (suggested method): Presses substrate and mask together with a small amount of force. This is the most common option and is similar to the contact on the MA6. Resolution: ~1.5-3 μm.
        vi. V + H Contact: Vacuum and hard contact between mask and substrate. Resolution: <0.8 μm.
        vii. Vacuum Contact: Vacuum and soft contact between mask and substrate. Resolution: <0.5 μm.
        viii. Vacuum Contact Purge: Vacuum between mask and substrate is purged with N2. Resolution: <0.8 μm.
4. Tooling:
    a. Maskholder:
        i. Click on the image of the maskholder and select which maskholder (4-inch or 5-inch) to use by checking the correct "Activate" box and clicking "OK".
    b. Chuck:

        i. Click on the image of the chuck and select which chuck (pieces, 3-inch, or 4-inch) to use by checking the correct "Activate" box and clicking "OK".
5. General (2nd column):
    a. Separation: Distance between substrate and mask during alignment process.
    b. Proximity: Distance between substrate and mask during exposure. Option only available with a proximity contact mode.
    c. Thickn. Mask, Thickn. Substrate, Thickn. Resist: N/A
6. Exposure:
    a. Exposure Time: Duration (units: seconds) of exposure. Used with "Constant Time" exposure mode.
    b. Dose: Dose applied to photoresist (units: mJ/cm^2). Used with "Constant Dose" exposure mode.
    c. Exposure Settings:
        i. Always set the "Exposure – Delay Before Exposure" value to 20-30 seconds. This is a short delay after moving the lamphouse to exposure position and before exposing the substrate to allow the stage to stabilize.
        ii. Intensity Set: If using I-line, choose "I-line CURRENT". While G-line and H-line are available to use, AggieFab is not able to measure the intensity, so their previously stored values are likely to be inaccurate.
        iii. Click "Set" to save changes.
7. Misc:
    a. Stop After Contact: Allows you to check your substrate/mask alignment before exposing your substrate.
    b. Unload M And S Together: If your photoresist is sticky and causes your substrate to stick to the mask after contact, select this option to unload the substrate and mask together.
    c. Separation Settings:
        i. Substrate – Delay: Change value to 2000 ms.
        ii. Substrate – Z-Motor Offset: Change value to 500 um.
        iii. Do not fill out any other parameters.
        iv. Click "Set" to save changes.
8. Comment:
    a. Write any comments or notes you have in this box.
9. Save recipe
    a. Click "Save Recipe As" on the tool bar towards the top part of the screen.
    b. Go to the "Recipes" folder under the EV6XX folder.
    c. Rename the recipe with your last name as part of it. Ex: "morse_backside.rcp"
    d. Save recipe in your folder.
        i. If you do not have a folder, create a new one named "[first initial]. [last name] ([advisor])". Ex: "E. Morse (Staff)"

Appendix B – Backside alignment methods

1. Crosshair method (recommended).
    a. An adjustable (in thickness and length) crosshair is placed on an alignment mark on two sides your mask, each corresponding to the left and right bottomside objectives. Once the crosshair's placement is satisfactory, adjust the substrate's alignment marks to the crosshairs without moving the objectives. If the objectives are moved during the substrate-crosshair alignment, misalignment will occur and the crosshair will have to be realigned to the mask's alignment marks.
    b. The technician suggested we use this method for all backside alignment work, as the possibility of misalignment is much less.
2. Overlay method.
    a. The system takes an image of the mask and the substrate is aligned to the image by adjusting the transparency of the image.
3. Transparent method.
    a. The bottom side of a transparent substrate (e.g. glass wafer) is aligned to the mask.

Appendix C – Changing objectives

1. Under the "System" tab on the bottom of the main GUI, click on "Change Objectives" on the right side of the screen and follow the instructions given.
2. Any objective (5x, 5x flat, 10x) can be used for both topside and bottomside alignment.

Appendix D – Recommended Photomasks

1. The EVG610 can handle either 4" x 4" or 5" x 5" mask plates.
2. Standard mask plate thicknesses are typically 0.060" or 0.090". The thicker plate thickness is generally preferred to provide a more rigid optical plane.
3. Mask materials are usually soda lime glass or quartz. Quartz is more expensive but it provides a truer optical plane and generally produces an image with better fidelity to the desired pattern. For patterns with critical dimensions > 10 microns and tolerances > 1 micron these differences may not matter.
4. Soft masks made from Milar material can also be used for patterns. These will require the use of a blank clear glass plate to provide stiffness and proper operation of the tool, and also to keep the soft mask in the proper optical plane. These masks are significantly less expensive than glass or quartz masks, but much less capable. Pattern clarity, minimum resolution, and feature size tolerances are generally much poorer.
5. References. Contact AggieFab staff for a list of photomask suppliers.