

## GENERAL PROCESS AND OPERATION SPECIFICATION

### EVG 501 Wafer Bonder

#### I. SCOPE

- a. The purpose of this document is to describe requirements and basic operating instructions for the EVG 501 Wafer Bonder. This tool is intended for both anodic and thermocompression bonding (as well as its derivatives, such as glass frit, etc). 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 in the EVG User Manual.
- c. Before using this instrument, please contact a staff member at least one (1) day in advance to verify the correct tooling is installed for anodic or thermocompressive bonding. If you run the wrong tooling for your bonding, it will destroy the tooling and you will be held responsible.
- d. If you are unsure about any procedure or indication while operating this equipment, contact a staff member or trainer for assistance.

#### III. APPLICABLE DOCUMENTS, MATERIALS AND REQUIREMENTS

- a. For more information about the detailed operation of this tool refer to the EVG 501 Operation Manual, available on the home screen below the Framework application.
- b. This tool is intended to be used with a restricted selection of substrate and bonding materials.
- c. Approved substrate materials: Silicon
- d. Approved bonding materials: Borosilicate glass (contains Alkali metal, such as sodium or potassium), PET (please discuss with staff member before bonding with PET)
- e. Other bonding materials must be pre-approved by the Materials Review Board before running in this tool. Do not, under any circumstances, attempt to use any other materials in the bonder without consulting the Materials Review Board first. This will result in an immediate ban from AggieFab.
- f. Appendix A: Exporting recipes and other information to a USB flash drive
- g. Appendix B: Using the EVG Process Recording Tool
- h. Appendix C: Creating and modifying recipes
- i. Appendix D: Bonding small pieces using the 4" wafer bonder

#### IV. OPERATION

- a. Login using your username and password.
  - i. If the instrument is turned off, contact a trainer or staff member to turn it on. Do not attempt to do this yourself.
- b. Navigate to the "EVG Control Software" on the left column and choose "EVG CIMFramework" to access the primary graphical user interface (GUI). If already open, choose the "EVG CF" item on the bottom left of the screen.
- c. To modify a recipe, go to the "Recipes" tab on the bottom left of the GUI. Please see Appendix C for more information on creating and modifying recipes. Note: only users with "Engineer" or "Maintenance" privileges are able to modify and create recipes. "Operator" privileges only allow for running a recipe. Please contact a trainer or staff member if you need help modifying or creating a recipe.
  - i. Choose your namespace on the left side of the screen.

- ii. Choose the recipe you would like to modify by double-clicking on the recipe's name. Note: on the bottom right-hand corner of the GUI, there is a space to type notes. It is suggested you write the date, materials being bonded, parameter values (see Step (iv) below for information on parameters), and any other info you would like to note down.
        - iii. Double-click on the "Bond Substrates" box in the middle of the screen.
        - iv. Change any necessary parameters by double-clicking on the step. Parameters for anodic bonding include time, pressure, temperature, force, voltage, current and charge, and parameters for thermocompression bonding (and its derivatives) include time, pressure, temperature, and force.
        - v. To add a step, choose the step from the left side column and drag and drop into the recipe where you would like it go. Make sure to set the parameter values for the new step.
        - vi. When finished, click "Validate" on the upper-left hand side of the GUI to make sure the changes are valid, then click "Save".
        - vii. Double-check all steps and parameter values to ensure they are what you want.
        - viii. If you would like to recall an old version of your recipe, there is a column next to "Recipes" titled "Versions". Click on the version you would like to examine to see its details.
      - d. Go back to "Jobs" by clicking on the "Jobs" tab in the bottom left-hand corner.
      - e. Clean both substrate and bonding materials and ensure there are no particles on either surface by shining the green flashlight on both surfaces.
      - f. Load your substrate materials, electrode/inlay, and clamping glass. Be very careful with the following steps.
        - i. Unlock the four knobs holding the chamber down two-knobs-at-a-time, starting at the one closest to the computer and the one diagonally opposite (top-right and bottom-left when facing the bonder). See Figure 1 below for more details.
        - ii. Open the bonding chamber.
        - iii. Vacuum out the bonding chamber with the vacuum cleaner in MCR 1.
        - iv. Place and align Si wafer on the heating chuck, with the wafer flat on the top side. Check one more time for any particles on the surface using the green flashlight available. See Figure 2 for correct alignment example.
        - v. Place all three spacers on the Si wafer, so they point towards the center of the wafer, with as minimal contact as possible. See Figure 2 for correct spacer positioning.
        - vi. Place and align glass wafer on top of Si wafer/spacers. See Figure 3 for correct alignment example.
          1. If using two wafers of the same material, place the thinner wafer on the bottom (Step (iv) above) and the thicker wafer on top (Step (vi) above). This prevents sagging due to the high temperatures.
        - vii. Carefully place and align clamping glass around both Si and glass wafers. Make sure the rectangles on the clamping glass are on the bottom.
        - viii. Carefully apply clamps on either side of the clamping glass without lifting the tooling. Make sure the clamps are perpendicular to the side of the clamping glass and they make contact with the clamping glass at the same time. If they are not perpendicular, the wafer may break. See Figure 4 for correct positioning of the clamping glass and clamps.

- ix. Carefully place graphite electrode (anodic bonding) or titanium inlay (thermocompression bonding) inside of clamping glass. See Figure 5 for example.
- x. Close bond chamber.
- xi. Lock the four knobs in the reverse order you opened them, still doing two-at-a-time.
- g. Run the recipe
  - i. Click on “Add Job” in the upper-left hand corner of the GUI.
  - ii. Choose your namespace, then select the recipe you will run by clicking on it once.
  - iii. Enter a “Lot ID”. Ex: “[name]\_bond\_[date]”
  - iv. Click “Finish” on the bottom of the “Add Job” window.
  - v. Click “Done”.
  - vi. Click “Take Over”.
  - vii. The recipe will begin to run. You can observe its progress in steps by watching the right side of the “Jobs” screen, or watch the EVG Recorder as it actively tracks the parameter values.
    1. If you need to stop the process, there are three options available on the left side of the “Jobs” screen. “Pause” will stop the recipe on the step it is on and wait for you to continue. “Stop” will finish the step it is on, then wait until you want to continue before moving on to the next step. “Abort” will completely stop the recipe where it is. If you choose “Abort”, click on “Cleanup” after it is done with the abort process.
- h. Remove your bonded wafers and tooling.
  - i. You MUST WAIT until both heaters’ temperatures are at 70°C. You WILL burn yourself if you do not wait. The value “DataValueInformation” on the left side of the “Jobs” screen will tell you this. This takes a long time and there is no way to speed it up.
  - ii. Unlock the four knobs using the same procedure as in step (f).
  - iii. Open the bonding chamber.
  - iv. Carefully remove the two clamps securing the clamping glass.
  - v. Carefully remove the clamping glass and place it back in its container.
  - vi. Carefully remove the electrode/inlay and place it back in its sleeve.
  - vii. Remove your bonded wafers.
  - viii. Vacuum out the bonding chamber with the vacuum in MCR 1 if there are any noticeable particles or pieces of your substrate material in the chamber.
  - ix. Close the bonding chamber.
  - x. Lock the four knobs using the same procedure as in step (f).
- i. Log out of the system by clicking on your name in the upper-right hand corner of the GUI.
- j. Fill out the log book with all necessary information.
- k. Clean up the workspace.

V. SIGNATURES AND REVISION HISTORY

- a. Author of this document: Ethan Morse
- b. Author Title or Role: Student Technician
- c. Date: 11 June 2018
- d. Revision: A

Approvals:

Technical Manager Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Revision History:

Revision	Author	Date
Original Issue	Ethan Morse	06/07/2018
Rev A	Ethan Morse	06/11/2018
Rev B		
Rev C		
Rev D		
Rev E		

## Figures

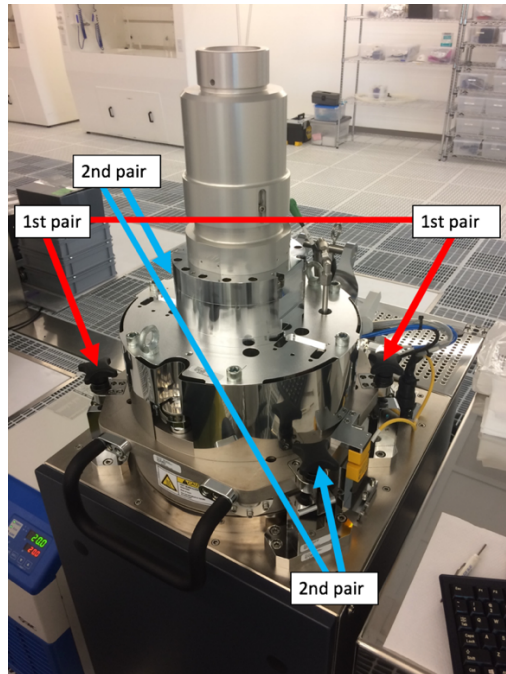


Figure 1: Unlocking the bonding chamber two knobs at a time

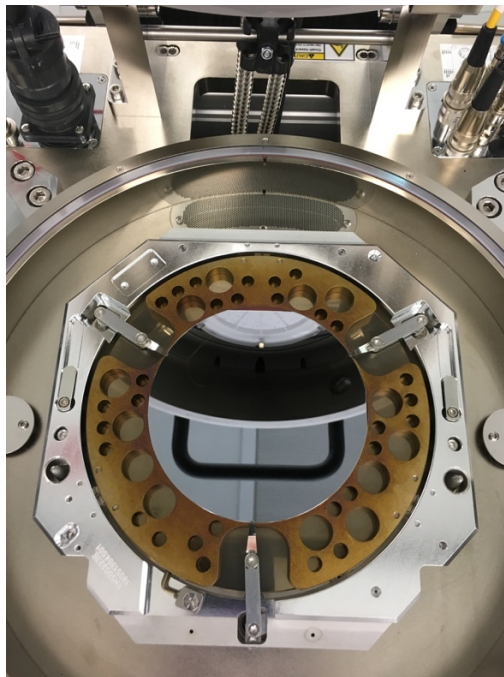


Figure 2: Correct alignment of a Si wafer on the heating chuck with spacers on top

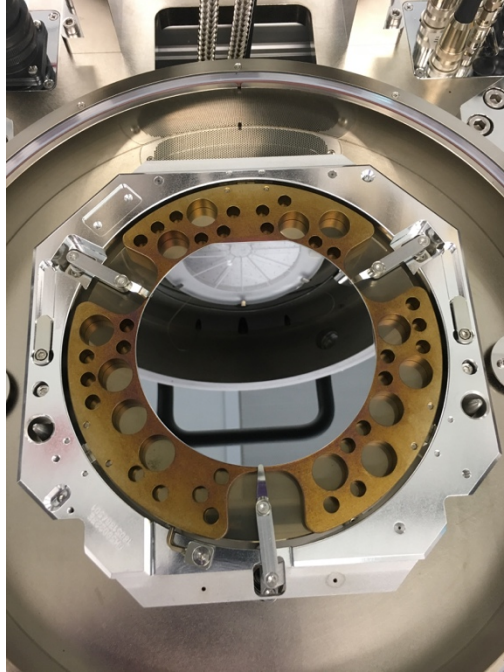


Figure 3: Correct alignment of glass wafer on top of Si wafer and spacers

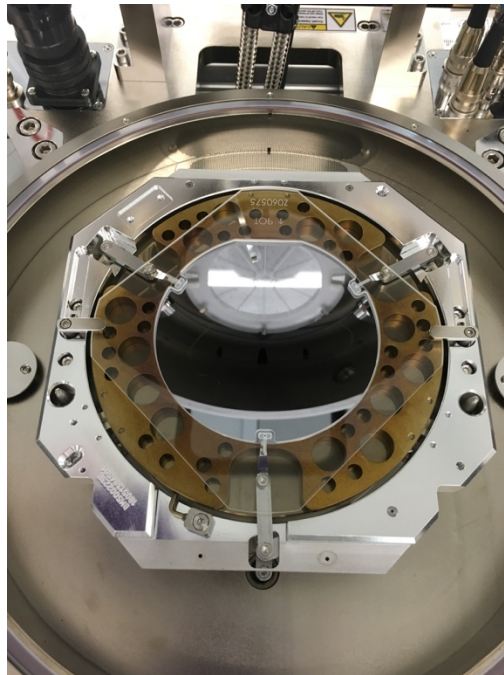


Figure 4: Clamping glass going around both wafers with clamps correctly applied

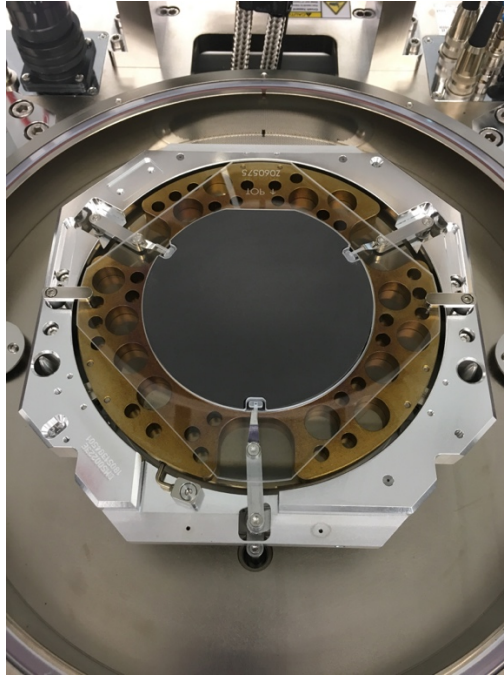


Figure 5: Electrode/inlay inside of clamping glass

## **Appendix A – Exporting recipes and other information to a USB flash drive**

1. **Ensure your flash drive is virus/malware-free before inserting by running a malware scan on your personal computer.** Malware can and will corrupt the software on the computer.
2. Insert flash drive in a USB port on the PC inside the right-side module's control panel.
3. Go to "Recipes" tab on the bottom of the GUI.
  - a. Select your namespace and the recipe you would like to export. Click on either "Export recipe to readable file" or "Export recipes" on the right side of the screen.
    - i. "Export recipe to readable file" will create an HTML file with all necessary information about the recipe. This option is the one most users should use.
    - ii. "Export recipes" will create a .rcp file, and is primarily for backing-up recipes.
  - b. Save in a location that is easy to find and with a distinct name.
4. Bring the mouse cursor to the bottom of the screen, and click on the EVG symbol in the bottom left-hand corner of the screen.
5. Click on "Maintenance Tools" on the left-hand column, then click on "Explorer".
6. Locate your file and copy/move it to your removable drive.
7. Remove your flash drive from the PC.



## **Appendix B: Using the EVG Process Recording Tool**

1. Bring the mouse cursor to the bottom of the screen, and click on the EVG symbol in the bottom left-hand corner of the screen.
2. Click on “EVG Control Software” on the left-hand column, then click on “EVG Recorder”.
3. Open your recipe run.
  - a. Click on “File”, then “Open”.
  - b. The recording files are organized in the following directory:  
D:/Log/Recording/[Year]/[Month]. Navigate to this directory.
  - c. The recording file names are organized in the following way:  
BOM\_[year][month][day]\_[start time]. Find the recording file for your recipe run and open it.
4. Select “Yes” for using the last curve settings.
5. All seven parameters are monitored during the recipe: bottom heater temperature, top heater temperature, piston force, gas pressure, voltage, current, and charge. You can choose which ones you would like to see by checking the respective boxes on the left side of the screen. Units for each are in parentheses next to the parameter.
6. To examine a specific area on the graph, left-click and drag the cursor to create a box around the area. Right-click to return to the previous area.
7. To use measure lines to measure specific values on the graph, hold control (“Ctrl”) on the keyboard and click anywhere on the graph. A vertical, colored measure line will appear.
  - a. Up to four measure lines are available for use.
  - b. To move measure lines, click and drag the line to the point you want to measure.
  - c. Under the “Measure Line Details” window, all measure line parameter (including time) values are shown, along with the difference ([line number]  $\Delta$  [line number + 1]) for each parameter.
  - d. To remove measure lines, go to “View” and click “Delete Measurebars”.

## **Appendix C: Creating and modifying recipes**

1. There are two main bonding templates, “Thermocompression Bonding Template” and “Anodic Bonding Template”, both found under the namespace “E. Morse (Staff)”. The thermocompression bonding template can only be used for thermocompression bonding and its derivatives, and the anodic bonding template can only be used anodic bonding.
2. Copy the bonding type recipe you would like to use to your namespace by selecting the recipe and clicking “Copy recipe to” on the right side of the screen.
3. Rename it by selecting the recipe and clicking “Rename recipe” on the right-side of the screen.
  - a. Please name recipes descriptively. Ex: “PET-Si bond – 150C 1kN 3hr”
4. Change (add, delete, modify steps) the recipe as needed.
  - a. Double-click the recipe you would like to change, then double click on “Bond Substrates”.
  - b. Add, delete, and modify any steps you need to.
  - c. Click “Validate” to ensure your changes are valid, then “Save” to save the recipe.
  - d. Notes on creating and changing recipes:
    - i. All recipes will follow a general procedure for the preparation of the bonding environment and finalizing the run. These steps, not including the heater temperature setpoint, should never be changed.
      1. Preparation: Equalize both heater temperatures, evacuate chamber, fill chamber with nitrogen, increase heater temperatures to setpoint, evacuate.
      2. Finalization: Fill chamber with nitrogen, set both heater temperatures to 0°C.
    - ii. The gradient of the temperature increase must stay at 20°C/min. This is both for the safety of the system and the user. The largest possible heater temperature is 450°C.
    - iii. The cooling of the heaters is passive, thus it will take at least an hour to get down to the safe temperature of 70°C, depending on your bonding temperature. There is no way to speed this up.

## **Appendix D: Bonding small pieces using the 4” wafer bonder**

It is still possible to bond smaller pieces depending on the pieces and the process. A word of caution, when processing pieces especially on a larger bond chuck and pressure disk there is a potential to damage if too much force is used, i.e. a 5 mm x 5 mm piece in the center with max force. Sometimes dummy pieces are placed towards the edges of the chuck to distribute the force over a larger area. Certainly the best way is to have dedicated tooling for each wafer size and for pieces, but understanding cost concerns there are work arounds.