

**MicroVoid CS-41 FT E-Beam Resist Development Station  
Standard Operating Procedure**



**NYU Nanofabrication Facility**

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# 1.Description

## a. Overview

The MicroVoid CS 41 FT E-Beam Resist Development Station is equipped with a Brewer Science Cee 200CBX-F Spin Coater a Brewer Science Cee 1300X-F Bake Plate. The station is equipped to dispense developer and bake e-beam resist according to a specific process routine as programmed by the user.

## b. Components and Function

Figure 1 shows the MicroVoid CS-41 FT E-beam Resist Station and its components:

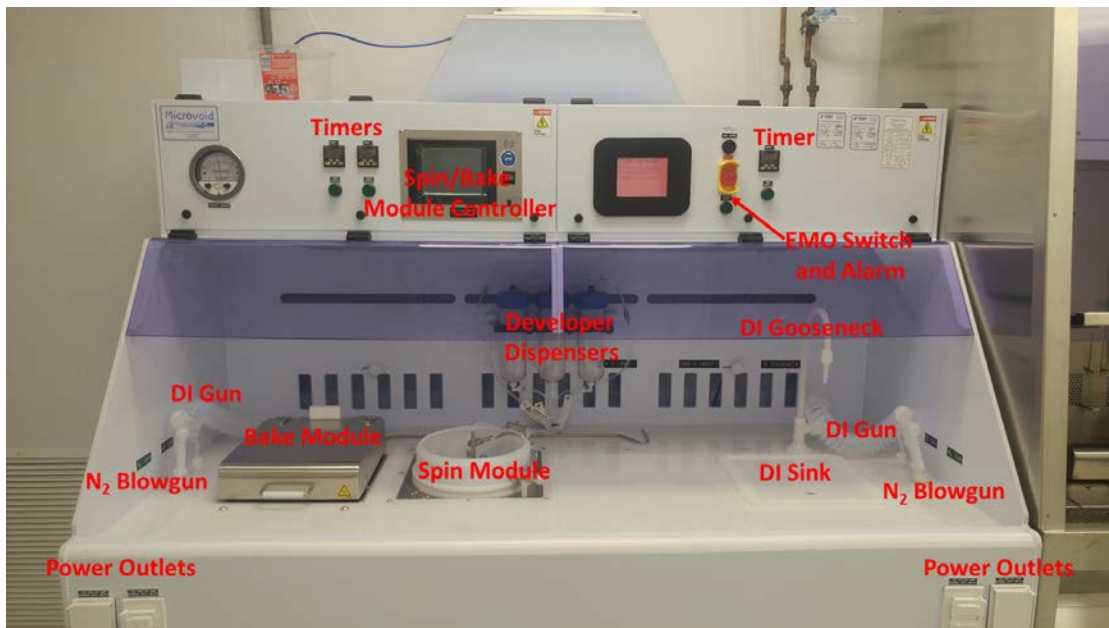


Figure 1: MicroVoid 4F-31 ELF Photoresist Station

The station has the following components:

1. Spin Module-used to dispense developer according to the spin speed, ramp time, and duration as specified in the spin/bake module controller program recipe.
  - A. Spin Speed: 0-6,000 rpm
  - B. Spin Acceleration: 0-23,000 rpm/s
  - C. Spin Speed accuracy: < 0.2 rpm
  - D. Spin Speed resolution: < 0.2 rpm
2. Bake Module-used to bake e-beam resist according to the bake temperature, ramp time, and duration as specified in the bake module controller program recipe.
  - A. There are three baking modes which can be automatically added to a recipe:
    - i. Contact-back side of substrate in direct contact with bake module surface
    - ii. Vacuum-back side of substrate held securely to bake module surface via vacuum
    - iii. Proximity-back side of substrate in proximity of bake module surface via cushion of N<sub>2</sub> gas between substrate and bake module surface.
  - B. Temperature Range: 22°C-300°C
  - C. Temperature Uniformity: ~ 0.3% across a substrate surface
  - D. Temperature resolution: 0.1°C
3. Developer Dispensers-reservoirs containing the developer to be used during a e-beam lithography process.
4. Spin/Bake Module Controller-computer control of the Spin/Bake Module
  - A. Full-color touch screen controls
  - B. 250,000 built-in process recipe programs
  - C. Unlimited number of user-defined recipe program steps
  - D. 0.1 sec step time resolution
5. Bake Module Controller- computer control of the Spin/Bake Module
  - A. Full-color touch screen controls
  - B. 250,000 built-in process recipe programs
  - C. Unlimited number of user-defined recipe program steps
  - D. 0.1 sec step time resolution
6. Timer-used to time stand-alone process recipes
7. Power Outlet-120 VAC 60 Hz single phase electrical outlets available for additional process equipment
8. EMO Switch & Alarm-designed for rapid disconnection of modules and dispensers from electrical power in the event of e-beam lithographic process or equipment failure. Please notify cleanroom staff immediately should such an event occurs.
9. N<sub>2</sub> blowguns-used to remove unwanted particles and debris from substrate surfaces before processing.
10. DI Gooseneck, DI Guns, and DI Sink-used to perform DI rinses and drain DI water

## a. General Operating Guidelines

The Microvoid® CS-41 laminar flow fume hood should be operated like a standard fume hood with the following exceptions:

- a. The work area should not be used for storage. Only necessary equipment should be inside the hood. This will ensure minimal disruption to the laminar flow and thus maintain a high level of cleanliness.
- b. Operating personnel should avoid, as much as possible, introducing hands and arms into the work area.

## b. Graphical User Interface (GUI)

### a. Run Process Screen

The Run Process screen is shown below in Figure 2:

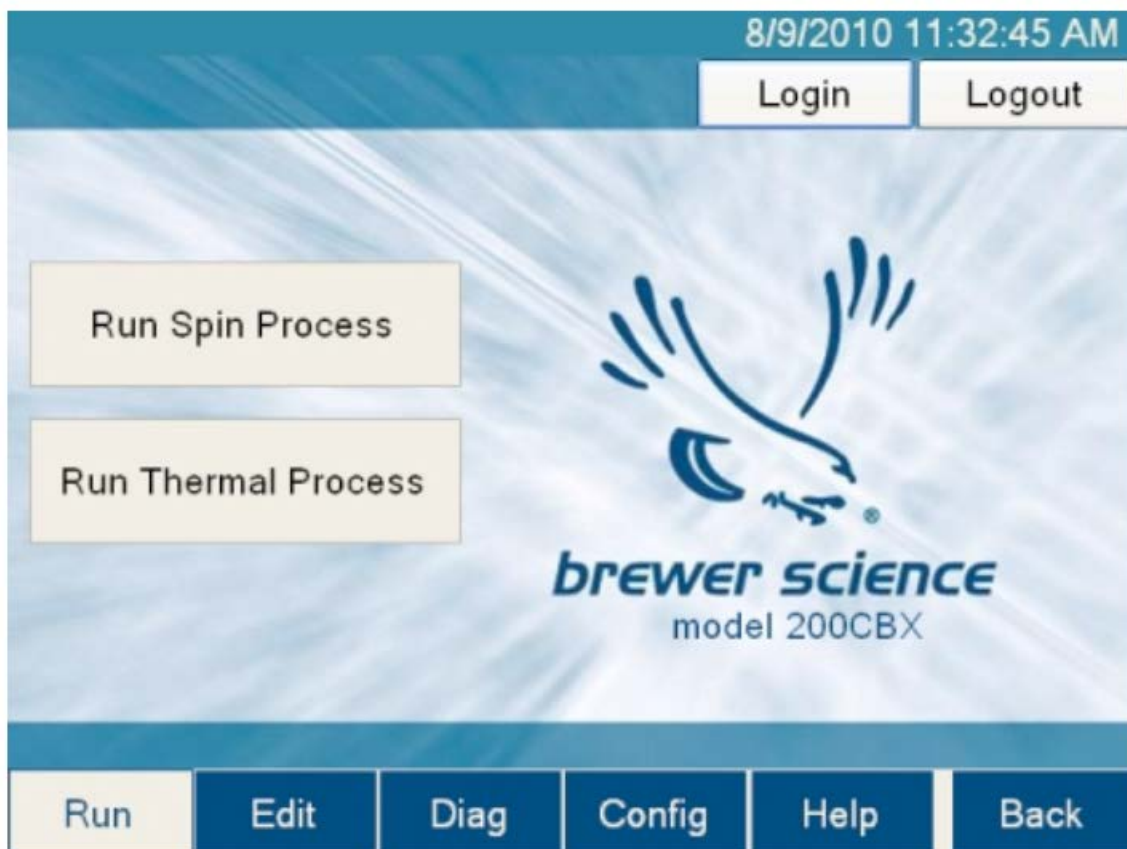
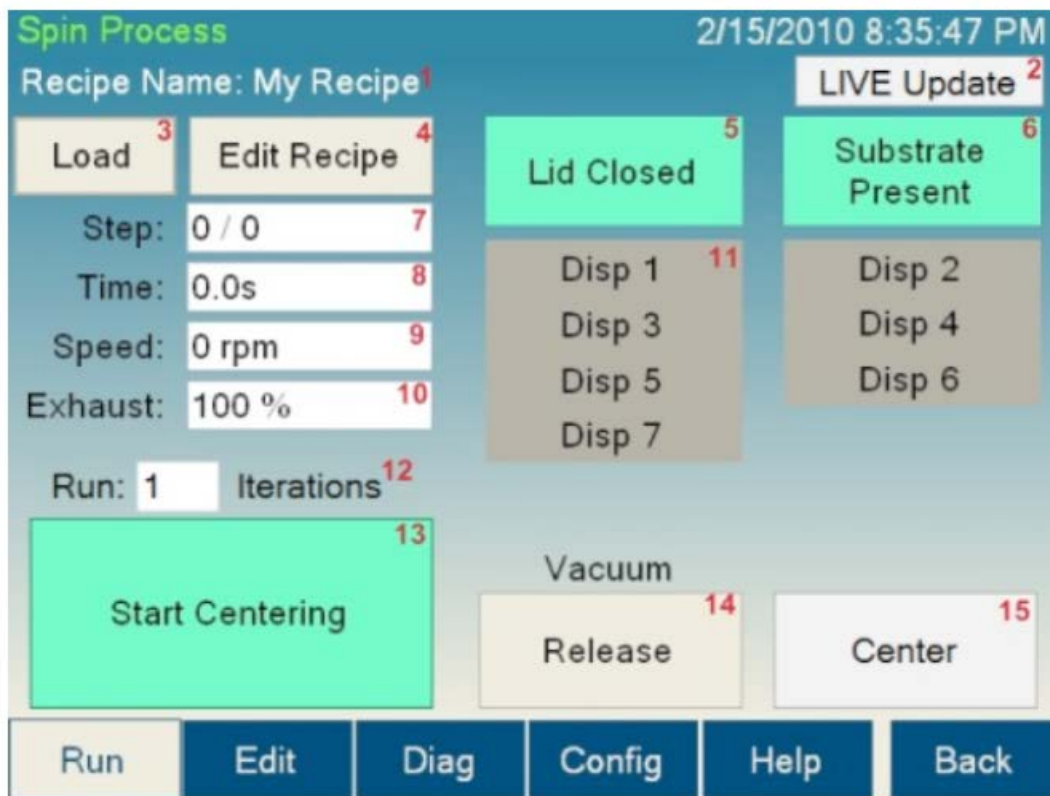


Figure 2: Run Process Screen

- A. The Spin Process and Thermal (Bake) Process screens can be accessed by pressing either the “Run Spin Process” or “Run Thermal Process” icons in the left center of the screen.
  - B. It is also possible to navigate to the “Run Spin Process” and “Run Thermal Process” windows, as well as other windows by using the navigation bar which is located on the lower edge of the Run Process screen.
- b. Spin Process Screen

The Spin Process Screen is shown below in Figure 3:



**Figure 3: Spin Process Screen**

**A. Field Definitions**

1. Recipe Name-The name of the currently loaded recipe
2. Live Update-Allows the user to change the process parameter in real time. Only functional during an active process
3. Load-brings up a recipe select screen to edit the recipe, or select the recipe for processing

4. Edit Recipe-will navigate to a spin process editor if a recipe is loaded. If a recipe is not loaded, then will direct to the recipe select screen
  5. Lid Closed-Indicator showing the state of the "Lid Closed" sensor
  6. Substrate Present Indicator-Indicator showing the state of the Spin Chuck Vacuum Sensor
  7. Step Indicator-shows the current step of the process
  8. Time Indicator-shows the time remaining on the current step
  9. Speed Indicator-Shows the current speed of the chuck spindle
  10. Exhaust Indicator-shows the current setting of the programmable exhaust
  11. Dispense Indicators-shows which dispenses are currently active
  12. Iteration Setting-allows the currently selected recipe to be run consecutively the entered number of times without stopping
  13. Process Button
    - I. Start Centering-spins the wafer slowly to check for centering on the wafer spin chuck
    - II. Start Process-starts the selected process
    - III. Abort-abort a currently running process
    - IV. OK-turns off the "Process Complete" buzzer
  14. Vacuum Hold/Release-allows the user to activate the vacuum of the spin chuck as the substrate is being centered.
- c. Thermal (Bake) Process Screen

The Thermal (Bake) Process Screen is shown in Figure 4:

The screenshot displays the 'Thermal Process' interface. At the top, it shows the date and time '8/2/2010 12:54:34 PM'. Below this, the 'Recipe Name' is set to 'My Recipe'. There are two buttons: 'Load' and 'Edit Recipe'. The 'Current Temperature' is displayed as '300.1' in a large red box. Below the temperature, there are input fields for 'Step' (1), 'Time' (10), 'Setpoint' (275), and 'Method' (Contact). A large green 'Start Process' button is at the bottom. At the very bottom, there is a navigation bar with buttons for 'Run', 'Edit', 'Diag', 'Config', 'Help', and 'Back'.

| Field               | Value     |
|---------------------|-----------|
| Recipe Name         | My Recipe |
| Current Temperature | 300.1     |
| Step                | 1         |
| Time                | 10        |
| Setpoint            | 275       |
| Method              | Contact   |

**Figure 4: Thermal (Bake) Process Screen**

**A. Field Definitions**

1. Recipe Name: The name of the current recipe

2. **Load:** Brings up the “Recipe Select” screen to select a recipe for processing
3. **Edit Recipe:** Will navigate to the Thermal Process Editor if a recipe is loaded. If a recipe is not loaded, it will go to the “Recipe Select” screen.
4. **Step Indicator:** indicates the current step in a thermal process.
5. **Time Indicator:** indicates the time remaining on the current step.
6. **Setpoint Indicator:** indicates the setpoint on the thermal chuck.
7. **Method Indicator:** indicates the level of contact of the substrate with the thermal chuck during the process:
  - I. **Contact:** substrate is in direct contact with the thermal chuck.
  - II. **Vacuum:** substrate is affixed to the thermal chuck by application of vacuum to backside of substrate
  - III. **Proximity:** substrate is in indirect contact with thermal chuck, as a cushion of N<sub>2</sub> exists between the backside of the substrate and thermal chuck.
8. **Process Icon:** It has three modes:
  - I. **Start process:** starts the selected process
  - II. **Abort:** aborts the currently running process
  - III. **OK:** turns off the “Process Complete” buzzer and resets the Process icon to the “Start Centering” mode.
9. **Current Temperature Icon:** Indicates the current surface temperature of the thermal chuck. If the temperature is within the setpoint, the indicator will be green. Otherwise, it will be red.

## 4. Procedures

- a. **Spin Coat Process**
  - i. Use N<sub>2</sub> blowgun to remove unwanted particles and contamination from front and backside of substrate before processing
  - ii. From the “Run Process” screen, set up the spin process by pressing the “Run Spin Process” icon
  - iii. Press the “Load” icon to bring up the Recipe Selection screen. Select a recipe by double clicking on the recipe to be used or click once to select the recipe to be used and press Enter. The system will revert to the Spin Process screen.
  - iv. **Center the substrate**
    - I. Load the substrate onto the chuck.
    - II. If the Centering Time parameter is set to 0 seconds, pressing the “Start Centering” button will allow the chuck to spin when the lid is closed. The chuck will stop spinning when the lid is opened. The lid can be opened as many times as possible to facilitate centering the substrate.
    - III. If the Centering Time parameter is set to a non-zero value, pressing the “Start Centering” button will allow the chuck to spin for the



Centering Time value. This will occur whether the lid is opened or closed. Once this time has elapsed, pressing the Center icon will restart the centering process

The screenshot shows the 'User Spinner Configuration' window. The title bar includes the date and time '2/24/2010 3:07:56 PM'. The window is divided into two main sections: 'Dispense Config' and 'Config'.

**Dispense Config:** This section contains a table with three columns: 'Num', 'Name', and 'Has Empty'. There are seven rows, each representing a dispense station. The first row is highlighted in blue.

| Num | Name       | Has Empty |
|-----|------------|-----------|
| 1   | Dispense 1 | None      |
| 2   | Dispense 2 | None      |
| 3   | Dispense 3 | None      |
| 4   | Dispense 4 | None      |
| 5   | Dispense 5 | None      |
| 6   | Dispense 6 | None      |
| 7   | Dispense 7 | None      |

**Config:** This section contains several settings:
 

- Centering Speed: 20 rpm
- Centering Time: 2 sec
- Idle Exhaust: 100%
- ☒ Enable Vacuum Chuck

At the bottom of the 'Config' section are two buttons: 'Revert' and 'Save'. Below the entire configuration area is a row of navigation buttons: 'Run', 'Edit', 'Diag', 'Config', 'Help', and 'Back'.

**Figure 5: Centering the substrate using the Spin Config screen**

- v. Once the substrate is properly registered on the Spin Chuck, start the loaded process recipe by pressing the "Start Process" icon. The lid must remain closed at all times during the process. The 'Start Process' icon will now change to the "Abort" icon. Press the "Abort" icon if a process needs to be terminated.
- vi. Once the process is complete, an audible alarm will sound. Press the "OK" button to silence the alarm. The system is gain now ready for use.
- vii. Multiple iterations of the same process can be consecutively performed by changing the number inside the "Iterations" field.

**b. Thermal (Bake) Process**

- i. Use N<sub>2</sub> blowgun to remove unwanted particles from front side and back side of substrate before processing.
- ii. From the “Run Process” screen, Press “Run Thermal Process”
- iii. Press the “Load” icon to load a thermal process recipe. The desired recipe may be selected by double clicking on the desired recipe or by selecting the desired recipe and clicking “Enter”.
- iv. Load the substrate onto the thermal chuck.
- v. Press the “Start” icon to begin the process. The “Start” icon will now change to the “Abort” icon. Press the “Abort” icon if the process needs to be terminated.
- vi. Once the process is complete, press “OK” to silence the alarm. The system is now ready to perform another thermal bake.

## **5. Recipe Editing**

**a. Spin Coat Process**

- A.** From the “Spin Process” window, press “Edit” on the Navigation Bar. This opens up the Spin Recipe Manager window. In a similar fashion, one can press the “Edit Recipe” icon to edit a loaded recipe.

**B. Field Definitions (Shown in Figure 6)**

1. Recipe Name-name of the currently loaded recipe
2. Load Button- opens the Dialog to load a recipe into the editor
3. Save Button-opens the “Save” dialog for saving the current recipe
4. Delete-opens the delete dialog for deleting recipes from the system
5. Velocity Column-input of velocity in RPMs of each step in the process

6. Ramp Column-input of angular acceleration of each step in the process
7. Time Column-input of the time duration value for each step in the process
8. Dispenses Column-input of which dispenses (e-beam developer, etc.) are available for each step in the process
9. Exhaust Column-input of exhaust percentage is defined for each step in the process
10. Oscillation-input of time between oscillations is defined for each step in the process.
11. Insert Icon-inserts a blank step in front of the currently highlighted step
12. Delete Icon-deletes the currently selected step
13. Clear All Icon-clears all data loaded into the editor
14. Scroll Up Icon-steps the recipe control input up one step
15. Scroll Down Icon-steps the recipe control input down one step
16. Highlighted Step-Darker Grey Color indicates which step is currently available to be modified.

Recipe Manager 2/22/2010 1:37:15 PM

Recipe Name: My Recipe <sup>1</sup>

| RECIPE                  | Step | Velocity (RPM)    | Ramp (RPM/s)      | Time (sec)      | Dispenses         | Exhaust (%)      | Oscillation (sec) |
|-------------------------|------|-------------------|-------------------|-----------------|-------------------|------------------|-------------------|
| Load... <sup>2</sup>    | 1    | 1000 <sup>5</sup> | 3000 <sup>6</sup> | 10 <sup>7</sup> | none <sup>8</sup> | 100 <sup>9</sup> | 0 <sup>10</sup>   |
| Save... <sup>3</sup>    | 2    | 2000              | 3000              | 10              | 2                 | 0                | 0                 |
| Delete... <sup>4</sup>  | 3    | 3000              | 3000              | 10              | 4                 | 25               | 0 <sup>16</sup>   |
| Insert <sup>11</sup>    | 4    | 4000              | 3000              | 10              | none              | 100              | 0                 |
| Delete <sup>12</sup>    | 5    | 5000              | 3000              | 10              | none              | 100              | 0                 |
| Clear All <sup>13</sup> |      |                   |                   |                 |                   |                  |                   |

Run Edit Diag Config Help Back

<sup>14</sup> <sup>15</sup>

Figure 6: Spin Recipe Edit Screen

- C. Pressing the “Velocity” (5), “Ramp” (6), “Exhaust” (9), or “Oscillation” (10) boxes will cause a numeric keypad to appear (Figure 7).
- D. By using the numeric keypad, the parameter values for the selected step can be entered. A valid range is associated with each step. Once the desired value is entered, press the “Enter” key. The numeric pad will disappear, and the system will go back to the “Spin Edit” screen with the selected value updated.

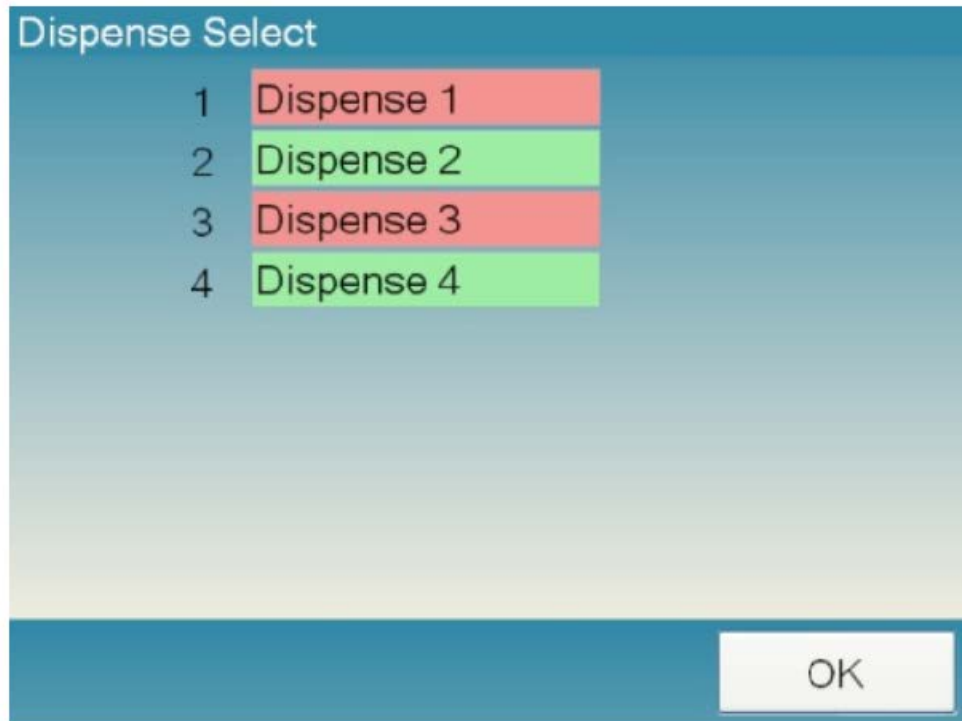
Valid range: 0 to 6000

1000 X

|   |   |   |           |
|---|---|---|-----------|
| 7 | 8 | 9 | BACKSPACE |
| 4 | 5 | 6 | DELETE    |
| 1 | 2 | 3 | ENTER     |
| - | 0 | . |           |

Figure 7: Numeric Pad

E. By Clicking on the “Dispenses” box (8), a Dispense Select screen will appear.



**Figure 8: Dispense Select Screen**

- F. The Dispense Select screen will show all the installed dispenses on the tool. Dispenses are selected to turn on by clicking on the dispense name, clicking again will deselect the dispense. The dispenses name can be configured on the Config Screen. Dispenses that will be turned on during the step will be highlighted as green, dispenses that will remain off will be highlighted in red. There is no limit to the number of dispense enabled per step. Clicking OK will return to the Spin Edit Screen, updating the dispenses box.
- G. Spin recipes have a limit of 100 steps. Steps that have values entered will be saved, steps with no values will not be saved. If a step has partial data entered, default values will be entered into the blank boxes. Recipes should be examined prior to running the ensure the default values are acceptable. If data is entered in non-consecutive steps, steps of all zeroes will be entered in between the steps containing data.

**b. Thermal (Bake) Process**

- A. From the “Thermal Process” window, press “Edit” on the navigation bar. This opens up the “Thermal Recipes” Edit screen.

**Recipe Manager** 8/2/2010 2:34:59 PM

**RECIPE** Recipe Name: My Recipe

| Step | Temperature (°C) | Time (sec) | Bake Method | Lift Pin Height (1/1000 inch) |
|------|------------------|------------|-------------|-------------------------------|
| 1    | 115              | 210        | Lift Pins   | 250                           |
| 2    | 115              | 30         | Contact     | 0                             |
| 3    |                  |            |             |                               |
| 4    |                  |            |             |                               |
| 5    |                  |            |             |                               |

**STEP**

Insert

Delete

Clear All

Run Edit Diag Config Help Back

**Figure 9: Thermal Recipes Edit Screen**

**B. Field Definitions**

1. Recipe name: The name of the currently loaded recipe
  2. Load Icon: Opens the dialog to load a recipe into the editor
  3. Save Icon: Opens the save dialog for saving the current recipe
  4. Delete Icon: Opens the delete dialog for deleting recipes from the system
  5. Temperature Column: where temperature data is entered for each step in °C
  6. Time Column: where the length of each step is entered in seconds
  7. Method Column: Allows the selection of the thermal method used for each step. Either Contact, Vacuum, or Proximity.
  8. Lift Pin Height: Where lift pin height is entered for each step (Not available on all models).
  9. Highlighted Step: Currently highlighted step is accented by a light blue color.
  10. Insert Icon: Inserts a blank step in front of a currently highlighted step.
  11. Delete Icon: Deletes the currently selected step.
  12. Clear All Icon: Clears all the data loaded in the editor.
  13. Scroll Up Icon: Steps the recipe up one step.
  14. Scroll Down Icon: Steps the recipe down one step.
- C. By clicking on Temperature (5), Time (6), or Lift Height (8) a numeric keypad will appear.
- D. By using the numeric keypad, the parameter values for the selected step can be entered. A valid range is associated with each step. Once the desired value is entered,

press the “Enter” key. The numeric pad will disappear, and the system will go back to the “Thermal Edit” screen with the selected value updated.

- E. Clicking on Method (7) will bring up a window to select the Contact method, and whether the Lift Pins will be used.
- F. Thermal recipes have a limit of 1000 steps. Steps that have values entered will be saved, steps with no values will not be saved. If a step has partial data entered, default values will be entered into the blank boxes. Recipes should be examined prior to running to ensure the default values are acceptable. If data is entered in non-consecutive steps, steps of all zeroes will be entered in between the steps containing data.

## 6. Allowed Materials

The materials allowed in the MicroVoid CS-41 E-beam Resist Development Station include, but are limited to:

E-Beam resists (Negative)

New or Processed wafers