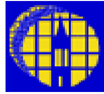
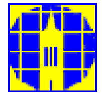


Lab Manual



UVBAKE

Fusion M150PC Photostabilizer System

(uvbake)

1.0 Title

UVBAKE, Fusion M150PC Photostabilizer System

2.0 Purpose

After reading this manual, the User should be able to describe all hazards associated with the M150PC (Uvbake), give a brief description of the M150PC process and theory of operation, and perform wafer/resist processing using this system.

3.0 Scope

The UVbake system uses both ultraviolet light and a heated chuck to respectively cross-link and harden patterned photoresist. The system may be used directly after developing the resist mask, and before dry-etching the substrate. Uvbake essentially replaces the conventional hard bake step prior to etching, and improves the selectivity of the resist greatly.

Uvbake irradiates ultraviolet (UV) light by means of an electrodeless, sealed bulb. High voltage DC power is converted to microwave energy by two magnetrons, which in turn produce a high-temperature plasma inside the bulb. This plasma then re-radiates the energy in the form of infrared, visible, and ultraviolet radiation. An optical reflector ensures a uniform distribution of energy over the plane of the substrate. The end result is a cross-linked resist with much improved mask selectivity for subsequent dry-etch applications.

4.0 Applicable Documents

Revision History

Fusion M150PC Maintenance Student Guide (original hardcopy located near machine)

5.0 Definitions & Process Terminology

5.1 **Fusion H-Mod Bulb** – This bulb is designed to produce very intense UV energy between 280 and 300 nm. This corresponds to the absorption characteristics of the novolak resin used in most positive photoresists.

5.2 **Magnetrons** – These components convert high voltage electrical energy to RF (radio frequency) energy. This RF energy is then transmitted through wave-guides and captured in the electrodeless H-Mod bulb.

5.3 **Faceted Reflector** – This component is designed to provide diffused source of UV energy from the bulb to the wafer surface in a three dimensional fashion. This way, vertical walls of the resist receive the same amount of UV cure.

5.4 **UV Energy** – Ultraviolet energy (wavelengths 320 nm – 10 nm). Direct exposure of this type of radiation is hazardous.

5.5 **Blisters** – The photoactive compound in resist will break down and give off N_2 gas after being exposed to UV energy. If the N_2 is not allowed to escape before the bulk of the resist becomes cross-linked, pockets of gas (blisters) will form. They will eventually **pop** and spew resist debris in all directions, therefore undesirable.

5.6 Reticulation – Wrinkling of the resist is also known as reticulation. The common cause is when the surface has not been cured enough to withstand the stress caused by the contracting bulk of the resist during thermal ramp-up.

5.7 Pullback – This phenomenon results in the shrinking or pinching in of the top portion of a resist pattern. The cause is the rapid reduction in volume that takes place when a large quantity of solvent is suddenly evaporated from the resist.

5.8 Pattern Flow – If the resist is heated above its glass transition temperature, it will flow and become rounded. White light has been shown to drastically reduce the glass transition temperature of resist.

5.9 Wet Edge – This refers to the degree of post-process resist hardness at the wafer edges. The phenomenon is sometimes seen with thicker resists. If the resist on the edges smears easily it should be wiped down with a technicloth before further processing occurs. Alternatively, wafers with wet edge may be further processed in uvbake with program O, which is essentially an additional 3-minute hard bake.

6.0 Safety

6.1 Microwave Radiation – The User should be aware that the uvbake system conforms to ANSI's standard for exposure to microwave radiation. This standard states that an individual should not be exposed continuously to microwave radiation at average levels exceeding 5 mw/cm^2 on a continuous basis at 2.45 GHz. Uvbake incorporates RF detectors that shut the system down if a peak level of 5 mw/cm^2 should ever occur.

6.2 UV radiation – The User should also be aware that excessive ultraviolet radiation can be dangerous to the eyes and skin. The uvbake system incorporates several interlocks to prevent such direct exposure to UV radiation. Some indirect UV light leakage may occur around the cover of the irradiator, but exposure to this light poses no hazard.

6.3 Pinch Points – The User must be aware AT ALL TIMES of moving parts of the uvbake system. These **danger** zones are labeled with red **Pinch Point** signs. They are located at the cassette loading and receiving areas and at the robotic transfer armload and receive points. The User must exert caution at all times such that a limb, finger, or article of clothing does not become trapped or entangled.

6.4 High Voltage – The uvbake system operates at 4000 volts. The User should never attempt to operate the system with any of the covers removed.

6.5 Ozone – The fusion H-MOD bulb generates ozone, which has a characteristically pungent odor. During normal operation the ozone will be removed through the exhaust port. If it is sensed that the exhaust port may not be working correctly, the User should cease operation and report this fault.

6.6 Heat – The surface of the thermo-chuck may reach 250ºC during normal operation. The surface temperature of the lamp will exceed 120ºF during normal operation. There is NEVER a reason for the User to come into contact with these components. Be aware however that a post-processed wafer may still be hot!

7.0 Statistical/Process Data

N/A

8.0 Available Processes, Process Notes

Currently there are several recipes that have been characterized for specific applications. See the Appendix for details.

8.1 Process/Theory of Operation

The UV bake process is a simple **one-stop-shop** stabilization treatment that replaces the conventional resist hard bake step. Recipes will differ in parameters of course, but the three basic segments of a process are:

8.1.1 **Pre Bake** – While simultaneously heating the resist, a low dose of UV energy breaks down the PAC (photoactive compound). This also cross-links the resist enough to allow for a thermal ramp-up without pattern degradation.

8.1.2 **Ramp Up** – The hot plate temperature is gradually increased to a high temperature (program dependent). During this thermal ramp-up the wafer is exposed to high intensity UV energy, and cross-linking occurs.

8.1.3 **Post Bake** – For a more densely cross-linked resist, a post-bake step is incurred in the recipe. The hot plate remains at a high temperature for an extended time during this segment.

8.2 Control Panel Description

The default status of uvbake LED screen should be **Main Menu** mode. In the **Main Menu**, from top to bottom the options are:

8.2.1 **Power Down** – Turns power to the machine OFF. The default state of the machine is with power ON, so this option should generally not be used.

8.2.2 **Process Menu** – Allows User to select and run processes.

8.2.3 **Diagnostic Menu** – Not available

8.2.4 **Wafer Handling Menu** – Not available

8.2.5 **Secs I Parameters** – Not available

8.2.6 **Automatic Deck Clearing** – Selecting this option will commence an automatic process that removes any derelict substrate from the processing chuck.

At the bottom of the screen in **Main Menu** mode, from left to right the options are:

8.2.7 **Last** – Selecting this will revert the screen to the previously used optio.

8.2.8 **Select** – Selecting this key will execute the highlighted operation to which the cursor arrow points.

8.2.9 **Arrow Up** – Allows cursor arrow to be moved up.

8.2.10 **Arrow Down** – Allows cursor arrow to be moved down.

8.2.11 **Stop** – Selecting this option stops all processing. It performs the same task as the emergency stop button.

The **Process Menu** allows the User to select and run processes. In the **Process Menu**, from top to bottom the options are:

8.2.12 **Main Menu** – Selecting this option will revert back to the Main Menu.

8.2.13 **Select Process** – Allows User to select one of 26 recipes (A-Z) for processing.

8.2.14 **Define Process** – Not available. Standard recipes have already been developed for use. For assistance with the development of non-standard recipes consult uvbake superuser.

8.2.15 **Process Monitor** – Not available

8.2.16 **View Lamp Status** – Selecting this option will allow the User to view the bulb's current state.

8.2.17 View Chuck Status – Selecting this option will allow the User to view the thermal chuck's current state.

8.2.18 View Cycle Status – Selecting this option will allow the User to view the current state of the process cycle.

8.3 Quick Cycling

Because the uvbake recipes are limited to seven steps each for illumination and baking, it is sometimes desirable to create a recipe which will be repeated a number of times in order to become a longer sequence of steps (such as recipe Y). In this case it may be advantageous to minimize the time between iterations of the uvbake cycle. The following are suggestions for steps to take to minimize reloading delay (about 20 to 30 seconds is possible):

8.3.1 In each cassette, place a dummy wafer in slot 2. Place the device wafer into slot 1 of the send cassette, and it will exit into slot 1 of the receive cassette. This facilitates quick swapping of the receive cassette back onto the send indexer.

8.3.2 Process the device wafer by choosing **CYCLE** processing (not **AUTO** nor **BATCH**), and pressing **CYCLE START**.

8.3.3 As soon as all bake and illumination steps are completed and the temperature begins to cool down, press **CYCLE STOP** to initiate immediate wafer unloading without waiting for the hotplate to cool. Do NOT press **STOP**, which is an emergency stop and will cause a lengthy delay while the tool resets.

8.3.4 Wait for the wafer to be unloaded to the receive cassette and the receive robot to return to the idle position. As soon as the **DISP** button changes to **MENU**, do the following steps as quickly as possible:

8.3.4.1 Press **MENU**.

8.3.4.2 Swap the receive cassette and the send cassette on the indexers.

8.3.4.3 Ensure that the device wafer is seated correctly in slot 1 of the send cassette (if it is not seated correctly all the way back into the cassette, loading or unloading errors may cause lengthy delays and are likely to damage the wafer).

8.3.4.4 Press **LAST**.

8.3.4.5 Press **CYCLE START**.

9.0 Equipment Operation

To run a process using uvbake perform the following steps:

9.1 From the **Main Menu**, highlight and chose the **Automatic Deck Clearing** option using the arrow keys and **select** button. This will remove any wafer inadvertently left in the system.

9.2 Load the substrate(s) to be processed into the load cassette, and place the cassette on the loading block.

9.3 From the **Main Menu**, highlight and chose **Process Menu** using the arrow keys and **Select** button.

9.4 In the **Process Menu**, chose the **Select Process** option. The User may then scroll through the recipes using the arrow keys. The **View Graph** option may be selected for a visual aid of the process. Press the **Select** key when the correct recipe is found. A subsequent message will express which recipe has been loaded, and then prompt the User to select the **Resume** key.

9.5 Next, selecting the **Menu** option will place the screen back in the **Process Menu**. Select the **View Cycle Status** option. This will bring up what is essentially a pre-process menu. The **Proc Mode** option toggles among **Cycle**, **Auto**, and **Batch** processing. **Cycle** should be selected when a

single substrate is being processed. **Auto** should be selected when more than one substrate is being processed in sequence. **Batch** processing is not used.

9.6 Select the **Cycle Start** (or **Auto Start**) key. Processing should begin by which the substrate is moved to the thermal chuck via the robotic transfer load arm. The User should note that once the **Cycle Start** (or **Auto Start**) key has been selected, the **Menu** option transforms to the **Disp** option. Selecting **Disp** allows the User to view the current process in a graphical display format.

9.7 When the process is complete, the robotic transfer receive arm will unload the substrate and place it in the receiving cassette. The User may need to select the **Stop** option to raise the cassettes after processing. Selecting **Stop** once halts all processing. Selecting **Stop** again should bring up the Fusion Semiconductor logo screen, and the option **Proceed**. Once **Proceed** is selected, automatic deck clearing will occur and the machine will revert back to the **Main Menu**.

10.0 *Troubleshooting Guidelines*

10.1 Avoiding Wafer Handling Errors

Placement of the send cassette sometimes jostles wafers in the cassette out of proper place. To prevent handling errors which can seriously damage wafers, always ensure that wafers in the send cassette are seated all the way back into the cassette before beginning the process.

10.2 A wafer gets stuck inside the chamber:

From the **Main Menu**, highlight and choose the **Automatic Deck Clearing** option using the arrow keys and **select** button. This will remove any wafer left in the system. An alternative is to select **Stop** twice. After the Fusion Semiconductor logo shows up, select **Proceed**. This will also remove any wafer inadvertently left in the system.

11.0 *Figures & Schematics*

N/A

12.0 *Appendix*

Standard Uvbake Recipes

uvbake program	**A**	**TEMP**	**TIME**	**STEP**	**LAMP**	**TIME**
used with svgcoat prog #s	**1,2**	100		**IDLE**		
developed for:	**lam3**	100	5	**1**	FLASH	0
		200	50	**2**	OFF	10
		200	5	**3**	HIGH	50
				4	OFF	0
RESULTS:		**blistering**	none	**reticulation**	None	
		pullback	none	**wet edge**	None	
		reflow	minimal	**Sel Al/PR**	2.2:1	

uvbake program used with svgcoat prog #s developed for:	B	TEMP	TIME	STEP	LAMP	TIME
		50		**IDLE**		
		50	20	**1**	FLASH	3
		90	60	**2**	OFF	60
		100	90	**3**	FLASH	5
		100	60	**4**	OFF	60
		100	60	**5**	LOW	20
		100	80	**6**	HIGH	60
		100	0	**7**	OFF	0
RESULTS: Not available		**blistering** **pullback** **reflow**	N/A N/A N/A	**reticulation** **wet edge** **Sel Al/PR**	N/A N/A N/A	

uvbake program used with svgcoat prog #s developed for:	J	TEMP	TIME	STEP	LAMP	TIME
	1,2	110		**IDLE**		
	sts	110	20	**1**	FLASH	0
		230	70	**2**	OFF	10
		230	10	**3**	LOW	10
				4	HIGH	70
RESULTS:		**blistering** **pullback** **reflow**	none none minimal	**reticulation** **wet edge** **Sel Si/PR**	See notes None ~100:1	

uvbake program used with svgcoat prog #s developed for:	O	TEMP	TIME	STEP	LAMP	TIME
	any	110		**IDLE**		
	post bake	120	10	**1**	OFF	0
		120	180	**2**	OFF	0
				3	OFF	0
RESULTS:		**blistering** **pullback** **reflow**	none none none	**reticulation** **wet edge** **Sel Si/PR**	None None Na	

uvbake program used with svgcoat prog #s developed for:	R	TEMP	TIME	STEP	LAMP	TIME
		110		**IDLE**		
		110	20	**1**	OFF	10
		140	20	**2**	LOW	10
		140	30	**3**	HIGH	50
RESULTS: Not available		**blistering**	N/A	**reticulation**	N/A	
		pullback	N/A	**wet edge**	N/A	
		reflow	N/A	**Sel Si/PR**	N/A	

uvbake program used with svgcoat prog #s developed for:	S	TEMP	TIME	STEP	LAMP	TIME
	4,5	120		**IDLE**		
	sts	120	23	**1**	FLASH	3
		240	120	**2**	OFF	10
		240	120	**3**	LOW	10
				4	HIGH	120
RESULTS:		**blistering**	none	**reticulation**	See notes	
		pullback	none	**wet edge**	slight	
		reflow	minimal	**Sel Si/PR**	100:1	

uvbake program used with svgcoat prog #s developed for:	U	TEMP	TIME	STEP	LAMP	TIME
	1,2	110		**IDLE**		
	Baseline runs	110	20	**1**	OFF	10
		140	20	**2**	LOW	10
		140	30	**3**	HIGH	50
				4	OFF	0
RESULTS:		**blistering**	N/A	**reticulation**	N/A	
		pullback	N/A	**wet edge**	N/A	
		reflow	N/A	**Sel Si/PR**	N/A	

uvbake program used with svgcoat prog #s developed for:	Y	TEMP	TIME	STEP	LAMP	TIME
		50		**IDLE**		
		90	35	**1**	FLASH	0.5
	thick resist			**2**	OFF	10
	cycle 25 times			**3**	FLASH	1.0
	see Section 8.3 on Quick Cycling			**4**	OFF	10
				5	FLASH	1.0
				6	OFF	10
				7	FLASH	2.0
RESULTS:	**blistering** ~3/cm^2	**pullback** possible	**reflow** possible	**reticulation** possible	**wet edge** N/A	**Sel Al/PR** N/A

uvbake program used with svgcoat prog #s developed for:	Z	TEMP	TIME	STEP	LAMP	TIME
		50		**IDLE**		
		50	5	**1**	OFF	5
		200	120	**2**	HIGH	120
		50	0	**3**	OFF	0
RESULTS:	**blistering** N/A	**pullback** N/A	**reflow** N/A	**reticulation** N/A	**wet edge** N/A	**Sel Si/PR** N/A

Notes:

I-line resist was found to be typically lest robust than its counterpart G-line when processing with the uvbake tool. For instance, slight reticulation along the edges of the wafer was detected with I-line, but not with G-line resist for the same uvbake program. Selectivity may also be higher with the G-line resist.

Uvbake program O should be used to cure wet edge sometimes found after initial uvbake processing. It should not have any effect on the resist pattern since the initial uvbake process should have cross-linked the resist previously.

Standard ashing (O_2 plasma) processes using Technics-c or Matrix were found to remove uvbaked resist in its entirety.