Chapter 5.7

Tystar7 P-type B-doping BCl₃ Atmospheric Furnace (6” and 8”)
(Non-MOS)
tystar7 - 386

1.0 Title
Tystar7 Non-MOS BCl₃ P-Type Doping Atmospheric Furnace (6” and 8”)

2.0 Purpose
Provide specific operation and process information for Tystar7 p-type BCl₃ B dopant atmospheric furnace that is capable of processing both 6” and 8” wafers. This tube is specifically assigned to p-type doping of Si wafers.

3.0 Scope
This chapter covers the general furnace description for Tystar7 and furnace operation procedures, which includes recipe loading, wafer loading/unloading, process status monitoring, problem diagnosis, and wafer cleaning requirements.

4.0 Applicable Documents

Revision History
4.1 Tystar Diffusion Furnace System Instruction Manual (copy in Office).
4.2 Material Safety Data Sheets for BCl₃, He, O₂, N₂, and Forming Gas H₂/N₂ (copies in the lobby).

5.0 Definitions & Process Terminology

5.1 FCS-10: touchscreen control terminal

5.2 BCl₃ Gaseous Dopant Diffusion: BCl₃ is reduced at normal process temperatures in an H₂ atmosphere to form elemental B for doping on the surface of an upright Si wafer. B then diffuses into the Si at a rate determined by the temperature of the furnace. Diffusion depth is found using the diffusivity of B at the furnace temperature.

5.3 Annealing: A high temperature process that uses N₂ to keep wafers in an inert atmosphere.

5.4 Furnace Flat Zone: An area inside the furnace with the least temperature variation across it (consequently the best place to process wafers).

6.0 Safety
Follow general safety guidelines in the lab as well as the specific safety rules, listed below:

6.1 Electric Shock Hazard: Tystar furnaces utilize high electric power (high current) to generate heat. Do not open the side panels or touch the high power electrical parts in the furnace cabinet.

6.2 Chemical Hazard: BCl₃ is used for in-situ p-type doping of Si and is not flammable. However, it is stored in a pressurized container which may explode during the elevated temperatures of a fire. BCl₃ does pose a serious health hazard if inhaled or ingested. Please refer to the MSDS for first aid information.
Wear a face shield when loading/unloading wafers. Proceed with caution. Avoid touching any furnace quartz ware to prevent burning your hands and/or contaminating the furnace. No flammable chemicals, especially organic solvents, are allowed at the load station when the tube is open.

6.4 New recipes are not permitted without the express consent of process staff.

7.0 Statistical/Process Data

7.1 Check the Problem and Comment section under the equipment menu of Mercury.

7.2 Check the message upon enabling for Tystar7.

8.0 Available Process, Gases, Process Notes

8.1 Wafer Cleaning Requirements, before loading them into Tystar furnaces.

8.1.1 Non-metalized wafers to be processed in Tystar7 must go through the standard pre-furnace cleaning procedure. This entails a 10 minute piranha dip in Msink8 and Msink6, and an ensuing one minute HF dip for oxide removal if desired. Photoresist coated non-metalized wafers must initially have their photoresist processed in the Matrix Asher or stripped at Msink1 (PRS-3000 bath). This is required for both MOS and non-MOS wafers. The wafers must then be cleaned in Msink8 and Msink6. Msink6 is the pre-furnace clean step prior to wafer introduction into Tystar7. This means photoresist removal from non-metalized wafers requires an additional cleaning at Msink8 regardless of whether the process is MOS or non-MOS. For a complete description of pre-furnace wafer cleaning please see Section 1.3 in Chapter 5.00, Tystar Furnaces Overview.

8.1.2 No cleaning steps are necessary when transferring wafers directly from one MOS furnace to another MOS furnace. Similarly, no cleaning is required when directly transferring wafers from one non-MOS furnace to another non-MOS furnace.

8.2 No metals are allowed in Tystar7.

Available Processes

8.3 Non-MOS BCl3 p-type doping of 6” and 8” wafers.

Available Gases

8.4 Boron Trichloride diluted with He (BCl3/He): Used for p-type doping of Si wafers.

8.5 Nitrogen (N2): Used to purge tube of atmospheric gases and keep tube in an inert/clean environment when idle.

8.6 Forming Gas (10%H2/N2 mixture): Used to reduce oxides on metal surfaces.

8.7 Ammonia NH3: Available – please consult with staff before use.

8.8 Argon (Ar): Available inert gas.

Special Process Notes

8.12 Tystar7 should be used for p-type BCl3 doping of Si only. In the event that Tystar7 is down, you may request staff to review your process to see if is suitable for Tystar14. If staff deems your process is OK, Tystar14 may be used as an alternate p-type doping furnace to Tystar7 for 6” wafers. There is currently no alternative furnace for p-type doping of 8” wafers.

8.13 Refractory metals such as W are allowed in Tystar7.

9.0 Overall Furnace Operation

9.1 General Tystar Furnace Operational Guidelines
9.1.1 Front Panel Special Function Buttons and Keypad Description (see Section 11.1 for the schematics of the front panel)

**ABORT:** ***USE ONLY IN EMERGENCY***, e.g. fire, toxic gas leak. DO NOT use this key to abort a recipe in progress. If you must stop a recipe, please contact a super-user or process staff. They know the proper procedure for stopping a process or evacuating toxic gases from the furnace. This action requires a password.

**MAIN MENU:** Displays the main menu (See the Appendix for the description of all menu commands)

**NEXT PAGE:** Used to display more information/instructions on the display. Use when prompted, otherwise the computer will freeze and you will need to find a process staff member to reboot it.

**CMD:** Used for certain special functions. (Mostly used with GS commands)

**Arrow Keys:** Used when prompted to select a recipe. Do not use the arrow keys for DEL/BACKSPACE when entering alphanumerical inputs. The computer will freeze and you will need to find a process staff to reboot it.

**Alpha-Numeric Keys:** Used to enter process parameters, e.g. gas flows, pressure, deposition time, and etc.

**ENTER:** Used to enter the menu command or alphanumerical inputs.

**CLEAR:** DO NOT USE ON THIS FURNACE. This will freeze the computer.

**BACKSPACE:** Used for correcting alphanumeric inputs.

**RUN:** Run the recipe loaded in computer memory.

**HOLD:** Hold a recipe step at its present process condition. Press the RUN key to resume the process.

**EVENT:** Acknowledge the process to go to the next step of the recipe when the current step time has not finished yet. For example, after you finish loading the wafers and want to close the furnace door before your 20 minute time limit is up. Note that some process recipe steps do not respond to the EVENT key.

**BOAT IN/OUT:** Move the boats in/out of the process tube manually, independent of the recipe. These are toggle switches, i.e. push once to turn on and the second time to turn off. If both are ON at the same time, then the boats stop moving.
9.2 Computer Terminal (loading recipes and looking at status of run in progress)

The Computer Terminal controls and monitors all user accessible Tystar7 Furnace operations.

Commands:
The computer terminal only recognizes CAPITAL letters. You can also use the special function buttons. However, it is suggested that you learn the commands manually as well.

Summary of Commands and Functions.

<table>
<thead>
<tr>
<th>Commands</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR</td>
<td>Displays available recipes. Use arrows and double enter to view recipe steps. Top of window gives instructions on how to view steps in detail. Press shortcut labeled NEXT PAGE to display next page of steps/sub-steps.</td>
</tr>
<tr>
<td>RL</td>
<td>Loads process recipes. You will be prompted to use the Arrow Keys to select a recipe. Afterward, press ENTER button twice. The computer will prompt you to enter process parameters, if/when needed.</td>
</tr>
<tr>
<td>DS</td>
<td>Displays current process status of Tystar5. Includes current step, time to go, and parameters status.</td>
</tr>
<tr>
<td>DH</td>
<td>Displays the process history from the last time the RUN button was pressed to present time.</td>
</tr>
<tr>
<td>GS</td>
<td>Changes the Display to graphic mode. It shows large characters with only selected process information. Use CMD button to select process parameters to be displayed.</td>
</tr>
</tbody>
</table>

9.3 Available Recipes

9.3.1 BDOPEA.007: BCl3 p-type doping. Variables are ramp and BCl3 deposit temperatures, N2 flow, H2 flow, BCl3 flow, BCl3 deposition and post-deposition wafer cool-down times.

9.4 Processing a Run (Loading Recipe and Wafers)

Loading a Recipe

9.4.1 Enable Tystar7 on Mercury.

9.4.2 Check that no recipe is running in furnace and that furnace status reads IDLE (status found at center top of DISPLAY STATUS sub menu).

9.4.3 Go to MAIN MENU and type RL (Recipe Load) to display available recipes.

9.4.4 Select desired recipe using arrow keys and press ENTER twice to begin.

9.4.5 Enter desired process parameters when prompted and press MAIN MENU, as instructed by the computer, upon variable entry completion. The furnace status should still read IDLE in Display Status.

Load wafers and run a process recipe

9.4.6 Put on the face shield.

9.4.7 Press RUN. The furnace door will open and wafer boats will come out. Be aware that the furnace door will automatically close after 20 minutes.
9.4.9 Load your wafers using the MOS clean vacuum wand with red tubing. These vacuum wands do work with 8" wafers, no special equipment is necessary. All wafers should be loaded with their flats up for optimal wafer support and consistent gas distribution.

9.4.10 Do not wear poly gloves over nitrile gloves when loading/unloading wafers. The poly gloves are usually too big and slippery for proper dexterity, and the tips of the poly gloves may melt, causing contamination and burns.

9.4.11 Once wafers are loaded, press EVENT to start the boat moving into the furnace.

Unload wafers after process ends

9.4.12 No alarm will sound when your recipe is finished running. You are in charge of checking the status of your run of your own accord. Recipe BDOPEA.007 is programmed to hold your wafers in an inert environment until you are ready to unload.

9.4.13 To unload your wafers, press EVENT. The boats will move out. When the boats stop moving, wait a few minutes for the wafers to cool down. Then use the MOS vacuum wand to unload into the cooling rack next to the furnace (Tystar7 quartz boats). Wafers may still be too hot, so you may have to wait for a few more minutes before placing them into your plastic cassettes.

9.4.14 Press EVENT to move the boats back into the furnace. The furnace status will return to IDLE once the door is closed.

9.4.15 Disable Tystar7 on Mercury and be sure to report any problems.

10.0 Troubleshooting Guidelines

10.1 Computer Terminal is blank.

10.1.1 Tap on the far right side of the screen. It should light up.

10.2 Door won't open/Boat loader stuck

10.2.1 Make sure there is nothing obstructing the movement of the boat loader.

10.2.2 Make sure the cable that pulls the boat loader is not loose. If so, ask staff to adjust the tension on the cable.

10.2.3 If the above steps fail, report the problem on Mercury.

10.3 The tube is at one of the abort sequences (step ABRT) when you come back to unload your wafers.

10.3.1 One of the process gas flows was out of tolerance due to a delivery system malfunction or empty gas cylinder.

Solution: Press MAIN MENU, then enter DH. Press ENTER when prompted for input. The process history for this run will be displayed. Note the last step before the abort sequence and report it on Mercury.

10.3.2 You did not enable the furnace. Find a staff person to restart the process.

10.4 The tube is at special hold (step SHLD)
Solution: Report as a fault on Mercury. Do not attempt to fix the situation yourself.

**11.0 Figures & Schematics**

**11.1 Figure 1 – Tystar7 computer terminal Display**
Appendix

FCS10 Furnace Computer Manu Commands

**D - Display Sub-Menu**
- **DE** equipment status
- **DD** file directory - Lists the recipes in memory. (Same as DI DI in Tycom)
- **DH** process history. In case of recipe abort, error message can be found.
- **DR** process steps in a recipe file. The system will prompt you to select a specific recipe from memory.
- **DS** process status that is continuously updated.
- **DT** temperature history
- **DE** and **DT** should not be used.

**R - Recipe Sub-Menu** (password protected except RL)
- **RE** Allows one to edit recipes. See the Tystar Manual for instructions.
- **RL** Load a recipe for subsequent use. Usually, this is the only command, which you will need to use from this sub-menu.
- **RM** Modifies current process parameters.
- **RR** Renames a recipe. Don't use this either...
- **RX** Deletes a recipe from memory.

**G - Graphics Sub-Menu**
- **GP** plumbing diagram
- **GE** plumbing edit (password protected)
- **GS** tube status. An abbreviated status summary screen is displayed.

The following sub-menu commands should not be used and are for reference only.

**H - Host computer Sub-Menu**
- **HP** host parameters

**C - Configuration Sub-Menu**
- **CC** contact closures
- **CM** MFS460 gases
- **CT** TCU temperature
- **CS** station options
- **CA** alarm selection

**X - Diagnostics Sub-Menu**
- **XM** memory utility

**Ti** (change time, date) and **PW** (change password) have no submenu. Don't use these commands.

Tystar5 Furnace Study Guide

Be sure to know…

1. Maximum temperature.
2. MOS vs. non-MOS rule.
3. Loading a recipe.
4. Troubleshooting the Computer Terminal.
5. Cleaning wafers before they go into the furnace.
7. Displaying the status of a process.
8. Unloading wafers and closing the tube.
9. Which vacuum wand to use.
10. Alarms and what to do when you hear them.
12. Which gases are used by tystar7.