

Technics 800C MicroRIE Operating Procedure

BioMEMS Laboratory Cleanroom

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Description

The Technics 800C microRIE is a plasma etch system capable of etching polymer or silicon ceramics. It contains a 30 kHz 350 W power supply, two gas mass flow controllers and is controlled by computer controlled interface. Currently the system is configured with Oxygen and Sulphur Hexafluoride (SF₆) gasses. The system can accommodate 4 inch silicon or glass wafers or other substrates of various sizes.

Startup

When first initializing the system the MicroRIE, computer and pump should be off with the chamber under vacuum. The two gas cylinders should be closed and the Compressed Dry Air (CDA) line should be off and the valve into the MicroRIE closed. The circulating water chiller should be off and the valve into the MicroRIE closed. Once finished with use the system should be returned to this state.

When starting up the systems you should complete the following in this order.

- 1) Open the wall CDA line. Turn on the circulating water cooler
- 2) Open the two quarter turn plug valves on the back of the MicroRIE (when facing the machine, the valve on the left is the CDA line and the valve on the right is the circulating water). The valves will be perpendicular to the line in the closed position and parallel to the line in the open position.
- 3) Turn on the pump using the toggle switch on the left side of the pump
- 4) Turn on the power to the MicroRIE pushing the green power switch on the back right of the MicroRIE
- 5) Turn on the computer by pressing the power switch on the front of the computer module.

Computer control

The MicroRIE is controlled by a computer interface written in Visual Designer 4.0. The program is located in C:/Program Files/Visual Designer/Visual Designer 4.0/-800/. The computer program is 800.dgm and is launched by launch.dgm. These have been converted into flow

control guis (800.fco, launch.fco). These should not be modified without permission. Please note* there are multiple 'legacy' versions of the control programs for different chamber configurations and other uses. These should not be used as they will cause hardware conflicts.

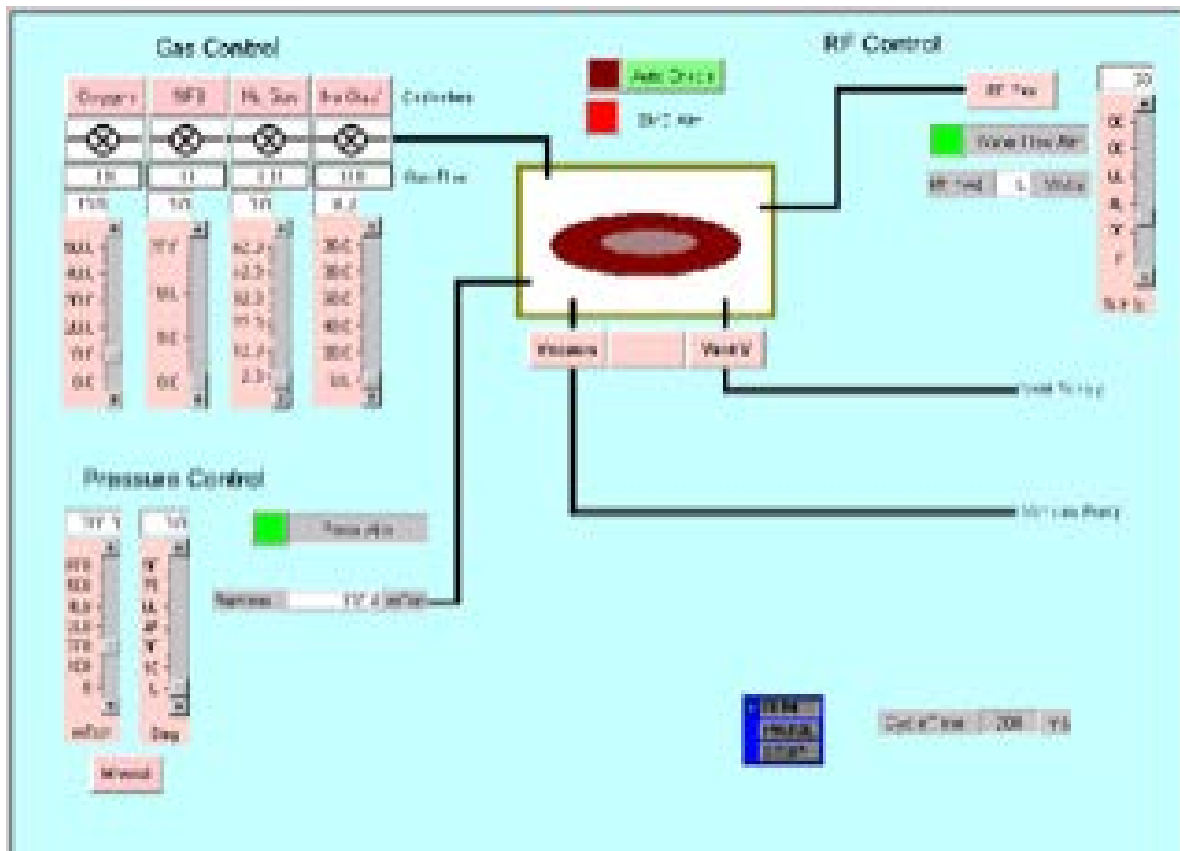
Once the computer is started

- 1) Press Ctrl-Alt-Delete to log in. Username: Administrator Password: None. These fields should already be filled in just hit return
- 2) A shortcut to the control program is on the desktop 800. Just click the icon to start the control program. It should take 30-60 for the program to load and initialize. It will ask you if you wish to save a log. Click yes. You can verify the program is initialized when the Chamber pressure reading changes from 0 mTorr to an actual reading (50-100 mTorr likely) once the baratron communicates with the computer.

The control program can be operated in manual or automatic program mode. The automatic program is controlled by an excel file (C:/ Program Files/Visual Designer/Visual Designer 4.0/-800/base.xls). The program will automatically open the excel file.

Manual Mode

An image of the control program is shown below.



There are 4 main systems to be controlled: Vacuum/Vent, Gas Control, Pressure Control, RF Control. There is also alarms and a Water flow interlock which must be green (If no water is flowing it will display red and the RF power supply will not turn on).

The Vacuum/Vent buttons are in the center of the interface. To open the vacuum or vent valves click on the button. The buttons are interlocked so you cannot have both valves open at once.

The Gas Control have 4 setting but only two MFCs. They are labeled Oxygen and SF6. The Oxygen MFC allows gas flow from 0-50 sccm. The SF6 MFC allows gas flow from 0-27 sccm.

The pressure control sets the chamber pressure setpoint (This may not be reached at higher gas flow rates)

The RF control sets the RF power. The control is in terms of power supply percent. 15% is equivalent to 50W, 30% is equivalent to 100W, 90% is equivalent to 300W. Chamber power should never exceed 300W. Once the RF is initiated the actual RF power is displayed.

In order to adjust the Gas Control, Pressure, or RF power sliders you can adjust the parameters by clicking on the bar or clicking the 'up' or 'down' button. Clicking on the bar above or below the setpoint will cause a large jump in the input parameter (usually ~10% of the total range). Clicking on the arrow will cause a small change (usually about 1 gauge unit).

To run the system in manual mode

- 1) Push the vent button. The chamber pressure will rise maxing out the Baratron at 15,000 mTorr (15 Torr). Wait about 30 seconds until the chamber has vented.
- 2) Once Vented click the Vent button to close the vent valve.
- 3) Open the chamber lid.
- 4) Load your substrate onto the platen.
- 5) Close the Lid
- 6) Click the vacuum button. This will pump down the chamber. You should pump until the pressure stabilizes below 50 mTorr (The pressure should stabilize between 20-30 mTorr). This should pump for ~1-2 minutes.
- 7) Set the Chamber pressure, Oxygen and SF6 flow rate, and RF power % using the sliders.
- 8) Open the Oxygen and/or the SF6 MFC valves by clicking on the Gas Control title buttons. Once the valves are open the buttons will change from Red to Green and the valve picture will indicate the valve is open.
- 9) Allow the chamber pressure to stabilize and pump out the MFCs for ~1 minute
- 10) Click the RF Power button and perform your etch
- 11) When finished click off the RF Power button.
- 12) Click off Gas MFCs and pump out chamber.
- 13) Click off Vacuum and Click on Vent to vent the chamber
- 14) Open lid remove your sample
- 15) When finished start shut down procedures

System Shut Down

When finished the system should be left in the base state as found. To shutdown follow these instructions in order

- 1) Make sure chamber is closed. Click on Vacuum and pump down below 50 mTorr until pressure stabilizes (usually between 20-30 mTorr).
- 2) Click off Vacuum button (IF THIS IS NOT DONE THE SYSTEM MAY HAVE TROUBLE UPON THE NEXT STARTUP AS THE VACUUM VALVE WILL REMAIN OPEN)
- 3) Hit stop on the Visual designer program. This will exit the program. Close the Excel File. Each program will ask you to save. If you save the Visual Designer program the current setpoints will remain the next time you initialize the program.
- 4) Shutdown computer in windows. Click off Computer power button on front of computer module
- 5) Click off MicroRIE power on the front right of the RIE module
- 6) Turn off vacuum pump with toggle.
- 7) Close the CDA and Circulating water quarter turn plug valves on back of MicroRIE
- 8) Close gas canister gate valves
- 9) Turn off circulating chiller
- 10) Close CDA line on wall

Recipes

*The following represent recipes in progress which will have to be edited and updated with user experience

Descum/PDMS Activation

Gas: Oxygen Flow: 20 sccm

Pressure: 200 mTorr Power: 50W

Time: 30 sec to 1 min

Shipley/AZ Resist Stripping

Gas: Oxygen Flow: 20 sccm

Pressure: 200 mTorr Power: 300W

Time: 7 min

SU-8/Parylene Etching 80% O₂, 20% SF₆

Gas: Oxygen Flow: 16 sccm

Gas: SF₆ Flow: 4 sccm

Pressure: 200 mTorr Power: 200W

Etch Rate: 1-2 μm/min

Silicon Ceramics Etching (Completed without He may affect etch)

Gas: SF₆ Flow: 13 sccm

Pressure: 200 mTorr Power: 100W

Etch Rate Silicon Nitride: 500 A/min

Etch Rate Silicon Dioxide: 200 A/min

Etch Rate Single Crystal Silicon: 8000 A/min

Automated recipe control

The system is designed to run automated recipes input in the base.xls file which automatically opens. The recipes are configured to run line by line with column 1 of the spreadsheet being the command to be executed and column 2 to be the command value (either on or off for digital command such as opening or closing a valve or a numerical value for a process setpoint (e.g. gas flow rate)). To create a new recipe hit the new sheet button on the base of the excel spreadsheet to open a new excel sheet tab. Right click the tab and rename to your recipe name. It is suggested that an earlier recipe be copied and modified into the new sheet. To run the recipe follow these instructions

- 1) Prepare the system for automatic operation by pressing the "Auto Enable" button in the top center of the screen.
- 2)
- 3) Click on the display worksheet.
- 4) Select your recipe using the select recipe pull down tab
- 5) Run the recipe by hitting the start button. The clock will display the time remaining to run the entire recipe (by adding up all prescribed time inputs in the recipe)
- 6) If you need to abort the recipe Press the "ABORT" button on the Visual Designer window. This button will force the system back into the Manual mode of operation.

Additionally designer notes are attached on the following pages for more information.

Software User's Notes

General Information

The Technics 800c operating software is built with two commercially available packages. Visual Designer from Intelligent Instruments is used to interface the computer to the physical hardware and to provide a visual interface to the tool for the interactive manual mode of operation. Excel from Microsoft is used to manage recipes and provide an automatic mode of operation.

These two applications share the screen of the system controller. Due to design choices made by the implementers of Windows 95, the window which has focus must always be on top of the window stacking order. Thus, when operating the system in the manual mode, the Visual Designer window will hide the Excel window. To bring the Excel window back to the top, it is necessary to click on the Excel tab of the task bar at the bottom of the screen.

It is assumed that *Operators* of this tool are generally capable of operating Windows NT software. This means the operator should be able to do "click" and "drag" actions with the mouse and be able to interact with standard Windows NT control elements.

It is assumed that *Process Engineers* are fully capable of using Windows NT and Windows applications. Since process recipes are stored as Excel spreadsheets, *Process Engineers* must have a working knowledge of Microsoft's Excel program.

System Startup

The system control software is configured to automatically start up when the computer is booted.

The control software may also be started by double clicking on the "Launch" icon located on the left side of the display screen. This feature is provided as a means of restarting the control software without re-booting the computer. DO NOT attempt to start multiple instances of the control software.

System Shutdown

When it is necessary to stop the control software, the applications should be closed in the following order:

1. Excel
2. Visual Designer Runtime Display

After Excel has been given a "Close" command, the user will be presented with a dialog box querying the user as to whether changes to the document should be saved or not. This question will be presented to the user even though the user thinks no changes have been made to the spreadsheet. This occurs because the Excel application is unable to distinguish cell value changes due to the communication with Visual Designer from cell value changes made by the user with the keyboard and mouse. The cell values changed by Visual Designer are the analog

and digital inputs from the data acquisition system and as such are transient data readings and need not be saved.

If no changes of substance have been made to a recipe worksheet, then the dialog box question may be answered NO to cause Excel to write the new recipe to the disk. If the user has been editing recipes then this question must be answered YES (or the SAVE operation already performed) to avoid losing the changes to an existing recipe or the newly created recipe.

Manual Operation

The manual mode of operation is mainly intended for R&D activities and system maintenance. In this mode, the operator interacts with the tool by “clicking” on the switch icons and/or “dragging” the indicator of the slider bar icons.

Switch icons are linked to hardware in the tool which is “binary” in nature. Included in this class of hardware are valves, heater and the RF generator enable controls. Slider icons are linked to hardware in the tool which is “analog” in nature. Included in this class of hardware are the set-points of the mass flow controllers and the RF generator power set-point.

Automatic Operation

The automatic mode of operation is identical to the manual mode except that the actions taken are entered into an Excel spreadsheet in advance of actual operation. While the automatic mode is active, screen interactions with the switches and sliders will have no effect on the hardware.

Running a Recipe

To actually run a recipe the following steps must be accomplished:

1. Prepare the system for automatic operation by pressing the “AUTOMATIC” button in the top center of the screen.
2. Bring the Excel window to the top of the window stacking order by clicking on its taskbar button.
3. Examine the name of the currently selected recipe. If it is not the one you intend to run, then operate the drop-list to select the correct name. Selection of a valid recipe will cause the large timer window to be initialized to the total running time of the process recipe.
4. Press “RUN”

The system will begin to run automatically to completion of the recipe.

Stopping a Recipe

Press the “ABORT” button on the Visual Designer window. This button will force the system back into the Manual mode of operation. This will happen more or less - instantly. Thus all recipes should be written with operator and tool safety in mind and thought given to the initial state of the system. Think very clearly here. The initial conditions of the tool are the same conditions the tool will revert to if it becomes necessary to ABORT a recipe. The most likely

state for initiating a recipe from is for all gas channels off, all chamber valves closed and all process parameters set to off or zero. This implies that the chamber is vented, but is not a requirement.

Recipe Management

Recipes are stored as spreadsheets in the Workbook "base.xls". They may be created and deleted by the normal methods provided by Excel for adding and deleting worksheets. Excel also provides the capability of renaming worksheets. Please refer to the Excel documentation for instructions if these activities are new to you.

The worksheets named "Display" and "IOtbl" are reserved to the system and must not be disturbed, edited or modified in anyway by anyone other than by the Technics factory personnel. Technics will not be responsible for damage to persons, material or equipment resulting from user modifications to these reserved areas of the workbook.

Recipe Programming

Recipes consist of values entered into the first three columns of the recipe spreadsheet. A valid recipe has the following characteristics:

1. All text in column 1 of the worksheet which precedes the keyword **RECIPE_START** is ignored. It is desirable (as an matter of sound engineering discipline) that the recipe be well documented in the lines which precede this keyword.
2. Column 1, will contain a keyword (see the keyword description section of the document) that is used to identify the parameter which is to be controlled or modified. If an unrecognized keyword is found, then an error message will be placed in the operator message box, recipe execution will halt and the system will be returned to the manual mode of operation. Blank lines will be ignored.
3. Column 2, will contain the value to be applied to the identified parameter found in column 1. For discrete (digital) parameters, several aliases are recognized. Use of aliases in recipes will improved readability. See Table 3. Continuous (analog) parameters require a numeric value.
4. Column 3 will contain a text string which will be displayed in the operator text box. This allows the process engineer the opportunity to further document the recipe and to advise operators as to the current status of the machine. Comments intended for operator viewing should be used with the sleep keyword. Comments attached to other keywords are more for the benefit of process engineers as the will displayed too briefly to be read when the recipe is being run.
5. The recipe is terminated with keyword **RECIPE_END**. All following text will be ignored.
6. All other areas of the recipe worksheet are ignored.

Keyword Glossary

Table 1

Binary Value	Aliased Values
1	OPEN, ON, AUTO, AUTOMATIC
0	CLSD, OFF, MAN, MANUAL

Table 2 - Discrete Outputs

Logical	Generic	Physical	Description
DO.0	GAS0V	O2V	Molecular Oxygen
DO.1	GAS1V	SF6V	Molecular SF6
DO.2	GAS2V		
DO.3	GAS3V		
DO.4		RoughV	Chamber Rough Valve
DO.5		VentV	Chamber Vent Valve
DO.6		RF_Enb	RF Generator Enable
DO.7			
DO.8		Htr_Enb	Platen Heater Enable
DO.9		HiVacV	Chamber High Vacuum Valve
DO.10			
DO.11		TboPmpPwr	Turbomolecular Pump Power
DO.12	**	IG_Enb	Ion Gauge Enable
DO.13		ForLnV	Foreline Valve
DO.14		TVdir	Throttle Valve Direction (Down stream pressure control option)
DO.15		VisAlm0	Visual Alarm

		PressMode	Downstream Pressure Control: Auto: regulate Manual: fixed
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Table 3 - Analog Outputs

Logical	Generic	Physical	Description
AO.0	GAS0SP	O2SP	Oxygen Flow Setpoint (sccm)
AO.1	GAS1SP	SF6SP	SF6 Flow Setpoint (sccm)
AO.2	GAS2SP		
AO.3	GAS3SP		
AO.4		RF_SP	RF Power Setpoint (watts)
AO.5		TVSPEED	Throttle Valve Speed (% Full Scale)
AO.6			
AO.7			
		PRESSSP	Pressure Setpoint - Pressure Regulate Mode (mTorr) (Downstream pressure control only)
		TV_ANGLESP	Throttle Valve Angle Setpoint - - Fixed Mode (degrees)