R·I·T

Title: Varian 350D Ion Implanter

Semiconductor & Microsystems
Fabrication Laboratory **Revision: H** **Rev Date: 12/16/16**

Approved by:

_____	/ /	R. Battaglia	12/16/2016
Process Engineer		Equipment Engineer	

1 SCOPE

The purpose of this document is to detail the use of the Varian 350D Ion Implanter. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS AND PEOPLE

- Varian 350D Implant manual
- Ion Implant lecture and video, L.F. Fuller and I.R. Turkman
- Steve Stefanski, Kodak Equipment Engineer
- Scott Blondell, RIT Facilities Manager
- Richard Battaglia, RIT Equipment Engineer

3 DEFINITIONS

3.1 General Description

The Varian 350D Ion Implanter is capable of implanting Boron (B11 or BF2) or Phosphorous (P31) in 4" or 6" wafers with doses of 1E12 to 5E15. Implant energy levels can be adjusted from 10KeV and 200 KeV.

NOTE: The **REMOTE ELECTRONICS RACK** contains switches and joysticks to adjust the beam setup, focus and steering parameters. The operator can also turn the adjustment dials manually on the **MAIN IMPLANTER CONSOLE**. Several of the remote switches and motor drives are inoperative and **must** be adjusted from the main console. This instruction set identifies the exact controls to use to avoid confusion.

4 TOOLS AND MATERIALS

4.1 The Varian 350D Ion Implanter has dedicated Teflon wafer boats for the 4" and 6" end stations. An attached label indicating "VARIAN 350D" identifies them.

5 SAFETY PRECAUTIONS

5.1 Refer to the following MSDS sheets:
- Boron Trifluoride
- Phosphine/Hydrogen
- Argon
- Fomblin Vacuum Pump Fluid

5.2 The following stored energies are present in this tool and represent potential hazards to operators and service personnel:
- High voltage DC supplies
- High voltage: 208VAC 3 phase
- Line voltage: 120 VAC
- Compressed Air: 80-100 psi
- Compressed Nitrogen: 20 psi
- Pressurized Water Cooling Lines: 40-60 psi

5.3 The following represent physical hazards:
- Pneumatic Cylinders
- Wafer Pick Arms
- Robotic End Station Cassette Handlers
- Load Lock Components

5.4 The following represent potential health hazards:
- Source pressurized gases
- Contaminated sources and source components
- Vacuum pump fluids

6 INSTRUCTIONS

6.1 System Start Up

6.1.0 Activate the card swipe interlock by logging in at **CARD SWIPE ACCESS 3** located in cleanroom hallway. **Panel 7 POWER key switch** is interlocked.

6.1.05 Verify that **NITROGEN** for the Varian 350 Implanter is turned **ON** at the **NITROGEN MANIFOLD 2765** located in **Service Chase 2765**. The manifold regulator gauge should read **20 psi**. The gauge on Implanter located below the endstation controller should read approx. **9 psi.**

* NOTE – Turn ON the Appropriate END STATION MOTOR POWER SWITCH located on the ENDSTATION OPERATOR CONTROL PANEL.

Switches are a lift and select style. Do not force them if they do not move.

6.1.1 Check the levels of the three **VACUUM GAUGE CONTROLLERS** located on **panels 3, 5 and 8**. All should read <1E-6 Torr on the **LOG** scale.

6.1.2 Use the **POWER** key to turn **ON** the **POWER** switch **(left side of panel 7 - remote rack).**

6.1.3 Remove **POWER** key from **panel 7**. Return the **MODE** key to **panel 6**.

6.1.4 Use the **MODE** key to select the **SET UP** mode (right side of panel 6 – remote rack).

6.1.6 Select **ES 1** for 6” or **ES 2** for 4” (End station 1 or 2) on the **BEAM FOCUS AND SCAN** portion of **panel 6**.

6.1.7 Press the **TERM ON** button (left side of panel 7). Ensure that gauges behind the viewing window inside the **HIGH VOLTAGE TERMINAL** illuminate.

6.1.8 Turn on the **VIEWING WINDOW LIGHT** to fully illuminate the meters inside the **HIGH VOLTAGE TERMINAL.**

6.1.9 Set the **BEAM MONITOR** to **I/X (panel 2).**

6.2 Beam Set Up

6.2.1 Ensure that **ALL** dopant gases are **OFF** – the **B, P and CAR ON** lights are **OFF**. If any buttons are lit, press them once to turn **OFF** that gas function.

6.2.2 For a source warm-up, select the desired gas by pressing the **B(oron) or P(hosphorous)** button **(panel 7 – DOPANT).**

6.2.3 Verify the **SOURCE VACUUM** pressure is in the range of 5 E-6 Torr to 5 E-5 Torr, as indicated by the **GREEN** markers **(panel 5).** If the vacuum needs to be adjusted, turn the **NITROGEN** gas adjust pot located on **PANEL 11 CW** to increase vacuum or **CCW** to decrease the source vacuum.

6.2.4 Verify that the **ARC-VOLTS** meter visible through the **TERMINAL VIEWING WINDOW** is reading between **60-110 volts** (gas dependent). B~110V P~60V

6.2.5 Verify that the **FILAMENT-AMPS** meter visible through the **VIEWING WINDOW** is approx. **0 amps**.

6.2.6 Verify that the **EXTRACTION VOLTS** meter visible through the **VIEWING WINDOW** is approx. **33KeV.**

6.2.6 Adjust the **SOURCE MAGNET** dial on **PANEL 11** to approx 200.

6.2.7 Set the **ARC** manual dial to 050 **(PANEL 11).**

6.2.8 Slowly increase the **FILAMENT** dial on **PANEL 11** while observing the **FILAMENT-AMPS** meter through the **VIEWING WINDOW**. As you approach **200 AMPS** check the **ARC-AMPS** meter for any

deflection from its zero position. This indicates plasma has been ignited.

NOTE: If **NO ARC AMPS** are indicated then decrease the **FILAMENT** current to **50 AMPS** and increase the **SOURCE MAGNET** dial to **400**. Slowly increase the **FILAMENT** current again, while observing the **ARC-AMPS** meter. This procedure will need to be repeated until the plasma is created, as indicated by an **ARC-AMPS** reading. If necessary, decrease the **FILAMENT** to **50 AMPS**, increasing the **SOURCE MAGNET** by another **200** and then increase the **FILAMENT** current towards **150 AMPS**. If no plasma is established after several attempts, contact a Technician for guidance (Rich @ 478.3834 or Scott @ 738.4073).

6.2.9 Pause at the point of **ARC-AMPS** deflection to allow the source to stabilize for 60 seconds.

6.2.10 Adjust the **ARC** dial to give approx. **0.1-0.3 AMPS** on the **ARC-AMPS** meter in the **VIEWING WINDOW**. Allow the source to stabilize at these settings for 5 minutes.

6.2.11 Readjust the **ARC** dial on **panel 11** to give approx. **0.2-0.5 ARC-AMPS**. Stable plasma is more desirable than a specific arc current.

6.2.12 Turn **ON** the high voltage (**If Needed**) by depressing the **HV** button located on the left side of **panel 7.**

6.2.13 Turn up the black **BEAM ENERGY ADJUST KNOB** located on the **right side of PANEL 13**, located just above the countertop. Watch **PANEL 6** for **ENERGY** readout in KeV.

6.2.14 Turn **ON** the chart recorder **LINE POWER** and **SERVO** power. Load chart paper and turn **ON** the **CHART HOLD**. Uncap the recorder pen.

6.2.15 Locate the desired species peak by monitoring the chart recorder for peaks while adjusting the **ANALYZER** dial on **panel 11**:

B11 ~ 290
P31 ~ 485
BF2 ~ 625
F ~ 385
It may be beneficial to plot the entire spectrum to verify the correct peak.

6.2.16 Adjust the **ANALYZER** dial slightly in both directions to obtain the peak beam current as displayed on the **panel 4 DOSE PROCESSOR meter.** Select the appropriate scale to display the current. Monitor the chart recorder during this step to stay on the correct peak.

6.2.17 Adjust the **SOURCE STEERING** joystick on **panel 7** in both **X directions** to maximize the beam current on the **panel 4 DOSE PROCESSOR meter. The Y-axis is disabled.**

6.2.18 While observing the M image on the **panel 2** scope, adjust the focus and center the beam using the **TRIM, BALANCE and OFFSET-SHIFT** pots on **panel 12.** Make adjustments for I/X and I/Y (select on panel 2).

6.2.19 On the **BEAM SCAN CONTROLLER (panel 10**) adjust the **H AMP** and **V AMP** pots for proper tail lengths on the I/X and I/Y M's. Adjust the **V STEER** pot for Y centering.

6.2.20 Set the desired implant dose on the **panel 4 DOSE PROCESSOR.**

6.2.21 Select the scanned implant area by choosing the desired end station:
- ES # 1 for 6" wafers = 196 cm2
- ES # 2 for 4" wafers = 91.5 cm2

6.2.23 Switch to **X/Y** on the **Beam Monitor Display (panel 2).** This value closely represents the actual implant current.

6.2.24 Calculate the implant time and adjust the **PANEL 11 ARC pot or SOURCE MAGNET pot** as necessary to yield an implant time > 20 seconds.

Time=(Dose x Area x q) / I where:
area =91.5 cm^2 for 4" or 196 cm^2 for 6"
q=1.6E-19

NOTE: On the computer desktop double-click on the Beam Current Calculator shortcut and enter the Dose, Area, and Desired Beam Current to calculate the Implant Time.

6.3 Doing the Implant

* NOTE – Verify the appropriate END STATION MOTOR POWER SWITCH located on the ENDSTATION OPERATOR CONTROL PANEL has been turned ON as per step 6.1.05.

6.3.1 Load the wafers in the marked Teflon cassette provided. DO NOT use any other cassette.

6.3.2 Standard orientation is wafers with flats up, device side facing into the Implanter, starting in the boat location and slot closest to the operator.

6.3.3 On the End Station Operator Control Panel, set the number of wafers to 00 on the thumb wheels.

6.3.4 Set Implanter mode to **IMPLANT (key switch on panel 6).**

6.3.5 Set the end station to **ES2 for 4"** or **ES1 for 6"** wafers **(IMPLANT MODE controls on right side of panel 6).**

6.3.6 Press the appropriate **START** button on the **END STATION** controller.

* NOTE – It is strongly recommended that the "ABORT" button be used in the event of a wafer mishandle event. DO NOT continue with a START command. THIS MAY BREAK YOUR WAFER AND/OR DAMAGE THE TOOL. Contact a technician to troubleshoot the problem.

6.3.7 The implanter will look at all 25 wafer slots and return to the **LOAD** position and an alarm will sound indicating lot completion. On the **End Station Operator Control Panel**, push the **COMP-MUTE** and then the **ERROR-CLEAR** buttons.

6.3.8 ***ERROR 21*** - If the **DOSE PROCESSOR** returns an **ERROR 21** after pressing the **START** button, this is an indication that the beam current is too high for the dose you have selected. In order to ensure a uniform implant the dose processor calculates the implant time (T) before starting the actual implant. If T< ~ 15 seconds, it will cause an error. Go to **SETUP**, lower the beam current, return to **IMPLANT** and press **START** on the **ENDSTATION**.

6.4 Shut Down/ Standby

* NOTE – Turn OFF the appropriate ENDSTATION MOTOR POWER SWITCH located on the ENDSTATION OPERATOR CONTROL PANEL.

6.4.1 Set the Key switch to **SET UP** mode **(panel 6).**

6.4.2 On **Panel 2,** switch the **Beam Monitor** to **I/X**.

6.4.3 Set the **SOURCE STEERING (panel 7)** to maximize current displayed on the **BEAM CURRENT** meter **(panel 4)**.

6.4.3 Turn down the **Beam Energy Adjust** knob located on **panel 13** to < 35 KeV as shown on **panel 6.**

6.4.4 Turn down **FILAMENT** dial to Zero **(panel 11).**
Check meter in viewing window to make sure it is as close to zero as possible. Dial at zero won't always get meter to zero.

6.4.6 Set **ARC** to **050** on dial **(panel 11).**

6.4.7 Turn **OFF** the Dopant Gas button on remote electronics rack **(panel 7).**

6.4.8 Turn **OFF** the High Voltage (**HV OFF**) **(panel 7).**

6.4.9 Turn **OFF** the Terminal Voltage (**TERM OFF**) **(panel 7).**

6.4.10 Turn **OFF** the **POWER** key button by pushing in the button **(panel 7).**

6.4.11 Turn **OFF** the **VIEWING WINDOW LIGHT** on the HIGH VOLTAGE TERMINAL.

6.4.12 Turn **OFF** Varian nitrogen on N2 **Manifold 2765** located in chase 2765.

6.4.13 Turn **OFF** End Station Motor on the End Station Operator Control Panel.

6.4.14 Deactivate the Card Swipe Interlock by logging off at **CARD SWIPE ACCESS 3**.

6.5 Errors During Run

6.5.1 Consult the **Error Code** chart posted on the Implanter for corrective action and contact a technician.

7 ATTACHMENTS

REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	R. Battaglia	A-12/13/02
Updated all instructions	Scott Blondell	B - 03/17/03
Added N2 instructions and ERROR CODES	Scott Blondell	C - 03/24/03
Updated all instructions	Scott Blondell	D - 08/07/07
Updated last page to include Recorder shut off	Mike M.	E – 6/25/07
Updated instructions using written edits from Rev E.	Kelly Johnson	F – 10/19/10
Updated all instructions; eliminated N2 carrier gas warmup.	Scott Blondell	G – 11/08/11
Updated all instructions using written edits in Rev G	R. Battaglia	H – 12/16/2016