1. Introduction

The critical-point dryer (CPD) is a tool used for drying samples without damaging their structure. MEMS device structures collapse if dried in air because of the surface tension as the water evaporates. CPD dries the samples without damaging and breaking the delicate structures.

The samples are rinsed with water followed by immersion in IPA (isopropanol) and are then loaded in to CPD chamber full of IPA. It displaces IPA with liquid carbon dioxide (LCO₂), brings the temperature and pressure above critical-point for CO₂ (31°C and 1070 psi) and then slowly bleeds the mixture followed by venting the gas.

Only trained and approved (qualified) users may use this tool.

2. Features and Specifications

a) Process 10 mm dies to 6" wafers
b) Process up to 5 pieces per run
c) Auto-processing with microprocessor controller
3. **Safety and Precautions**

   a) The EMO button is located at the front panel of the tool. Press the EMO button if there is an immediate danger to personnel or the equipment. Inform the staff immediately.

   b) The CPD system normally operates under very high chamber pressures (~1,350 psi). DO NOT DEVIATE from the correct procedures for loading samples and securing the chamber lid.

   c) An uncontrolled release of CO₂ can cause personal injury due to frostbite. Again, DO NOT DEVIATE from the correct procedures. Make sure that you are always wearing protective eye-ware.

4. **Operating Procedure**

   Activate the equipment in FOM before use and deactivate after use.

   After etching sacrificial layer with HF, make sure to rinse in at least three DI water baths followed by two IPA baths before loading your sample in to CPD chamber.
2. Turn "Chiller Power" ON at least 30 minutes prior to 1st process run of the day. This is necessary to "Chill" coolant fluid to proper operating temperature required to cool chamber.

NOTE:
Turn "Chiller Power" ON 30 minutes before the 1st run of the day.
DO NOT RUN 24/7. It will cause additional unnecessary motor wear and condensation in the Coolant (HC-50) decreasing it's purity over time.

3. Turn "Condenser Power" ON.
4. Turn "Chamber Power" ON.

Green LED on VENT button will illuminate. This indicates the power is ON and the unit is in standing by in the VENT mode.

5. Let 915B stand for 3-5 minutes. This initial wait period will allow all internally heated plumbing components to "warm-up".

6. The pressure gauge should be in the "0 psi" range. Remove the chamber lid and carefully place chamber lid on a soft surface face down in preparation for a process run. Once the chamber lid is removed, always protect chamber face.
Pressure Gauge (0 psi)

A = Minimal residual pressure still remaining
B = Chamber pressure drop to 0 psi. Chamber is safe to open

7. Now, press the VENT button once. The VENT LED will begin to blink indicating the 915B is in STANDBY mode. This indicates that the VENT solenoid is closed and you may now introduce ultra-pure alcohol into the chamber.

NOTE:
"Ultrapure Alcohol" refers to a minimum of at least 99.5%+ purity.

8. At this point, you may fill the chamber with sufficient ultrapure alcohol (IPA, Methanol, or Ethanol) to cover your wafer(s) or die upon transfer. Determine what size wafer or die holder you will use and place the appropriate number of inserts into the chamber (if required).

NEVER EXPOSE CHAMBER TO ANY ACIDS
9. Carefully and quickly transfer your wafer(s) from your wafer container into the 915B process chamber. For best results, minimize exposure time to air.

**"Star Pattern" Chamber Closure Sequence**

10. Carefully lower the chamber lid onto chamber. Initially use fingers to evenly tighten the 8 knurled nuts around the circumference of the chamber lid. Use the spanning wrench provided to uniformly tighten each knurled nut in a "Star Pattern". Tighten the knurled nuts in the numbered sequence as shown in the following photo. Repeat this rotation "Star Pattern" sequence until the knurled nuts are unable to tighten further.

**NOTE:**
It is not necessary to exert excessive pressure while tightening knurled nuts.

**Setting Purge Timer**

11. Once the chamber lid is secured, it is time to set the PURGE timer located to the right of the push button switches. The "Purge Time" setting is best determined by the individual investigator. Some general "Purge Time" settings are listed below:

- To purge 1/4 chamber full of alcohol = 10 minute purge time.
- To purge 1/2 chamber full of alcohol = 15 minute purge time

**NOTE:**
Actual purge time may vary depending on sample type in combination with the FILL and PURGE metering value adjust positions.
12. After the “Chiller Power” has been ON for a minimum of 30 minutes, a process run may begin. Press the COOL button. The COOL LED light will go ON, and the VENT LED will turn OFF. The chamber temperature will slowly begin to drop. The process chamber will cool from room temperature (20–22°C) to 10°C in approximately 3 minutes. Once the chamber temperature reaches 10°C, you may proceed to the next step.

![COOL mode diagram]

13. Press the FILL button and the 915B chamber will begin to fill with LCO₂. From this point forward, the 915B will automatically cycle through all the drying sequence modes until process completion. During the FILL mode, LCO₂ will enter and fill the chamber for 8 minutes. The process chamber temperature is automatically maintained below 10°C during this FILL mode.

![FILL mode diagram]

14. After the 8 minute FILL mode expires, the 915B will automatically advance into the PURGE mode. This will be indicated by the illumination of the PURGE LED.

![PURGE mode diagram]

15. At this point of the cycle, the 915B will remain in the PURGE mode for the duration of time pre-set by the operator via the PURGE TIMER (See p.20). The process chamber temperature is automatically maintained below 10°C during this PURGE mode.

![NOTE:]

Turn “Chiller Power” ON 30 minutes before the 1st run of the day. **DO NOT RUN 24/7.** It will cause additional unnecessary motor wear and condensation in the Coolant (HC-50) decreasing its purity over time.

![NOTE:]

The alcohol exiting the 915B Chamber Exhaust connect hose during PURGE Mode will be collected directly into the internal SOTER™ Condenser.
16. Upon Completion of the PURGE mode, the 915B will automatically advance into the POST-PURGE-FILL mode in which the chamber fills with LCO2 for an additional 4 minutes. This mode is indicated by both the FILL and PURGE LED's simultaneous illumination.

**NOTE:**
POST-PURGE-FILL Mode helps insure that the process chamber is full of LCO2 prior to advancing into the HEAT mode.

17. Upon completion of the POST-PURGE-FILL mode, the PURGE and FILL LEDs will turn off and the HEAT LED will illuminate. The HEAT mode is the stage in which the wafer(s) are carried through the "Critical Point". Both the pressure and temperature will steadily rise and be maintained above CO2 critical point parameters of 1072 psi and 31°C (Consult Check-Out Data Sheet in the appendix of this User Manual).

18. The process chamber pressure will increase and go beyond 1072 psi, and will stabilize in the range of 1350 psi (+5%). As the temperature reaches 31°C, the process chamber has achieved the "critical point" and this is where the 'tousimis equilibrium' cycle starts. The HEAT LED will begin to blink for the next four minutes indicating your 915B is in the 'tousimis equilibrium'.

*It is normal for the temperature to stay above 31°C during HEAT and BLEED modes.*

19. At the end of the 4 minute 'tousimis equilibrium' period, the 915B will automatically advance into the BLEED mode. The HEAT LED will stop blinking and the BLEED LED will illuminate.

* 'tousimis equilibrium' is the point during the critical point passage in which both the pressure and temperature are maintained above the critical point within the chamber for a period of 4 minutes prior to advancing into the BLEED mode.
20. At this point, the process chamber will begin to BLEED the internal chamber pressure at an average rate of 100 - 150 psi/min.

21. At approximately 360-400 psi, the 915B will automatically advance from the BLEED mode into the VENT mode. The BLEED LED will turn off, while the VENT LED will illuminate. The chamber pressure will then more rapidly drop back towards "0" psi.

**NOTE:**
The BLEED rate has been factory pre-set (See Check-Out Data sheet in the appendix of this manual).

**NOTE:**
It is not necessary to readjust the PURGE VENT metering valve flow rate. The chamber should then come to atmospheric pressure in approximately 3 minutes.

**"Star Pattern" Chamber Opening Sequence**

22. The chamber lid may now be removed by alternatively and evenly loosening all of the knurl nuts using the spanning wrench in a "reverse star pattern".

**NOTE:**
You may begin another process run immediately after completion of process run.

23. The wafer or die can now be removed from the process chamber. After removing wafer or die, it is best to store chamber lid back onto chamber to protect chamber. Seal the process chamber with the chamber lid to help keep it clean and moisture free.
25. After the final process run is complete for the day (or shift), power down the 915B in the following sequence:
“Chiller Power OFF” → “Condenser Power OFF” → “Chamber Power OFF”

NOTE:
Turn “Chiller Power” ON 30 minutes before the 1st run of the day.
**DO NOT RUN 24/7.**
It will cause additional unnecessary motor wear and condensation in the Coolant (HC-50) decreasing it’s purity over time.