PDS 2010 LABCOTER 2 PARYLENE DEPOSITION SYSTEM SOP

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PURPOSE

This system is designed to deposit a thin film of Parylene, a unique polymer that, depending on the type of Parylene used, provides thermal, moisture, and dielectric barriers to any vacuum compatible substrate. It is biocompatible, conformal, and has a high mechanical strength.

Figure 1 PDS 2010 System

The PDS 2010 system (see Figure 1) consists of a series of connected vacuum chambers that sequentially produce Parylene vapor, pyrolyze it, deposit it as a polymer, and then capture its effluent (see Figure 2) . The Vaporizer chamber is a horizontal tube at the bottom of the tool behind the front panel. It has a hinged door that is held in place with a simple latch. This is where an aluminum foil boat with Parylene dimer is loaded into the system. The paralyzer furnace is a vertical tube connected to the back of the horizontal vaporizer, and is the place that the dimer vapor is broken into monomers in preparation for deposition on the substrates in the deposition chamber. Samples are loaded onto the rotating plate in the deposition chamber which aids with coating uniformity. The exhaust is pumped into a cold-trap by a mechanical pump, then exhausted to the house exhaust system.

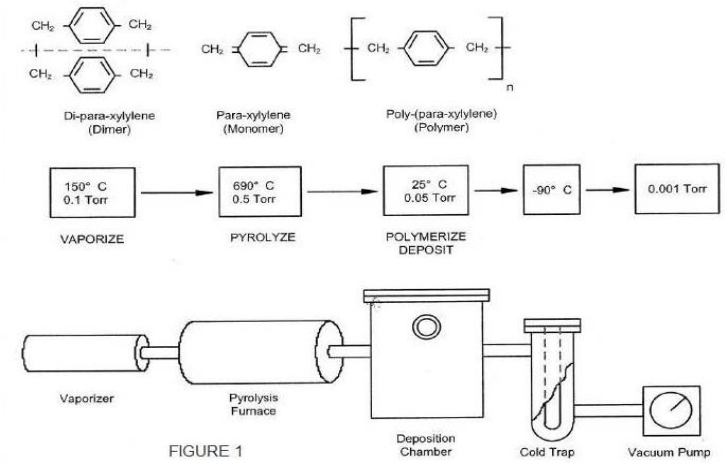

Figure 2 Operational principles of paryline deposition in the PDS 2010

PRE-OPERATION STEPS

1. Be sure your samples are properly cleaned. If adhesion promotion is required, please follow the adhesion promotion treatment process.
2. Wear nitrile gloves when touching the interior of the vacuum chamber or handling anything that will be placed in the system vacuum.

STEPS FOR OPERATION

3. Log into the tool in FOM.
4. Release the **EMO** button by turning while pulling outward.
5. Make sure that the vaporizer and furnace switches are turned to **DISABLE**. Press and release the white **POWER** button on the front panel (see Figure 3).

Figure 3 System front panel and sample chamber

6. Vent the system. Switch the **VACUUM SWITCH** selector to **VENT**. When the **CHAMBER PRESSURE** controller reads approximately **1000-1010** vacuum units, turn the vacuum switch to **HOLD,** the **CHAMBER** is at atmosphere.
7. Make sure that all temperature, pressure and alarm settings are correct. Original System Default Set points (for Type C)

Furnace	Chamber Gauge	Vaporizer	Vacuum
690°C	135°C	175°C	25

8. Using the two handles, remove the **CHAMBER** lid. Turn it upside down and gently place the viewport side on the work bench

NOTE: A good method for removing the chamber is to twist it before lifting. This is easy and creates a nice clean break in the Parylene coating. If Parylene coating build-up from previous coating runs is blistering or separating from the machine surfaces, the Parylene film must be removed at this time.

9. Before beginning a process cycle, always make sure the chamber and cold probe are clean and free from earlier coatings of Parylene. If cleaning is necessary:
    a. The fixture base should be removed for cleaning.

b. Strip all the film from the Chamber, Viewport, Furnace Port, and any other surfaces of the fixture that are coated. Loose pieces of previously deposited film may dislodge and reduce the effectiveness of the deposition and/or the vacuum pump. Therefore, removing, as much as possible, any previous deposition reduces potential problems. Use a Scotch-Brite type abrasive pad and vacuum cleaner to facilitate the removal of deposits. All O-rings and seals must be in good condition and all sealing surfaces must be clean. Even small strips of Parylene film on the O-rings will cause vacuum leaks that will impair the process.

c. With a spray bottle and a lint-free cloth, apply a 2% solution of MicroSoap to all the bare stainless steel surfaces from where the Parylene coating must later be stripped. Apply the MicroSoap to:

- the interior of the coating chamber;
- the interior of the chamber lid and sight glass;
- the inlet and outlet ports of the chamber;
- the inlet and outlet baffles;
- the turntable and fixturing;

WARNING: Do not apply a release agent over deposited Parylene coating from previous runs. The sequential runs make the Parylene thicker and easier to remove as sheets, rather than in small pieces.

10. Use a cloth wrapped around the probe to twist and remove the deposits. Remove the cloths and vacuum the base of the probe to remove all deposits. If necessary, use Scotch Brite abrasive pad to remove the rest of the deposits. Apply a 2% solution of MicroSoap to the COLD TRAP PROBE and allowed to air dry before continuing.

11. Place the cold trap probe into the cold trap well at the top of the right rear of the machine and TURN ON the refrigeration unit by flipping the green power switch to ON position located on the front panel of the refrigeration unit.

WARNING: The lines to the cold trap are fragile after it is chilled therefore avoid bending them at small radii.

NOTE: This refrigeration unit should be turned on 30 - 45 minutes prior to beginning a deposition cycle to allow it to reach the proper temperature before deposition begins. Failure to do this may result in damage to the vacuum pump if vaporized dimer is allowed to deposit in the pump.

12. A new dimer boat may be formed using clean aluminum foil. The size of this boat should be close 4 inches long or less and small enough to fit into the 2-inch diameter furnace tube. Weigh in the desired weight of Parylene dimer into the boat. If you spill any, clean it up. Turn the scale off when done.

NOTE: The maximum amount of dimer must not exceed 100 grams.

13. Open the front door of the coater cabinet and open the vaporizer door, see Figure 4. Inspect for cleanliness, especially the door and door seal. Load the dimer boat into the vaporizer, push the boat in approximately ½ inch past the opening. Close the vaporizer door.
14. Load cleaned and prepared samples onto the rotating platform or turntable. Place chamber on chamber base.
15. Make sure the cold probe is centered and flat on the gasketed cold trap, and the flexible tubing to the chiller is not too bent or stressed in any way. Turn the vacuum switch from VENT to VACUUM position. This should begin the pump-down of the chamber and in a few seconds the vacuum units display should begin to drop, the vacuum should hold the cold probe in place. If it does not, listen for sounds of a leak. It may be necessary to apply a small force to the top of the chamber downward to help create the vacuum seal.

Figure 4 Vaporizer location for loading monomer

16. Switch FURNACE and CHAMBER GAUGE selector to ENABLE.
17. Switch VAPORIZER selector to ENABLE, this enables the turntable. Rotating the parts insures even distribution of the Parylene coating.
18. Depress PROCESS START/STOP. The system will now begin an automated deposition run. After depressing this pushbutton, the button will be illuminated green. None of the heaters can begin to heat unless this button is depressed and illuminated.

The process is automatic from this point forward until the cycle is complete (see the diagram in Figure 5). The vacuum continues to reduce to a base level, while the Furnace and Chamber Gage values ascend toward their respective temperature set points. When these are reached, as much as an hour later, the Vaporizer begins to rise to its temperature set point. Then, automatically, the Parylene is released, increasing the chamber pressure from its base pressure to a higher value indicating that Parylene coating has begun. When the Parylene supply begins to diminish, pressure in the chamber will once again reduce towards a lower base pressure. At this time, the green PROCESS START/STOP button will begin to flash signaling the end of the coating cycle.

19. Press the PROCESS START/STOP button to stop it from blinking continuously. All heaters will be disabled
20. Shut OFF the refrigeration/chiller unit. But DO NOT immediately remove the cold-trap probe, but be aware that it must be removed in approximately 5 minutes.
21. Switch FURNACE and CHAMBER GAUGE selector to DISABLE.
22. Turn the VACUUM selector to VENT and allow the chamber to return to atmospheric pressure.
23. Remove chamber and unload parts.

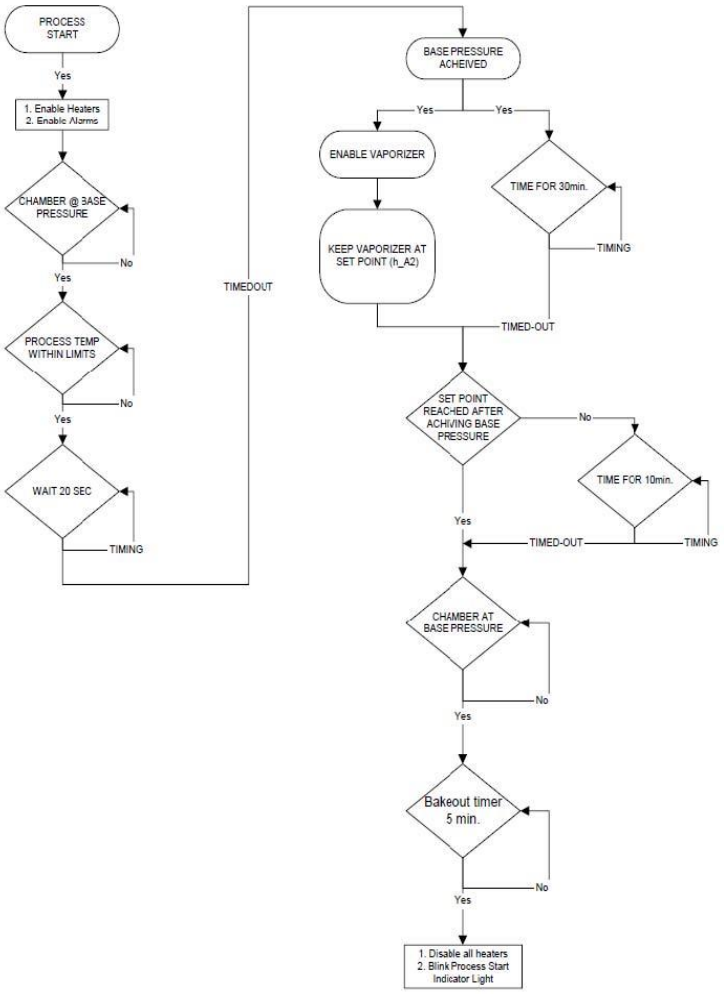

Figure 5 Process flow chart

24. The cold-trap probe flex-line is very cold at this point. Allowing the unit to sit for about 5 minutes or more before moving the cold-trap probe gives the flex-line time to reach an ambient temperature on the perimeter of the hose so that it reduces stress in the hose. It requires EXTREME care when it is handled cold. Grab the cold-trap probe with one hand and the middle of the flex-line with the other hand. GENTLY AND VERY SLOWLY, remove the cold-trap probe from the trap moving both hands to reduce stress on the hose as much as possible, then place the probe into the COLD TRAP HOUSING a few inches away at the far right-hand comer. A security clamp may be engaged with the cold-trap probe to keep it from moving in the holder. Most repair problems arising with the use of this machine are associated with the mishandling of the frozen cold-trap flex-line. The reason for not leaving it in the cold-trap until it completely warms up is that frozen condensation on the probe may enter into the vacuum system causing extensive damage to the pump, and contamination of the vacuum system oil.

25. The system must be cleaned after making a process run. The furnace, vaporizer, and cold probe must be at ambient temperature prior to cleaning. Do not use any sharp metal objects to clean the system. This will scratch the surfaces, making it harder to clean and could cause vacuum leaks. The plastic scraping tools, Scotch-Brite pad, and Micro-90 cleaning solution are used to clean the remainder of the exposed parts.
26. It is not recommended that the cold trap probe be cleaned while it is still cold, however it must be cleaned prior to subsequent depositions.
27. After the vaporizer has cooled to below 40°C, the door can be opened and the aluminum boat removed and discarded.
28. System must be left in a state of slight vacuum. This is accomplished by placing a glass piece over the cold-trap well, placing a clean vacuum chamber on the machine and starting the vacuum pump. Turn the vacuum switch from VENT to VACUUM position for a few seconds. When the vacuum gage reads about 300 vacuum units, the system is sealed and under vacuum. Set the vacuum switch to HOLD at this point for storage of the system.
29. Log out from the tool in your FOM account.

USEFUL PARAMETERS FOR PARYLENE DEPOSITION

Deposition rates: Parylene N ~ 00003 inches/hour (0.762 um/hour)

Parylene C ~ 0002 inches/hour (5.08 um/hour)

Maximum deposition thickness before cleaning chamber walls: 0.001 inches (25.4 um)

(Clean yellowish deposit in pyrolysis heater after 400g of Parylene used)

Typical Process Settings

Parylene	Vapor Heater SP	Pressure SP	Pyrolysis Heater SP
Type N	160°C	Base +55 vacuum units	650°C
Type C	175°C	Base +15 vacuum units	690°C

The vacuum pressure controller provides a displayed value that very nearly represents absolute pressure (in mTorr) for the process range of 10 to 100 units. After that point in becomes non-linear (i.e. display of 500·units is approximately 2.2 Torr)

For processing it has a factory set point of 15 units above base pressure. Increasing or decreasing this value will increase or decrease deposition rates, but too high of a deposition rate can lead to poor quality films.

Vaporizer: Temperature above which coating initiates: 90°C
Temperature below which more Parylene can be added to boat: 60°C

Surface area of chamber, baffle, fixture, and plate: ~900 in^2

1. Consider the total amount of surface area when determining the amount of dimer needed to achieve a given coating thickness. In addition to the substrate, the chamber walls, baffle, and fixturing are part of the total surface area. Therefore, doubling the substrate does not double the area being coated. If the substrate load is increased from 40 in^2 to 80 in^2 the total area is increased approximately 5%. So roughly 5% more dimer would be added to achieve the same thickness.
2. The type of substrate being coated has little effect. Parylene will coat onto any type of substrate that is vacuum compatible. If the material exhibits abnormally high outgassing, an extended pump down will be required to reduce the number of interfering gas molecules that could affect even deposition.
3. It is best to distribute the substrate evenly within the deposition chamber. Relatively large spaces with little or no surface area will tend to result in a cloudy coating. When a large amount of substrate is to be coated, position them to minimize the shadowing effect that individual parts may have on one another. It is recommended to maintain at least 0.5'' between parts. The rotation of the fixture helps distribute any non-uniformity over the entire fixture, however, it does not help in distribution variances from the top to bottom of the chamber.
4. Place substrates around the rotating platform the same distance radially out from the center. The film thickness is approximately 8% thinner in the center (next to the spindle) than out towards the edge of the platform.