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Load Lock to Chamber Water Transfer

Part 3: The Solution *Chamber*

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As load locks continue to proliferate in modern process applications, and concerns about the presence of water vapor in process chambers become more prevalent; the next step in tracking water vapor is to evaluate its transfer from the load lock into the chamber. Whether the work comes from the load lock directly into the process chamber or whether it first goes into a transfer chamber in a cluster tool, water vapor can be introduced on the surface of the work. This, in turn, can lead to a complex series of transfer of water vapor from surface to surface throughout the process chamber(s) and the process itself.

Often, the only feasible technique for minimizing the transfer of water vapor is to use UV energy transfer from a Phototron source to maximize desorption early in the process.

WORK FROM THE LOAD LOCK AS A SOURCE OF WATER

Any work that is cycled into a process or transfer chamber can be considered as a source of water contamination unless it has been totally desorbed of water molecules. In a practical system, this can be considered just about impossible. If a Phototron has been used in the load lock to pre-desorb the work as discussed in detail in Part 2, the desorption rate of the work will be lower than if no Phototron was used. However, any water still desorbing will enter the chamber and most of it will end up on the walls of the chamber.

In Part 1, we saw that the molecules desorbing from the walls were impacting the work at about the same rate as desorbing molecules were leaving the work. If the work is partly desorbed in the load lock, the impacts from the chamber desorption will actually cause a net increase in the water molecule population on the work, and hence, raise its desorption rate.

Although it's tempting to think of a chamber's walls as free from desorption when the chamber is pumped down to its ultimate, there's still plenty of water left. Figure 1 shows a long term chamber desorption process that is taken to "completion," where further desorption under Phototron UV bombardment is no longer detectable. The chamber had been pumped down to 1×10^{-7} torr and held for several days at this pressure prior to Phototron treatment.

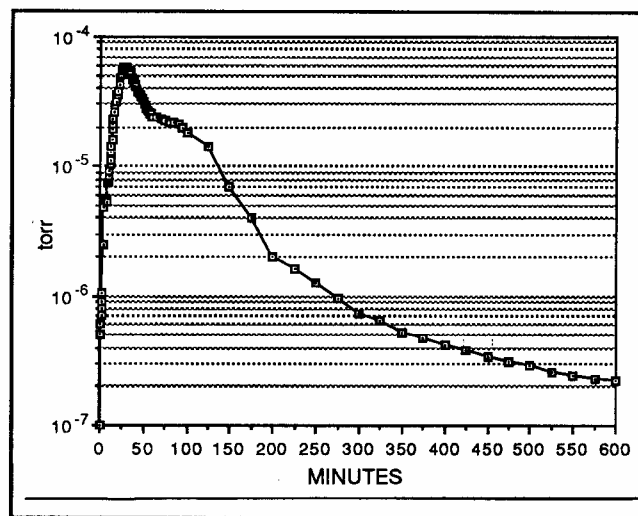


Figure 1. Complete Desorption of Chamber, 16.8 mw.sq.in., 0.071 l/sec./sq.in.

THE CHAMBER'S DESORPTION RATE

The Phototron treatment shown in Figure 1 can tell us a good deal about the condition of the chamber's internal surfaces. Even though the pressure had stabilized at about 1×10^{-7} torr for several days, the pressure rose to the middle of the 10^{-5} torr scale very quickly once UV was applied. Note, though, that the power level was 16.8 mw/in.², and this is a very high power level. Power levels of 2.5-5.5 mw/in.² are much more common for mere pumpdown procedures.

The first sudden rise is mostly due to line-of-sight energy transfer since any UV energy that strikes a water molecule will transfer that energy to the water molecule.

Once a site is cleared, though, the UV will reflect, and this is what we see starting to happen with the first drop in pressure to about 50 minutes. Beyond that time, the UV energy is undergoing multiple reflections as it reaches down into areas that are difficult to reach such as very large virtual leak positions such as flange gaps.

The long tail-off is the final process where the very tightly bound water molecules are being removed. After 10 hours of high energy bombardment, the surfaces are virtually clear.

CHAMBER WALLS AS SORPTION SITES

Once the chamber walls have been cleared of sorbed water molecules, the problem of desorbing molecules from the walls striking surfaces of work being introduced from the load lock disappears. The sorption/desorption problem now does a 180° shift. The cleared walls now present attractive sorption sites for water molecules desorbing from the work.

In part 2, we discussed two desorption conditions for work entering the chamber from the load lock;

1. Lowest desorption rate, and
2. Highest desorption rate.

The Dilemma

If work is introduced at the lowest desorption rate, fewer molecules will leave the work to be re-sorbed by the clean walls, but the work will contain more surface water during processing. If the work is to be as water free as possible during processing, the work should be introduced at the highest desorption rate since that means that more water will be desorbed from the work's surfaces; but that will mean that more water will sorb on the chamber's walls.

The Solution

It's possible to obtain the lowest amount of water coverage on the work's surfaces and keep the walls clean of sorbed water by operating a high power Phototron source within the chamber at all times while both work is being transferred in and between transfers. What this means, then, is as follows:

1. Clean the chamber's walls with the Phototron as in Figure 1, and
2. Operate the Phototron at all times to keep the walls clean.

If work is introduced that is still at a high desorption rate because a Phototron was operated in the load lock during the entire load lock pumpdown process, the Phototron in the chamber will continue to bombard both

the work's surfaces and the chamber's surfaces during the time in the chamber. This would be during the transfer process in a cluster tool transfer chamber, or the time before processing in a process chamber.

Water desorbing from the work would be continually energized by UV while it was in flight and in play within the chamber which would cause it to tend to stay in play until it statistically entered the pump. Additionally, any water molecules that tried to sorb on the chamber's clean walls would be desorbed quickly and put back in play until they were pumped away as well.

THE CHAMBER AS REFLECTOR

Once cleared of sorbed water as in Figure 1, the chamber walls become extremely reflective of the UV from the Phototron source, and this makes the energy more and more available for energizing water both on the work's surface and after desorption as discussed above. This means that the efficiency of the Phototron will be much higher than if it also has to deal with water molecules sorbed on the chamber walls since it will lose energy once it impacts a water molecule.

THE PHOTOTRON AS SORPTION BARRIER

Continuous bombardment of a desorbed surface will make it possible to maintain the desorbed condition since a molecule that tries to lose its energy at a surface will be immediately re-energized by the UV and caused to re-desorb.

CONCLUSIONS

The use of multiple Phototron sources throughout the load lock and chamber train as discussed in Parts 2 and 3 can deal with the problems associated with water vapor sorbed on fresh surfaces as discussed in Part 1. In many cases, processes can be speeded up in terms of product throughput and product quality can be improved due to less surface water sorbed on the work prior to processing. Additionally, water vapor can be minimized within the process.

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