

Add Water Vapor to Oxygen, Ozone or other Reactive Gases to Improve Removal Rate with Minimal Wafer Damage

RASIRC's RainMaker Humidifier purifies and controls the ratio of water vapor delivered to wafer cleaning processes

The Semiconductor industry's current photoresist stripping processes are quickly becoming inadequate as the size of the device geometries continues to shrink. Rising costs, environmental hazards, and waste treatment of toxic chemicals used in ashers and wet benches to remove photoresist are rapidly increasing the demand for an all-dry process for removal of photoresist and chamber cleaning.

Oxygen and Ozone are well known to remove photoresist by converting the carbon compounds to volatile hydrocarbons. To increase the removal rate, the concentration or temperature must be increased. Solubility limits in water for oxygen and ozone are limited to ppm levels and reduce with increasing water temperature. By converting from a wet process to a vapor process, oxygen and/or ozone can be increased to in excess of 50% by volume. The addition of water vapor maintains the same wet chemistry to aid in the removal of the photoresist and allows the operating temperature to be raised from 50°C to above 100°C.

Until now, the delivery of water to a process has been difficult. Choices have been limited to direct liquid injection (DLI), bubblers, or membrane contactors. These each have their own issues.

Direct Liquid Injection

DLI is costly and problematic with different flow rates. At low flow rates control has limited accuracy and at high flow rates it is susceptible to bubbles in the liquid which generate erratic values. DLI needs a metallic vaporizer or an additional metal hot plate to convert the liquid to gas, can vaporize only

limited quantities due to thermal transfer rates. Most critically, it cannot provide any purification of the liquid being vaporized, since everything in the liquid is vaporized into the process.

Bubblers

Bubblers are low cost, but have inaccuracies due to the temperature of the gas, liquid, operating pressure, liquid level, and thermal droop. They leave behind some contamination during vaporization and cannot prevent entrainment of dissolved gas, volatile molecular contaminants, and micro-droplets which can carry particulate and ionic molecular contaminants. Bubblers have very limited gas flow rates. If the flow rate exceeds limited velocities, explosive bubbles blast the source liquid out of the vessel and into the downstream piping, forcing the use of phase separators which lead to increased particulate, condensation, and flow instability.

Membrane Contactors

Membrane contactors can be used to allow gas transfer between a liquid and gas, but are not specific to which gases can permeate so have no purification capability. They are made with hollow fiber membranes which are porous, allowing simultaneous transfer of the gas into the liquid and the liquid into the gas, so the carrier gas can permeate the liquid source. This can be problematic if the carrier gas is pyrophoric or toxic such as ozone. Most hollow fibers are hydrophobic and must be modified to work with hydrophilic molecules.

Some hollow fibers can be chemically modified, but it is a surface treatment that is only partially effective. Microdroplets can still diffuse through the hollow fibers leading to ionic contamination.

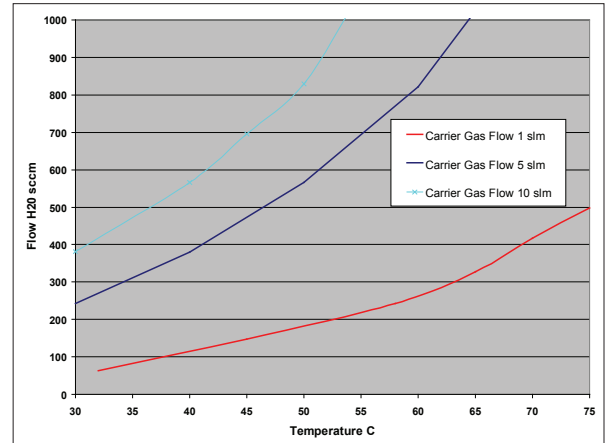


Figure 2: With RASIRC's RainMaker, you can add a lot of water relative to flow rate. You can also control water vapor for a specific flow rate by adjusting temperature.

rification of water vapor directly into a carrier gas stream. With the RainMaker, controlled and purified vapor can be delivered into most carrier gases including oxygen, ozone, and fluorinated compounds. The amount of water vapor added is a ratio of the carrier gas. The percentage added is controlled by added heat and measurement of the downstream temperature of the humidified gas stream. Based on the model the percentage added can be independent of the carrier gas flow rate.

The RainMaker Humidifier consists of a non-porous membrane that excludes particles, micro-droplets, volatile gases, and other opposite charged species from being transferred to the carrier gas and ensures only water vapor is added. The membrane is designed specifically to allow only water molecules to cross the membrane. Other contaminants in the liquid source cannot permeate across the membrane or enter the carrier gas stream, resulting in a saturated product that is consistent and pure. Because the RainMaker works on 100% saturation of the carrier gas, the system can be cycled on and off without significant effect on accuracy.

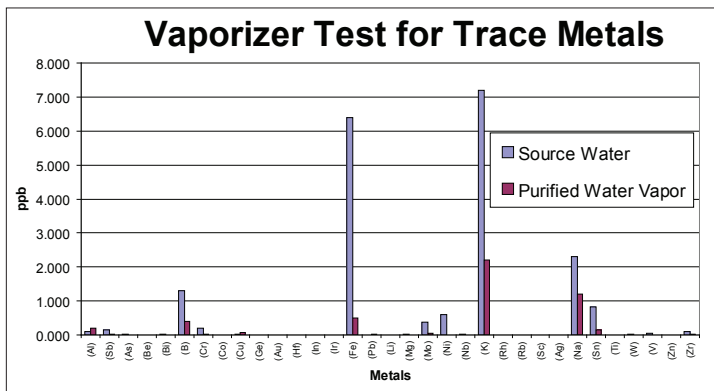


Figure 1: RASIRC's RainMaker purifies DI water and removes metals during humidification. There is no need for strict water control.



www.rasirc.com

(858) 259-1220 • info@rasirc.com
11760 Sorrento Valley Road, Suite E
San Diego, CA 92121

RainMaker Humidifier

The RainMaker™ Humidifier controls the transfer and pu-