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**RASIRC Introduces the RainMaker Humidifier to Control and Purify the
Water Vapor Added to a Carrier Gas Stream**
Humidifier meets ultrapure semiconductor process requirements

San Diego, Calif. – September 18, 2006 – RASIRC™, the steam purification company, introduces the RainMaker™ Humidifier, a device that controls the transfer and purification of pure water or ammonia hydroxide directly into a carrier gas stream. With the RainMaker, controlled and purified vapor can be delivered into most carrier gases including hydrogen at flow rates as low as 18 micrograms per minute or as high as 1 kilogram per minute depending on the model, carrier gas, and delivery pressure. The temperature of the carrier gas and the liquid source, the system pressure, and carrier gas flow rate are tightly controlled for precise delivery of a purified carrier gas for use in the semiconductor industry.

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 select only the source gas molecules. 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.

The RainMaker fully saturates the carrier gas based on the temperature of the gas, providing for accurate delivery of water vapor. With the addition of a back pressure regulation device, accurate delivery of low vapor pressure gases can be delivered into sub-atmospheric processes.

The temperature range is from the freezing point to the boiling point for the liquid with a maximum operating temperature of 120 degrees Celsius.

The RainMaker Humidifier is highly selective. It prevents most carrier gases from crossing over into the source. This allows for the safe use of gases that should be constrained from mixing with liquid water. It also limits the pressure the source container will see during normal operation, since the pressure of the carrier gas does not significantly affect the source container. This allows for vessels made from quartz to be used where more robust materials would be required for some other methods. In addition, when working with flammable chemicals such as hydrogen or isopropyl alcohol, metallic containment is often required depending on the local codes. With the use of the RainMaker, metallic impurities that may have been picked up from the metal source container are prevented from contacting the carrier gas, so safety and purity are both improved.

The basic system has a mass flow control device to control the flow of the carrier gas, a vaporizer that contains a source container, a heater to control the temperature of the source and carrier gas, and a membrane assembly to allow the carrier gas to enter the source, become saturated with the source vapor, and exit the vaporizer without direct contact with the liquid. If the system is not delivering to an atmospheric process, it can also contain level detection for the source liquid and a downstream pressure control device. The membrane allows for the rapid transfer of water vapor into a carrier gas such as nitrogen, compressed clean dry air, forced ventilation air, helium, oxygen, or hydrogen.

Until now, the delivery of water to a process has been difficult. Choices are limited to direct liquid injection (DLI), bubblers, or membrane contactors. 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, and there is a potential for chemical decomposition. Most critically, it cannot provide any purification of the liquid being vaporized, since everything in the liquid is vaporized into the process.

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 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. 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.

Applications for the RainMaker Humidifier include rapid thermal processing (RTP), atomic layer deposition (ALD), plasma stripping, immersion lithography, diffusion, wafer cleaning, and to control humidity in cleanrooms. Water vapor is also needed to grow oxides. RTP needs high flow rates of water vapor for short periods of time. ALD needs very small amounts of water vapor for High K film formation where the purity of water vapor is critical for good film formation. Plasma stripping is more effective with water vapor to help lift the film off the wafer surface. Lithography needs high flow rates of humid clean dry air. The humidity in semiconductor and medical cleanrooms requires very tight control of air purity.

“The RainMaker Humidifier is the only ultrapure humidifier capable of meeting semiconductor process requirements for delivery of water vapor and other low vapor pressure gases,” said RASIRC founder and president Jeffrey Spiegelman. “It is safe, simple, and cost effective.”

The RainMaker's unique ultrapure design is made of either all fluoropolymer or fluoropolymer and 316L stainless depending on the application. Fittings are based on customer requirements, which can include face seal, compression, flare, or tube stub. These fittings are commonly known as VCR[®], Swagelok[®], or Flaretek[®]. The RainMaker can be supplied with heaters and temperature control. Price is based on flow rate. Prices start at under \$1000. Lead time is 3 weeks on standard configurations.

About RASIRC

RASIRC develops products that purify and deliver ultra pure liquids and gases, with a primary focus on water vapor. While steam is used extensively in the semiconductor industry, RASIRC technology is the first to purify live steam to generate ultra high purity (UHP) steam. Starting with de-ionized water and using specialized membranes to reduce total metals to less than 10 parts per trillion while achieving very high flow rates, this technology reduces cost, improves yield, and dramatically improves safety. The UHP steam generated by RASIRC products is of critical importance for many applications in the semiconductor, pharmaceutical, medical, biological, fuel cell, and power industries. RASIRC is a winner of the 2006 *Gases & Technology* Gassy Award, the *Solid State Technology* SEMICON West Attendee's Choice Award, and was selected by SEMI for its Technology Innovation Showcase. For more information, contact Jeffrey Spiegelman at +1 858-259-1220, e-mail info@rasirc.com, or visit the website at www.rasirc.com.