

# Precise flow rate steam generation and delivery

Flow rates up to 50 slm from integrated unit that replaces torches, vaporizers and bubblers

The **RASIRC Steamer** combines a clean steam generator and steam purification assembly into a single system. All wetted components in the liquid path are quartz or Teflon®. The **RASIRC Steamer** is proven to increase oxide growth rate, chamber uniformity, film quality, and/or reduce operating cost when compared against all other steam technologies.

Tests show reduction of 67 different metals to below detectable limits. Some contaminants have been verified to less than 0.0005 parts per billion. Urea, Nitrogen and CO2 can also be eliminated. Because the **RASIRC Steamer** works with water vapor at low pressures, stainless steel delivery systems can be replaced with quartz and fluoropolymer piping systems.

The two major components of the RASIRC Steamer are:

- **Steam generator** that converts DI water into high flow, Ultra High Purity (UHP) water vapor.
- **Purifier assembly** that purifies clean steam to Ultra High Purity (UHP) steam by selective removal of dissolved gases, metals, and particulates to below levels of detection.

## Benefits of the RASIRC Steamer

The **RASIRC Steamer** is the only system that can provide controlled delivery of ultrapure steam from DI water. Some of the benefits include:

- **Purity**—Patent pending technology eliminates volatiles, ionic contaminants and other impurities, resulting in equal to or better purity than pyrolytic steam created by burning oxygen and hydrogen.
- **Yield**—Metals, hydrocarbons, and particles are rejected by the non-porous membrane to deliver the purest steam

possible.

- **Throughput**—Continuous unattended 24/7 operation. Up to 18% improvement in growth rate by elimination of carrier gases such as hydrogen and oxygen that can slow the growth rate. No thermal build up with increased flow rate as with pyrolytic torches.
- **Safety**—Eliminates H2 and O2 from the oxidation process, eliminating flammable and explosive materials. Operates at significantly lower temperature (below 125°C as opposed to above 500°C).
- **Cost of ownership**—Eliminates costly hydrogen and oxygen usage and storage. Low operating cost generates a rapid pay back and there is no cooling requirement unlike with torches.
- **Versatility**—Handles a wide range of flow rates and pressure levels.

## How It Works

- Heater generates steam from DI water.
- A non-porous hydrophilic membrane within the **RASIRC SPA** purifies the steam, selectively allowing water vapor to pass. Selectivity is significant with up to 1,000,000x relative to nitrogen molecules. In the vapor phase, the membrane selectively passes water molecules. All other molecules are greatly restricted, so contaminants in water such as dissolved gases, ions, TOCs, urea, particles, viruses, bacteria, pyrons, and metals can be removed in the steam phase.
- The flow rate is calculated based on pressure drop across a calibrated flow restrictor.
- The flow rate is increased or decreased



by adjusting heater energy to raise or lower the pressure drop.

- Water levels are constantly monitored and adjusted to ensure continuous steam flow.

## Water Vapor Flow Rate Options

- Steamer 125: up to 10 slm
- Steamer '02: 10 to 50 slm
- Steamer 501: Up to 50 slm

## Product Specifications

### Features

- Auto level / fill control
- Microcontroller
- Local and remote control
- Secondary temperature control loop
- Pressure sensing
- Patent pending flow control of steam
- Purge/drain capability
- Integrated purifier
- < 10 ppt for total metals; check with factory for other contaminants

### Materials of Construction

- All wetted components in the liquid path are quartz or Teflon® fittings and valves
- 316L stainless steel pressure transducer upstream of steam purifier

Purification Performance Results (ppb)			
	DI Water Source	Pre-Purified Steam	Purified Steam
Total Metals	19.8	0.15	0.009
Total Organic Carbon	1200	380	22
Total Silica	28	4.3	0.7
Urea	2200	48	2.6
Ammonium	1.468	1.117	0.116



# Oxide Growth Rate Up to 18% Faster

Wafer-to-wafer and across-wafer uniformity improved with the RASIRC Steamer

Recent test results delivered up to 18% improvement in oxide growth rate for bubblers and over 7% when compared with a pyrolytic torch. Operating costs were reduced significantly by eliminating carrier gases and oxygen or hydrogen for pyrolytic generation.

Users of the **RASIRC Steamer** demonstrated increased growth rate and uniformity by being able to fully saturate the furnace tube with 100% pure water vapor at flow rates not normally available from alternative techniques. Results reached maximum theoretical growth rate.

## Throughput

- Increases throughput by delivering high quantities of pure steam
- 100% UHP Steam eliminates oxygen and hydrogen, so there is no interference with steam diffusion into the silicon oxide and theoretical maximum growth rate is achieved
- Eliminates thermal shadow introduced when using a torch, so the entire furnace tube can be used for thermal oxidation
- Runs process recipes with multiple flow set points High and Low

## Cost Reduction

- Eliminates hydrogen/oxygen costs
- Delivers bottom line savings via increased throughput and process uniformity
- Eliminates chillers and spares for torches

## Contamination Control

- Equals or exceeds the purity of pyrolytic steam by enabling the use of water vapor from purified steam
- Eliminates the torch and the particles it generates
- Prevents particles from passing through with the steam by employing a nonporous membrane
- Eliminates metal components and catalysts, ensuring metallic free steam

## Repeatability

- Improves front to back uniformity by eliminating thermal shadow from the torch
- Ensures furnace saturation by delivering high quantities of steam (greater than possible with a torch)
- Maintains 100% partial pressure of water vapor resulting in better chamber uniformity
- Purifies steam instead of DI water, yielding ultra high purity and consistency

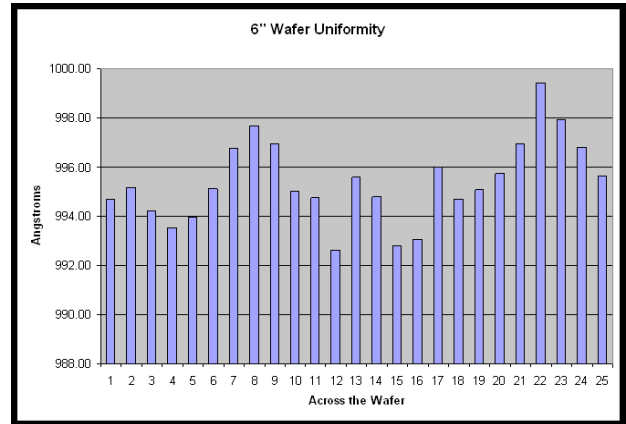


Figure 1: Tests of wafer uniformity on 1000 Angstrom film show less than 1% variation across 25 points when the RASIRC Steamer is the source of ultra pure steam.

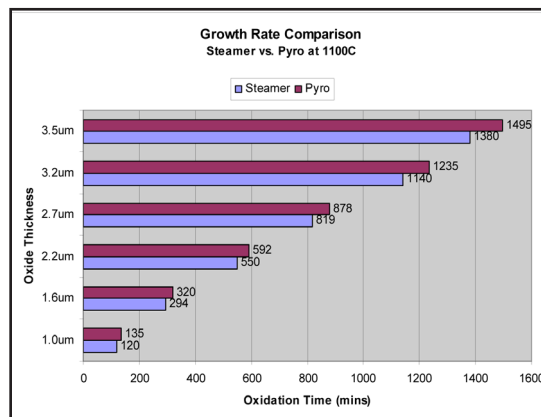


Figure 2: Faster oxide growth with RASIRC Steamer versus torch due to higher partial pressure of steam species.

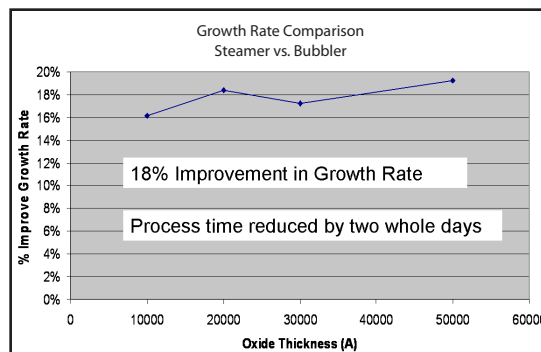


Figure 3: Tests comparing RASIRC Steamer performance versus a bubbler show continuously faster growth rate exceeding 18%.

## Safety

- Eliminates explosive hydrogen and oxygen
- Eliminates high temperature external torch
- Operates at a safe temperature, significantly lower than torches

## About RASIRC

RASIRC develops products that purify and deliver ultra pure liquids and gases, with a primary focus on water vapor. RASIRC steam generators, humidifiers and dryers are of critical importance for many applications in the semiconductor, photovoltaic, pharmaceutical, medical, biological, fuel cell, and power industries. Custom systems are available upon request. Call RASIRC to see how to solve your water vapor challenges.



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