Tech Note: Non-Uniformity in Wet Thermal Oxidation

In wet thermal oxidation, the yield is determined by the uniformity of the film, growth rate of the film, and contamination sensitivity of the film.

Addressing Non-Uniformity

Uniformity requires tight temperature control across the wafer and throughout the furnace tube—better than 0.5C. Gas flow dynamics play a critical role in determining the temperature profile within the furnace.

There are two basic types of non-uniformity. The first is along the length of the furnace tube while the second is across the face of the wafer. All are related to water vapor pressure and temperature of the furnace and the gas stream.

If the process shows a front (gas inlet) to back (loading door) non-uniformity this can be addressed as described in the table below.

Problem	Solution
Film is too thin in the front of the furnace, affecting as many as the first five wafers. This happens when the front of the furnace is too cold. When using a pyrolytic torch, heat from the torch raises the gas temperature and the front of the tube can get too hot. However when using a RASIRC Steamer, the water vapor is just above saturation temperature—ranging from 105˚C to 120˚C depending on the operating pressure. If the line downstream of the Steamer is not sufficiently heated, then the steam will not have enough time to come up to furnace oxidation temperature of 850˚C or greater. By the time the steam has travel passed the first few wafers they have picked up sufficient heat to insure adequate growth downstream. **Others signs to look for:** Condensation on the steam delivery line or past the control valve to the furnace.	Add more heat tape to the delivery line up to the furnace gas inlet. Do not overheat the control valve (check with manufacturers specifications). Check to make sure all water condensation has been eliminated. Add a heater to the entrance to the furnace. Raise entrance heater temperature until wafer non-uniformity is eliminated. Verify front zone of furnace is at desired temperature and working properly.
Film thickness increases from top to bottom of wafer face in front part of furnace	Add more heat tape to the delivery line up to the furnace gas inlet. Do not overheat the control valve (check with manufacturers specifications). Check to make sure all water condensation has been eliminated. Add a heater to the entrance to the furnace. Raise entrance heater temperature until wafer non-uniformity is eliminated. Verify front zone of furnace is at desired

11760 Sorrento Valley Road, Suite E • San Diego, CA 92130 • 858.259.1220 • 858.259.0123 fax
info@rasirc.com • www.rasirc.com

Problem	Solution
	temperature and working properly.
Film is too thin at the center of wafer face	Raise process flow rate of steam. Lower or eliminate oxygen purge. Verify middle and loading zone of furnace are at the desired temperatures and working properly.
Film is thin in load portion (rear) of the furnace.	Raise process flow rate of steam. Lower or eliminate oxygen purge. Verify middle and loading zone of furnace are at the desired temperatures and working properly.

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