

Wet Oxidation System for VCSEL Fabrication

VIXEL-320 is a stand-alone lateral wet oxidation system intended for the fabrication of Vertical Cavity Surface Emitting Lasers. It is an atmospheric-pressure oxidation system with in-situ monitoring of oxide aperture formation. It accommodates single wafers of up to 150mm (6") in diameter.

The user creates system programs according to the requirements of each product. A program consists of a set of system parameters that change over the course of wafer oxidation. Each program may be recalled and executed as needed, or the system may be operated in manual mode. Maximum allowed chamber temperature is 500°C. Typical oxidation temperature range is ~ 380-440 °C.

In-situ oxidation monitoring is done by an infrared optical microscope that is focused on VCSELs or oxidation test structures. The entire area of the wafer chuck (175mm or 7" diameter) can be examined by the microscope during oxidation. The optical window is thin thanks to the atmospheric pressure chamber. This allows better visibility of the oxide front. Typically, the oxidation duration is selected as an upper limit in the software, while the operator monitors the oxidation progress. The process stops either automatically at the maximum duration programmed, or by the operator when the desired aperture size is reached.

System Specifications:

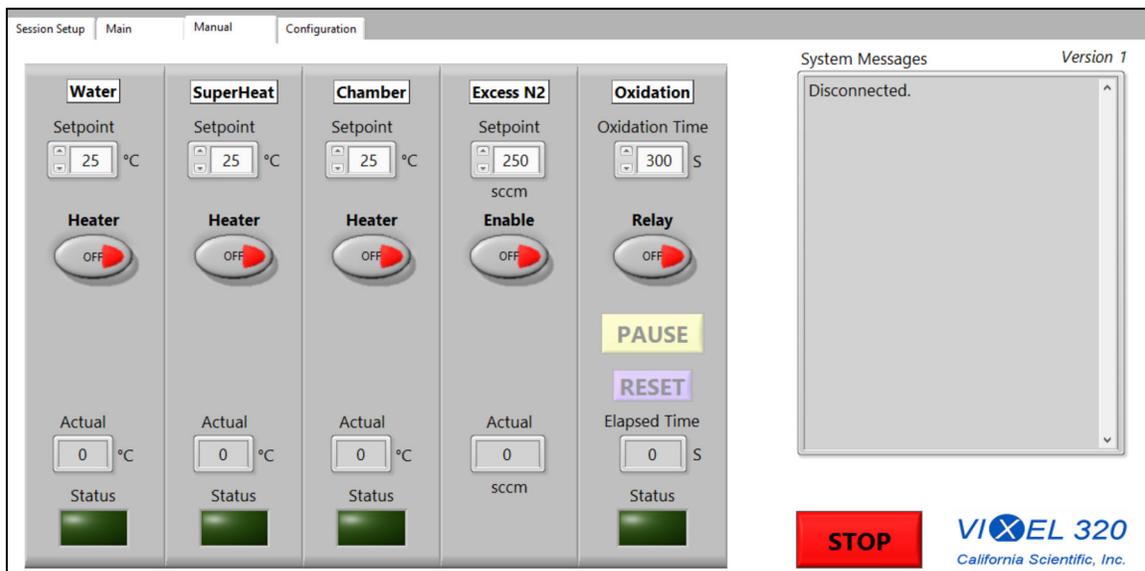
Parameter	Min	Typ	Max	Unit	Comment
Wafer Size			150	mm	Any Size up to 6"
Wafer Chuck Diameter		175		mm	7" Diameter for up to 6" Wafers
Microscope Travel		175		mm	Entire Wafer Area is Visible
Oxidation Rate		0.5-1.0		µm/min	Typical, Recommended
Temperature Range		420	500	°C	
Temperature Uniformity		± 2.5		°C	Over a 100mm diameter wafer
Heating Rate		1		°C/s	Recommended Rate
Cooling Rate		1		°C/s	Average, down to 200°C
Oxidation Start/Stop Lag		12		s	
Maximum Throughput		1		Wafer/hr	Limited by temperature ramping
System Dimensions					
Length		36/91		in/cm	
Width		24/61		in/cm	
Height		53/135		in/cm	
System Weight		90/200		Kg/lb	
Power Consumption			2.5	kW	



User Interface

VIXEL-320 is controlled by a provided computer and a software package that allows either manual or programmed operation of the system. Oxidation progress is viewed on a separate monitor with the capability to optimize the image, make measurements, and to save still images or video clips of the oxidation as needed.

The manual tab in the user interface is shown below. Various parameters are chosen and activated by the user. This mode of operation is useful for experimentation and optimization.



In manual operation, the user has full control of all system parameters.

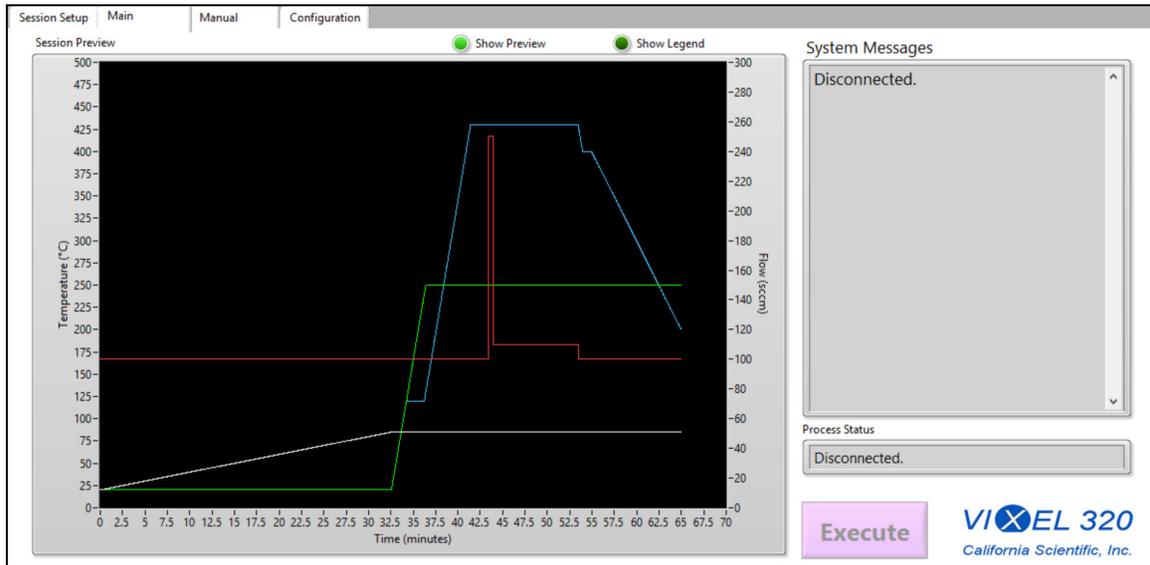
Session Setup tab and Main Tab are used to program and operate the system as shown in the following two images (next page). The information entered in the Session Tab is saved as the program and may be graphically previewed in the Main tab.

The Main tab can either display the actual progress of the program or it can show its preview.

The graphical display of the program is a powerful tool that helps the user see how system parameters such as bake times, purge times and gas surge and decline evolve in parallel.

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Automated Operation Windows:

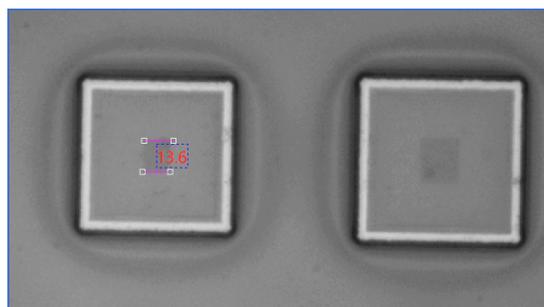


A preview of selected oxidation parameters over time can be seen. The image shows various soak and purge steps and variations in temperature and gas flow.

In-Situ Monitoring

Due to the high sensitivity of wet oxidation rate to multiple parameters, oxidation time for achieving any target aperture size varies from run to run. For this reason, it is preferred to be able to monitor the progress of oxidation in real time and to stop the oxidation once the desired aperture size is reached. VIXEL-320 offers this capability through infrared imaging at selectable

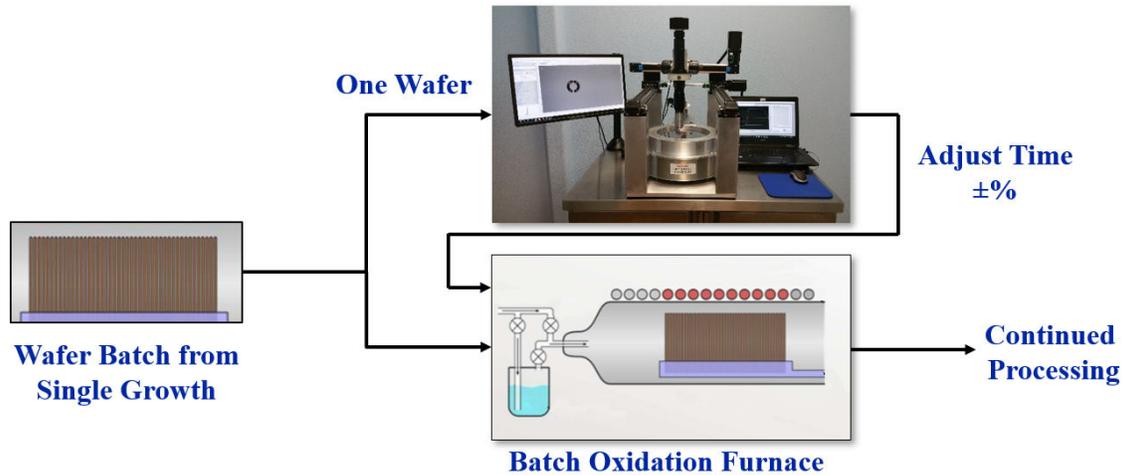
magnification (12× zoom) as can be seen in the images below. Any point on the entire wafer surface can be monitored. The position of the microscope is controlled by software and the image is seen on a separate monitor. On screen measurement of aperture size is shown below.



On screen measurement and monitoring of oxide aperture dimensions.

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Suggested Use in Volume Production:



Single-wafer oxidation systems are not cost effective for volume production. Wafers from a single batch of epitaxial growth tend to oxidize at the same rate and may be oxidized in a batch oxidation furnace if their oxidation rate is known. Instead of sacrificing a wafer to fine-tune the oxidation rate for the batch, one wafer of the batch is oxidized in VIXEL-320 with in-situ monitoring. The obtained oxidation rate is then used to fine-tune the oxidation time in the batch furnace. This combination is most cost effective for volume production. The concept is shown visually above.

Installation Requirements:

- 110V or 220V electrical outlets
- High purity house or bottled dry carrier gas (N₂)
- DI water line
- Low volume exhaust

CSI provides installation, training and technical support for the VIXEL-320 system.

For additional information please contact info@californiascientific.com

California Scientific manufactures optoelectronic fabrication and test equipment for the scientific community.