

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.

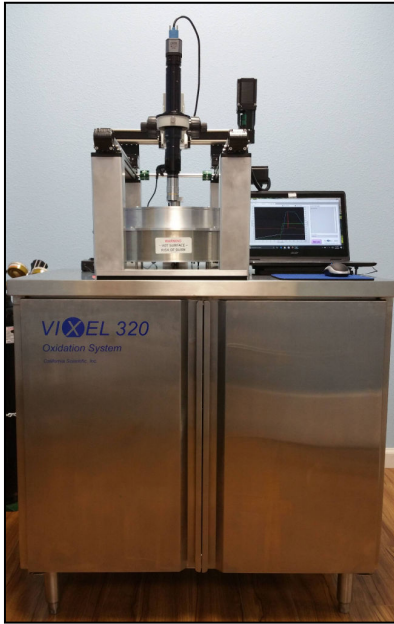
In-situ oxidation monitoring is done by an infrared optical microscope that is focused on VCSELs or oxidation test structures. The entire area of the heating chuck (175mm or 7" diameter) that holds the wafer can be examined by the microscope during oxidation. Typically, the oxidation duration is selected 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.

CSI provides installation, training and technical support.

For additional information please contact info@californiascientific.com

System Specifications:

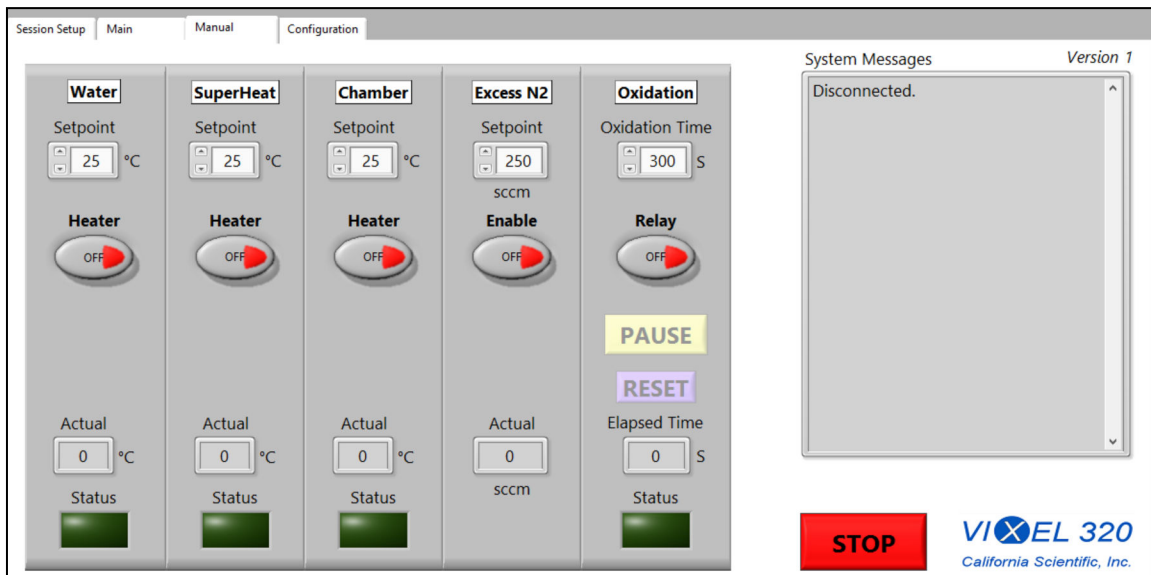
Parameter	Min	Typ	Max	Unit	Comment
Wafer Size			150	mm	Any Size up to 6"
Wafer Chuck Diameter		175		mm	7" Diameter for up to 6" Wafers
Microscope Travel		175		mm	Entire Wafer Area is Visible
Oxidation Rate		0.5-1.0		µm/min	Typical, Recommended
Temperature Range		420	500	°C	
Temperature Uniformity		± 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 in a separate window with the capability to optimize the image 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.

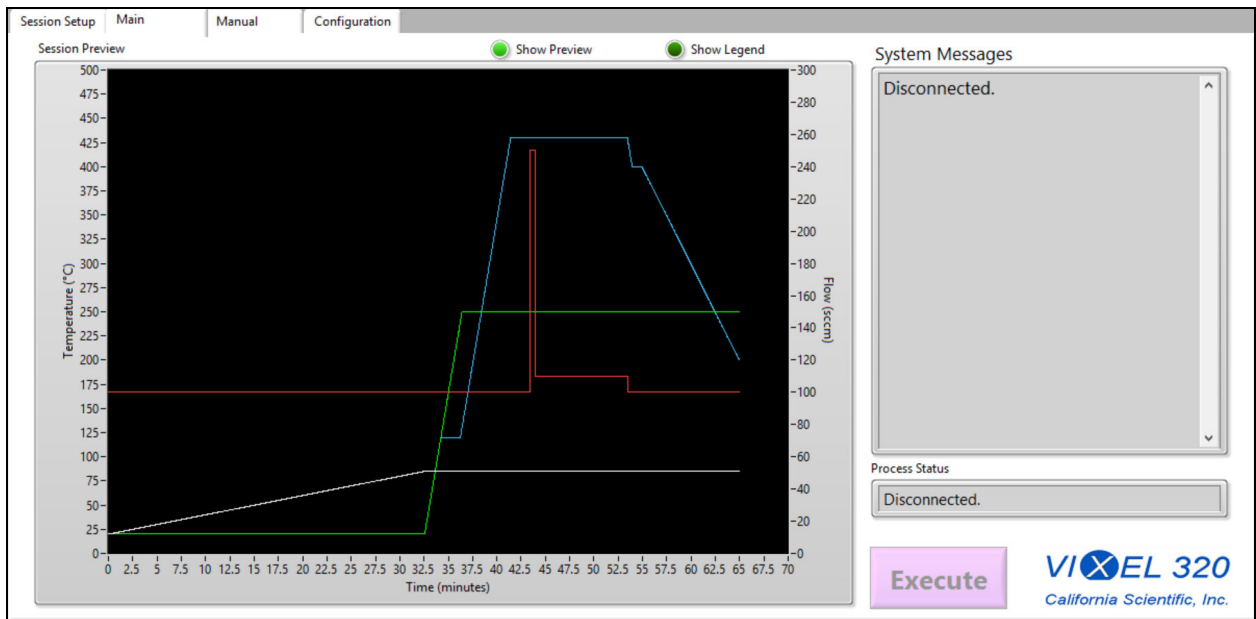
The graphical display of the program is a powerful tool that helps the user see how system parameters such as bake times, purge times and gas surge and decline evolve in parallel.

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Automated Operation Windows:

Session Data	Session Details	
Date: <input type="text" value="9/20/2015"/>	Water Temp: <input type="text" value="85"/> °C	Oxidation Duration: <input type="text" value="600"/> sec
Job Name: <input type="text" value="Test"/>	Oxidation Temp: <input type="text" value="430"/> °C	Wet Flow Surge: <input type="text" value="150"/> sccm
User Name: <input type="text" value="Operator"/>	SuperHeater Temp: <input type="text" value="250"/> °C	Wet Flow Decline: <input type="text" value="10"/> sccm
Setup File: <input type="text" value="default"/>	Soak 1 Temp: <input type="text" value="120"/> °C	Dry Purge Temp: <input type="text" value="400"/> °C
Comments: <input type="text" value="This is a test"/>	Soak 1 Duration: <input type="text" value="120"/> sec	Dry Purge Duration: <input type="text" value="60"/> sec
	Soak 2 Duration: <input type="text" value="120"/> sec	Temp Ramp Down: <input type="text" value="Natural"/>
	Dry Flow Rate: <input type="text" value="100"/> sccm	
	Wet Flow Rate: <input type="text" value="100"/> sccm	

Session information and oxidation parameters are entered in the “Session Setup” tab. The program can be previewed and automatically executed in the “Main” tab (below).



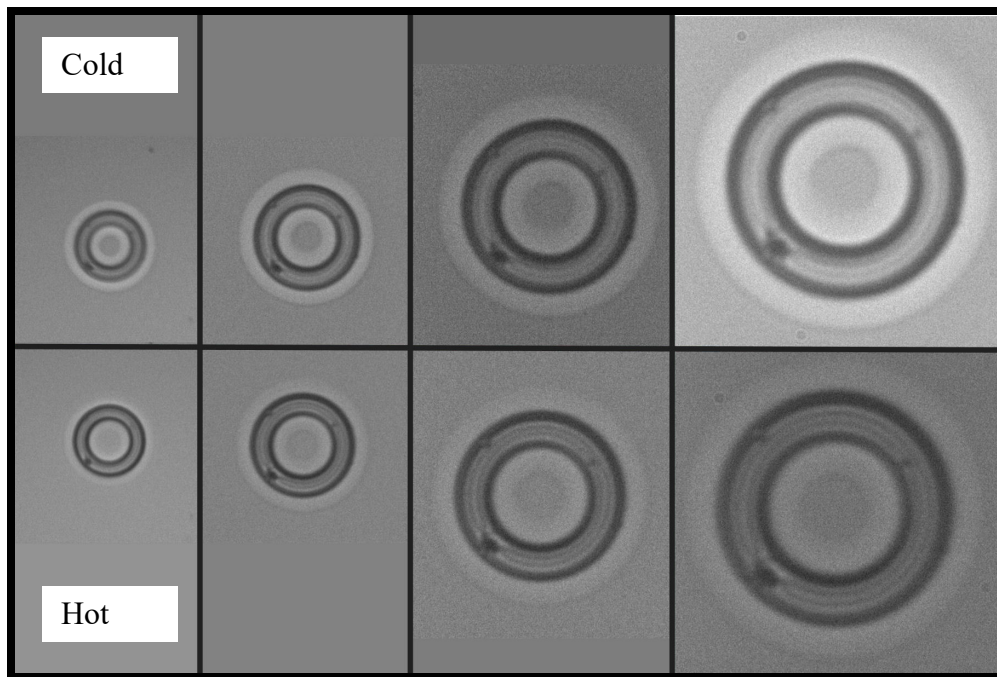
A preview of selected oxidation parameters over time can be seen. The image shows various soak and purge steps and variations in temperature and gas flow.

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 (12x zoom) as can be seen

in the images below. Any point on the entire wafer surface can be monitored.

It is noteworthy that some contrast loss is inevitable when monitoring at elevated temperatures. This is due to thermal lensing. Also, the visibility of the oxide front varies significantly with VCSEL design. The position of the microscope is controlled by software and the image is seen on a separate monitor.



Oxidation depth images of a 30-micron trench-isolated VCSEL at different magnifications. Top row images were taken at room temperature, and bottom-row images were taken at 400°C. The reduction of contrast at high temperatures can be seen.

Installation Requirements:

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

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