OPTOGAN
LED SOLUTIONS

System for creation desired surface topology of sapphire substrate by exposing liquid reagents **/**

Sapphire Etch Tool

Specification

Sapphire Etch Tool

1. Manufacturer – Lotus systems GmbH (http://www.ap-s.de/)
2. Description - (according to Attachment №1 to Supply agreement №50100201078)
3. Ownership data – from 2010 year
4. Location – Germany

№	Title	QTY
1	• Automated Wet Bench 2600 x 1400 x 2400mm • Chemical Supply System 2x60 liter • Fire Suppression System • Cooling System Braun FWA 30KW • Quartz Carrier 2" – 25 Wafers • Quartz Carrier 4" – 25 Wafers • Transport Cart for Drum Transfer • CE marked system • An ENGLISH manual on standard paper and a CD-ROM	1

Sapphire Etch Tool™

by Lotus ®

General System Information

Description:

The Sapphire Etch Tool is a fume hood with automatic handling system for etching application of sapphire substrates.

The system partitioned in two working areas. These areas separated by an automatic door (2nd security window). In the left area are the I/O-Station, the gripper cleaner and the QDR located. The right area is for the hot acid process bathes. All necessary electrical parts and the operator interface integrated in a independent standing electrical cabinet on the left side of the tool. The size of all bathes is calculated to process one standard 4” (25 wafers) or one 2” (25 wafers) quartz glass carrier. Only one carrier can be inside the tool during the process stream.

A specified throughput is 1000 wafers/week (7days / 24h per day)

Features:

- Housing
  - Base frame / Safety construction
  - Filter fan unit under working areas for signalization about fume
  - Exhaust system (for guarantee that no contaminated air escapes from the inside of the fume hood to the operator)
  - Automatic front gate (for separating operator area and clean room from the handling area inside of the machine)
  - Automatic 2nd Security Window (for the two hot acid process batches from left wet and handling area)
- Flowchart
  - Wet Input and Output Station
    - Fix mounted position to pick up the quartz carrier I a reliable way by the operator
    - Carrier sensor to examine the right position of the carrier. This is important for the automatic handling to pick up the carrier reliable.
    - Front gate will be closed and sensed during any automatic handling.
  - Gripper Clean
    - Working surface in PP with holes to pass through the laminar flow from the top
    - One set of PP rings with nozzles to rinse the gripper with UPW
    - One set of PP rings with nozzles to purge and dry the gripper with CDA or N2
    - The automatic handling will clean (rinse and dry) the gripper after every dive in acid or QDR.
  - Bath QDR
    - PP bath to rinse acid contaminated wafers by water overflow or quick dump rinse with spray nozzles on top of the bath
    - Size (W x L x D) approx. 200 x 200 x 200mm, which corresponds to a volume of around 8 liters.
    - Bath with serrated edge, equipped with automatic lid.
    - Resistivity measurement for process control and drain separation done in parallel tubing.
    - Automatic valve to switch between CITY DRAIN BUFFER and NEUTRA BUFFER.
  - Bath Hot Acid 1 & 2
    - Bath to etch wafers with an acid mix of H_2SO_4 und H_3PO_4.
    - Size approx. Ø=240mm x h=350mm which corresponds to a total volume of around 15 liters. Usable volume will be 11 liters which corresponds to a height of 250mm of liquid in the process bath.

- Process temperature is adjustable between 100°C and 300°C with a tolerance of ± 5°C with closed lid
- Bath is manufactured out of quartz glass. The support-tubes to fill and drain the bath will also made in quartz glass and are fixed welded to the bath.
- A special designed heater provides the heat to create the specified process temperature. It is integrated in the heat–isolation and supports the heat from the bottom and from the side of the process bath. The isolation is engineered to keep the process heat inside the bathes and guarantees a max. outside temperature of 50 °C.
- For final process control and exactly measurement of the liquid temperature, system equip with a pyrometer, looking from the side-wall inside the bath.
- A very special design of the process bath environment provides an optimal bath exhaust if the lid is opened.

- Premix Tank
  - The purpose of the premix tank is to setup the right mixture of chemistry before they will transfer to the process bathes. Both process bathes will be supported by one premix-system.
  - Specified Mixture is: 3 parts H_2SO_4 (98 % Vol.) / 1 part H_3PO_4 (85 % Vol.)
  - The volume of each premix cycle will match exactly the volume of one process bath filling approximately 11 liter
- Cool Down Tank
  - The purpose of the cool down tank is to cool active the hot acid down to a specified drain temperature. The drain temperature will be approx. 50°C
  - The acid will be transferred from both process bathes to the tank with a max. temperature of 150 °C
  - The valves in this line are extremely temperature stable from CKD
  - The tank is made in PFA with a heat exchanger – also in PFA - inside.
  - The volume of the tank is big enough to support both bathes at the same time. We would like to design the tank with a usable volume of 30 liters.

- ❑ Automatic Handling System
  - There is one automatic handling for the transportation of carriers within the machine. The carriers are always picked and transported through the machine by the handling system. The handling area is totally secured by different safety- and monitoring devices.
- ❑ Electrical Cabinet
  - According to VDE-Norm 0113/IEC EN60204-1, all electrical and pneumatic components correspond to the demands and safety devices of the following mentioned European Community-guidelines and correspond to the harmonized European Standards (EN) which has been announced in the official gazettes of the European Community for programmable logic controller (PLC): 89/336/EWG, 73/23/EWG and etc.
- ❑ Control system
  - PLC Siemens S7 315-2 PN/DP
  - Remote Control
    - The remote control enables LOTUS systems´ software department to access onto the system´s software in order to install updates and provide support for troubleshooting. The operating company must provide a VPN-access to use this option. Alternatively, an analogue or ISDN line might be employed.
  - Software Design
    - The user language is English. Distinct functions can be individually controlled with different password-protected operator levels.
  - Alarm Device
    - All occurred errors or alarms will be saved in an alarm log file. The alarm message enables a direct access to detailed information within a database. A code number for any error assists LOTUS systems´ software experts to analyze the malfunction.
  - Maintenance Mode
    - In maintenance mode, modules and handling system can be operated manually. Trouble shooting is typically executed in this mode, too.
  - Interface for external signals
    - The tool provides 1 external “EMO” dry contacts input. The tool provides 1 external “Leak Alarm FAB” dry contacts input
- ❑ Connection to MES
- ❑ Fire Suppression System

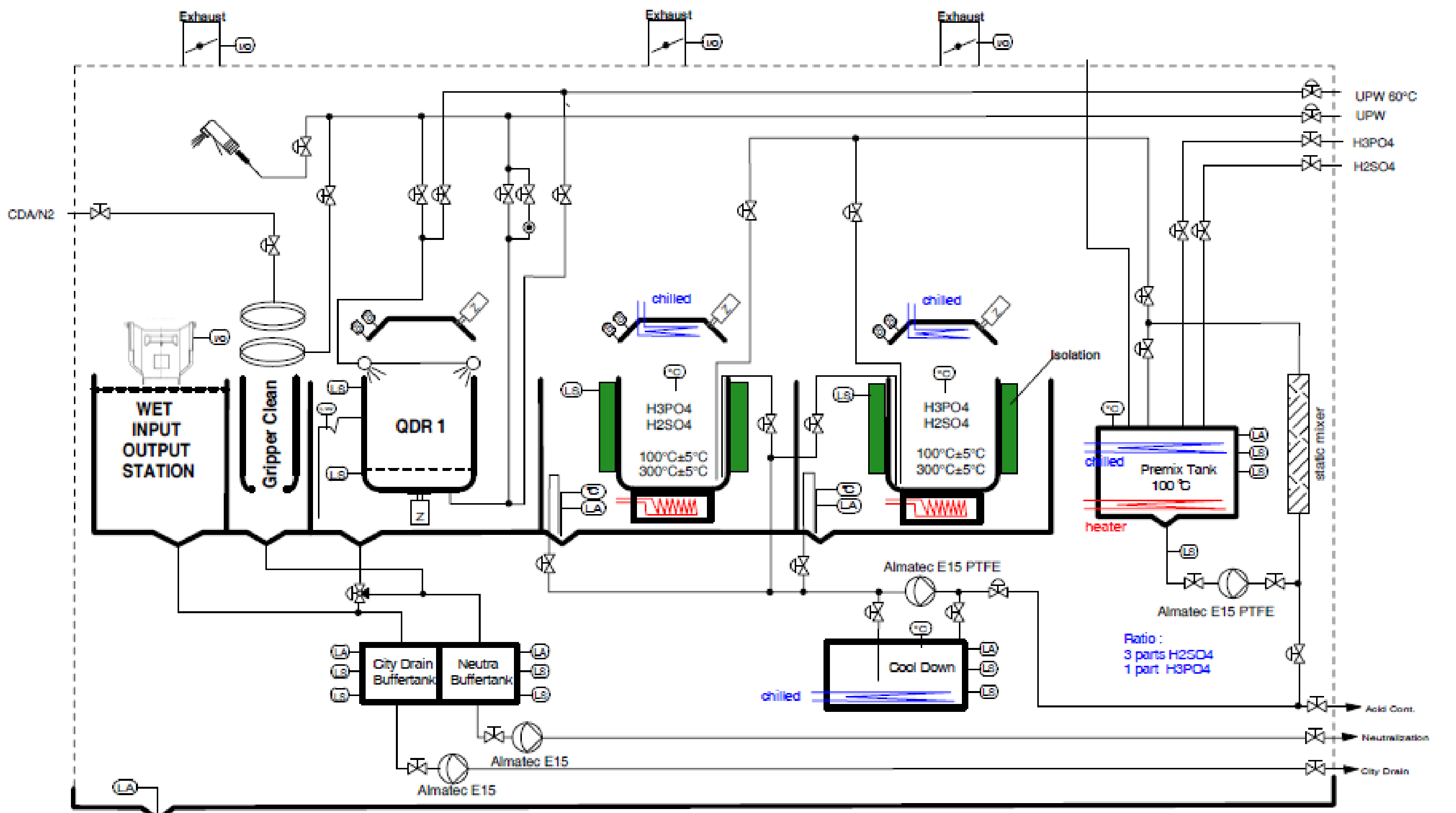
  The tool is equipped with a fire suppression system from MINIMAX which is working with ARGON. Each area of the wet bench supported by a flame detector and a nozzle for ARGON.

- Flame detector
  - The Det-Tronics PM-5MPX Dual Spectrum® flame detector is optimized for the rigorous semiconductor fabrication industry, which is beset with many hazards that result in stringent requirements for fire protection safety systems.
- Signalization and manual release
  - The system includes an optical and acoustic alarm signal.
  - Both signal devices are mounted in the side wall (front of tool) of the electrical cabinet
  - The manual release of the fire suppression system is also mounted there.
- Electrical Cabinet and Controller
  - Small footprint : w=800 x d=600 x h=2000 mm
  - 1 bottle of ARGON is hanging inside cabinet. One bottle is necessary to support the system in case of any fire and is included in the quote.
  - Weight control system guarantees the ARGON bottles are each time filled. The system will create an alarm by passing a light barrier if the ARGON will be lost due to a defect in the valve or seal.
  - In case of any fire situation, the system will close the exhaust-lines of the wet bench and switch down the FFU in top of the tool prior any suppression with ARGON.

❑ Chiller for Cooling Water
- System Braun FW A 30
  - Coolant is R 407 C - FCKW-free. System is completely assembled and tests, with all necessary special fittings for a fully automatic function. Nominal cooling performance with 15°C inlet temperature amounts to 30 KW (with 25°C ambient temperature).

❑ Chemical Supply System 2x60 liters “Purus Duplex”
  - Small footprint: w=1200 x d=600 x h=1600 mm
  - Supports 2 drums with 60 liters for each chemistry
  - System can be used also with 30l H2SO4 and 25l H3PO4 canisters
- Shuttle Drum Area
- Media area

Conceptual Flow Diagram



Throughput Calculation

The calculation based on this specified process flow:

- 1. Step…..Load dry Carrier at Input / Output station
- 2. Step…..Load and proceed carrier in Bath 2 – 100°C acid for. 60s
- 3. Step…..Load and proceed carrier in Bath 3 – 300°C acid for 600s
- 4. Step…..Load and proceed carrier in Bath 2 – 100°C acid for 60s
- 5. Step…..Load and proceed carrier in Bath 1 – rinsing with ambient or hot UPW
- 6. Step….. Unload wet Carrier at Input / Output station

	I/O	Bad 2	Bad 3	Bad 2	Bad 1	I/O	
	loading tool by OP	Hot Acid 1 100 °C	Hot Acid 2 300 °C	Hot Acid 1 100 °C	QDR	unloading tool by OP	
Handlingtime (s)	30	30	30	30	30	30	180
Process Time (s)	120	60	600	60	600	120	1560

Summary of Time to run the carrier through the tool :	1740	s
Process Time :	89,56	%
Handling Time :	10,34	%

Calculation :	Summary production time 100 %	60 min	
	Free productiontime with 95 %	57 min	(abz. PM/M)
	Cycle time each carrier	26 min	
	Cycle time incl. 12 % handling time	30 min	
Throughput :	(25 wafer/carrier) x (2 runs/h)		
Throughput :		50 wafer / hour	
Summary Throughput at 24h/7 days :		8000 wafer / week	

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Packing photos: