OpTool Evolution-64 System Technical Specification

Configuration	
Fully Automated Nano Imprint Lithography System designed for 4-inch Sapphire wafer patterning with maximum throughput of 120 wafers per hour, dependent on PR (Photo-Resist on Substrate) Includes: The System consists of three 4-inch-wafer cassettes and one Stamp 6-inch cassette and two Imprint Modules. Furthermore the system includes robot, aligner, stamp spin coating, Foil Handling System, Substrate Handling System, Computer Controlled User Interface and Integrated HEPA Filters and Ionizer.	
Master Stamp Specification	
Master Stamp size	6-inch Semi Standard with primary flat, thickness: 675 ± 25 µm
Master Stamp Handling	Stamps on one cassette, Cassette-to-Cassette, Automatic robotic align and pick and place
Substrate Specification	
Substrates Sizes	4 inch, Sapphire wafers with primary flat, Thickness: 650 ± 10 µm, Diameter: 100 ± 0.1 mm
Cassettes handling	Substrates will be deliver in cassettes. 3X cassette holder included.
Substrate Handling	Cassette-to-Cassette, Automatic robotic align and pick and place
Process station Specification	
Imprint Area (Maximum)	100 mm Ø
Pressure (CDA-driven)	0 - 10 bar (dependent on Air pressure supply)
Temperature	Ambient temperature - 100°C
Temperature Setting Accuracy	± 1°C
UV Wavelengths and Power intensity at sample	365 nm ± 10 nm, 2x : 100mW/cm^2 and 2x 280mW/cm^2 (*the system includes 4 UV-units*)
Stamp Spin coater	
Spin coater	Programmable speed range: 1100-3000 rpm; Including edge cleaning and back cleaning functions
Media input	3 container size 10 litters plastic can
Pump system	3x Peristaltic Pumps and 3micron media filter, flow rate 1mL/s,
Polymer stamp material	PS-90
Cleaning chemical	Isopropanol alcohol 95% or higher CAS Number: 67-63-0
Automation	
Pre-aligner	6-inch Silicon Stamp and 4-inch sapphire wafer centre and flat alignment within lateral 0,1mm and rotational 0,1°
Robot	Harmonic Dual arm Robot with placement accuracy of 100µm (X, Y)
Tact capacity	maximum 120 Wafers per hour
System overall	
Mini Environment	Class 10 *(installation in Class 100 clean room)*
Tact time	120 wafers per hour
Throughput capacity	maximum 120 Wafers per hour
System Safety	
CE Mark	Marked
Lock out/Tag out disconnect	Safety
EMOS	Two set, one on each side
Interlocked safety cover	Prevent accident EMO

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Other system specifications:

Imprint Performance	
Minimum Feature Size	< 100 nm
Pattern Replication Accuracy	± 100 nm *(relative to stamp pattern)*
Minimum Residual Layer Thickness	3% of the height of the pattern *(relative to stamp uniformity)*
Imprint Uniformity: within wafer	Δ height <2%
Imprint Uniformity: wafer to wafer	Δ height <2%
Defect levels performance *	• No Air bubble, • No Air inclusions • S, M, L, O < 300ea • E = 0 • Scratch 1 & 2 = 0
Maintenance	
Scheduled maintenance	Approx. 1 hours per day and dependant on utilization level
Unscheduled maintenance	Approx. 2 hours per week and dependant on utilization level

(*) Particle levels: S+, M+, L+, O+, E+, S-, M-, L-, O-, E-
(+) meaning there is defect inside the resist (Particle added before process or Pattern Lost)
(-) meaning there is particle on the resist (particle added after process)
S: Any defect larger than 34 pixel in length
M: Any defect larger than 67 pixel in length
L: Any defect larger than 134 pixel in length
O: Any defect larger than 268 pixel in length
E: Any defect larger than 1000 pixel in length
Scratch 1: Any defect larger than 5000 pixel in length
Scratch 2: Any defect larger than 10000 pixel in length

Compressed air	
Pressure	5-8 bar
Flow	Minimum 100 l/min, Peak 200 l/min
Connection	Ø 8 mm Push to connect fitting
Quality	Dry & filtered to 0.01 µm / 0.01 ppm (CDA)
Cooling Water (alternative Air cooling)	
Pressure	1,8 – 3 bar
Temperature	15 - 25°C
Flow	5 – 15 l/min
Connection	Fast Water connector fitting or Ø 8 mm Push to connect fitting
Quality	Clean
Vacuum	
Vacuum level	85% - 90%
Number of ports	3 ports (for Stamp, Wafers, Spinner)
Option:	*3 external vacuum pumps can be delivered (driven from system at 220VAC)*
Exhaust	
Outlets	2
Size	Ø100mm (Exhaust hose inner diameter 102mm)
Total Flow (max)	6000 l/min
Flow per Outlet	3000 l/min
Miscellaneous	
Clean-room Compatible	ISO 5 / Class 100 (Installation in class 100 clean room recommended)
Room Temperature	18 – 23°C
Relative Humidity	40 – 65%
Power	400 VAC, 3 phase, grounded, 50/60 Hz, 32A
Physical Dimensions	
Dimensions (L x W x H)	150 x 160 x 180 [cm]
Weight	1300 kg

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General expected System performance:

Item	Terms		Note
PR profile: (Compared to Stamp)	Height:	2.5 µm	AFM
	Width Top:	1.9 ± 0.05 µm	SEM, Cross Section
	Width bottom:	2.15 ± 0.05 µm	SEM, Cross Section
	Angel:	≤ 2 degree	SEM, , Cross Section
	Residual layer:	40-100 nm	Dependent on initial PR thickness. SEM, AFM
	Appearance:	Non bubble, PR rip-off or pattern shape	ADI, Optical Microscope
PR curing time	Exposure time	5-40 s	Dependent on the PR sensitivity
PR Uniformity	Within Wafer:	≤ 2.5 %	=(Max - Min) / (Max + Min) x 100
	Wafer to Wafer:	≤ 2.5 %	
Capacity	Maximum tact-time: 120 W/h , or minimum 55000 W/month		
AOI Yield	≥ 90%		
Software	PLC, microcomputer, USB for extract the LOG file		
Support	On site engineer		

Downstream process optimisation goal:

Item	Terms		Note
Pattern Profile After ICP etching :	Height:	1.75 ± 0.1 µm	AFM
	Width bottom:	2.75 ± 0.05 µm	SEM, Top View
	Pattern Profile:	Conic pyramids	SEM, Cross Section
AOI Yield	≥ 90%		
Support	OpTool will help and support in etching optimization process		

Yield calculation

All imprinted substrates that have inspected values which are within the set point range described below are to be considered as good wafers i.e. accepted yield. Any substrates that have any inspected values which are not within described range below are to be considered as yield lost.

Defects	4-inch substrate	Note
Appearance:	Non bubble, PR rip-off or change of shape	System performance
Qualified patterned area	Diameter of 98mm, Center of substrate	System performance
Defect count S, M, L , O, E ((+) or (-)), Scratch 1, Scratch 2	S, M, L , O < 300ea E = 0 Scratch 1 & 2 = 0	System performance

(+) meaning there is defect inside the resist (Particle added before process or Pattern Lost)
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Scratch 1: Any defect larger than 5000 pixels in length

Particle levels: S+, M+, L+, O+, E+, S-, M-, L-, O-, E-

Uniformity of yielded substrates

The uniformity is defined by the value of the average on each parameter measured inside the wafer. The requirements on the pattern replication uniformity inside wafer on the yielded substrates are as follows.

	Pattern according to stamp features	Uniformity requirement on yield wafers
Feature height	2500 ± 50 nm	≤ 50nm
Top width	1900 ± 50 nm	≤ 100 nm
Bottom width	2100 ± 50 nm	≤ 100 nm
Feature height uniformity	2.5 %	≤ 63 nm
Feature line width uniformity	2.5 %	≤ 53 nm
Residual layer	N/A	≤ 80 nm

The uniformity shall be measured in 5 points in 4" imprinted substrates.

Silicon stamp to be used for FAT/SAT

Customer shall provide a Silicon stamp for the purpose of performing the FAT/SAT which have the following characteristics and quality;

- Semi-standard Silicon Wafer;
- Diameter 150 mm (6-inch)
- Thickness: 675 ± 25 μm
- Primary flat
- Patterned area: Minimum 110 mm in diameter

Requirements on Sapphire substrates and spin coating

Customer will supply the FAT/SAT substrates. The substrates should be coated with same Photoresist (PR) and the layer thickness must match the requirement according to Stamp pattern design.
The specification of the substrates is as the following:

	4" Sapphire
Diameter	100 ± 0.1 mm
Thickness	650 ± 10 μm
Surface roughness	Ra < 0.3 nm
TTV	<10 μm
BOW / Warp	0 ~ -15 μm / < 30 μm
Flat	Single Flat
Cleanliness	Clean room condition Class 100

- Coating condition:
  - Resist: suggested GMN-PRN2000 / others from customer
  - Thickness: 1100 nm ± 10 nm

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Material to be prepared by customer:

- 6-inch Silicon stamp
  - Pattern structure: Pillars Arranged in triangular lattice
  - Pattern height: 2500 nm ± 50 nm
- 1000 pcs ×4" coated Sapphire substrates (for each specific Sapphire substrate thickness)
  - Dummy/sharp wafers (Good surface quality wafers to be able to indicate the system performance)

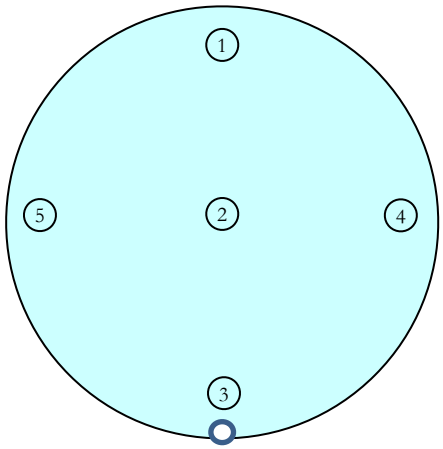
Evaluation of test imprints

Imprints one (1) through two hundreds (1000) of the-substrate imprint samples that were created in each step 3.1 should be measured defect level measurement. Twenty (20) substrates will be measured with SEM /AFM.
All substrates will be measured in all five (5) positions, as indicated in the figures below.
Please note that an SEM can show deviations from real values if not calibrated. Therefore the measured real value of the stamp and imprint needs to be compared, rather than specification values for the stamp.

Measurement points:

- Measuring points 1, 3, 4, 5 are located about 30 mm from the outer pattern edge.
- Measuring point 2 is in the center.

Note: The points may be slightly shifted due to the sample preparation for SEM characterization, during the wafer cutting.



Defects evaluation

After the substrates are imprinted and picked out for evaluation, the defects evaluation will be performed directly before any further processing and characterization is performed. Since any of the additional operation will introduce more particles and defects into the imprinted pattern, it will degrade the pattern quality and affect the defects evaluation.

Defects evaluation will be performed with Automated Optical Inspection (AOI) systems at customer site. Different magnification will be used to characterize the defects level of the imprinted pattern and the size and numbers of the defects will be documented into the yield rate calculation.