

A USER MANUAL
FOR MASKLESS MICROMODEL FABRICATION
USING HEIDELBERG (MLA-150)

1. Written by Wonjin Yun, PhD (wy30422@gmail.com)
2. Reference: Yun,W. “Advanced microfluidic framework for understanding of fluid-flow in porous media : microfabrication, imaging, and deep-learning / Appendix.3” (PhD Diss., Stanford University, 2019), 220-37. <http://purl.stanford.edu/wt253cj8804>
3. Ver. 4 updated on July 28 2019
4. This file is available at <https://web.stanford.edu/~wyun/Heidelberg/>

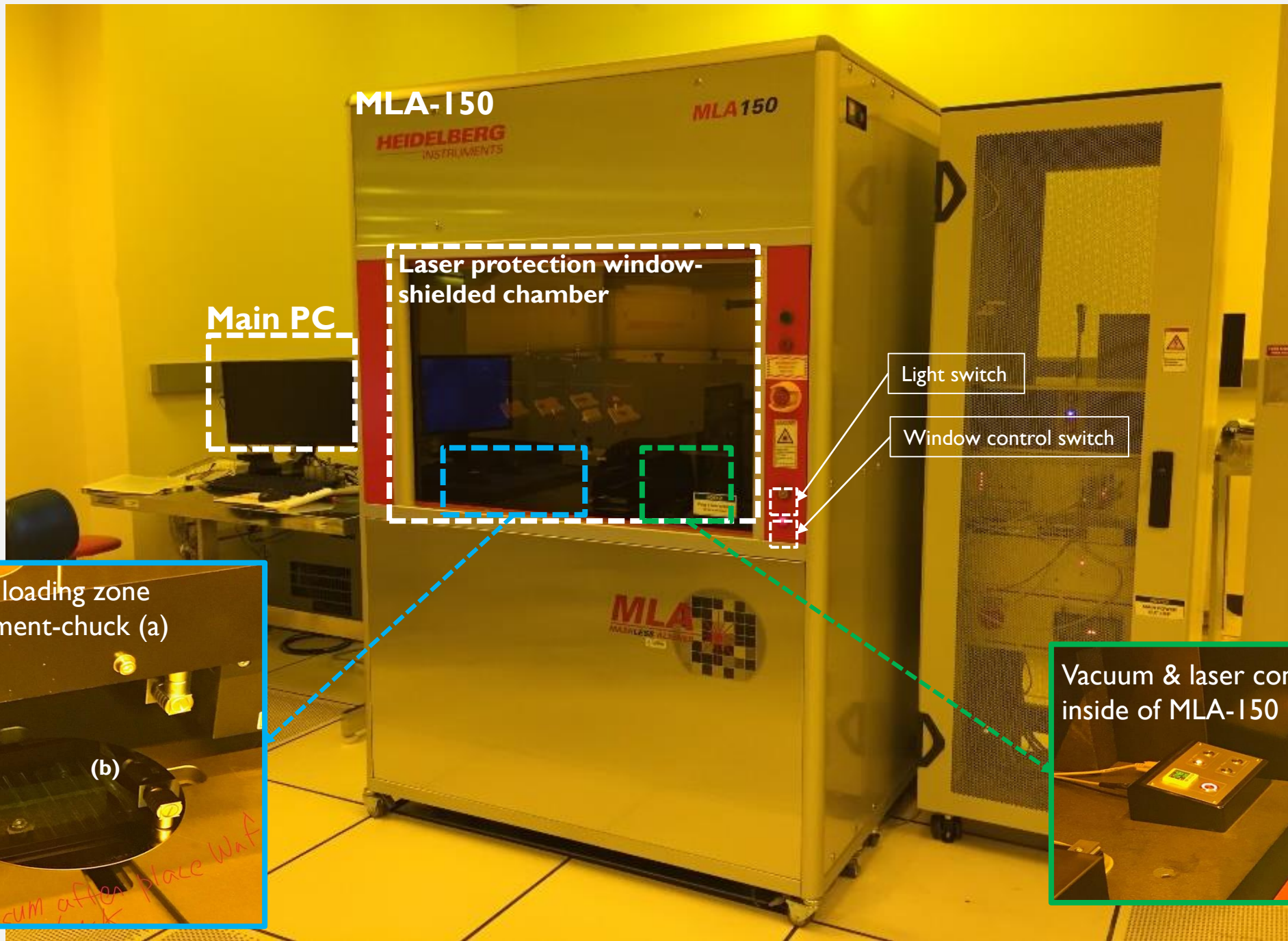
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 - Step 2: Loading wafer + parameter setting
 - Step 3: Exposure + unload wafer



HEIDELBERG (MLA 150): A HIGH SPEED DIRECT WRITE LITHOGRAPHY TOOL

- 1) Directly expose pattern without prior fabrication of a mask resulting in a significantly shorter prototyping cycle
- 2) Light source at 405 nm and 375 nm
- 3) Allows using substrates of any size and shape
- 4) Exposure area upto 150 by 150 mm²
- 5) Provides flexible change of pattern using drawing mode
- 6) Produces structures down to 600 nm
- 7) Alignment accuracy - as good as 500 nm
- 8) Automatic labeling and serialization



MLA-150

MLA150

HEIDELBERG
INSTRUMENTS

Main PC

Laser protection window-
shielded chamber

Light switch

Window control switch

Wafer (b) loading zone
with alignment-chuck (a)

(a)



(b)

Vacuum after place waf

Vacuum & laser control switch
inside of MLA-150

MLA
MASKLESS ALIGNER




2. POINT-OF-CONTACT

- Want to become a user of MLA-I50 ?
 - Swaroop Kommera / skommera@stanford.edu /  721-7546
- Any question regarding tool, file preparation, and shadowing?
 - Wonjin Yun / wyun@stanford.edu /  650-862-2190
 - <https://web.stanford.edu/~wyun/Heidelberg/>
- Want to read full manual ?
 - <https://snf.stanford.edu/SNF/equipment/nSiL/heidelberg-mla-I50>
- Check training schedule ?
 - <https://snf.stanford.edu/SNF/training/training-calendar>

3. DESIGN YOUR MICROMODEL

1. AutoCAD-based design
2. File format conversion

AUTOCAD-BASED DESIGN TIPS

- It will show an example of way to design channel using AutoCAD
 - You can download “tutorial.dxf” file from <https://web.stanford.edu/~wyun/Heidelberg/>
- Couple of useful tools will be introduced for quicker and easier design
 - a. Mirror : easy to copy many objects at designated coordinates
 - b. Join: Connect all polylines, arc, and lines. Prerequisite to “hatch” command.
 - c. Region: redefine all object or joined object as Regions. Prerequisite to “Union” and “Subtract”
 - d. Union : Combine two regions into single region 
 - e. Subtract : Subtract two regions 
 - f. Hatch : Fill the region or joined object 

CHANGE BASE UNIT

The image shows the Autodesk AutoCAD 2018 interface with the 'Drawing Units' dialog box open. The dialog box is titled 'A Drawing Units' and contains the following settings:

- Length:** Type: Decimal, Precision: 0.0000
- Angle:** Type: Decimal Degrees, Precision: 0, Clockwise
- Insertion scale:** Units to scale inserted content: Microns
- Sample Output:** 1.5000,2.0039,0.0000
3.0000<45,0.0000
- Lighting:** Units for specifying the intensity of lighting: International

The dialog box has 'OK', 'Cancel', 'Direction...', and 'Help' buttons at the bottom. The background shows the AutoCAD interface with the 'Tools to maintain the drawing' panel open on the left, highlighting the 'Units' tool. The title bar indicates 'Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf'.

DRAW OBJECT

The screenshot displays the Autodesk AutoCAD 2018 interface. The title bar reads "Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf". The ribbon is set to the "Home" tab, with the "Draw" panel active. A red dashed box highlights the "Rectangle" tool icon. A red text annotation "2- use this tool if you want to draw rectangle" points to it. The "Layers" panel is open, showing a list of layers: "CONTROL", "waferedge", "hatch", and "ByLayer". A red dashed box highlights the "CONTROL" layer, with a red text annotation "1- choose one of layers where you want to draw you design" pointing to it. The Properties palette is open on the left, showing the "General" tab with the "Layer" property set to "CONTROL". The drawing area shows a red dashed rectangle centered at the origin (0,0) of the World Coordinate System (WCS). A red text annotation "(0,0) : the coordinates represent a center of wafer" points to the origin. The status bar at the bottom shows "MODEL" and "1:1" scale.

2- use this tool if you want to draw rectangle

1- choose one of layers where you want to draw you design

(0,0) : the coordinates represent a center of wafer

CREATE SQUARE

1- Define and Fine-tune your object (rectangle) by setting the coordinates of all vertices

Now, your object becomes 1000 micron size square that is centered at (0,0) coordinates (center of water).

Property	Value
Color	ByLayer
Layer	CONTROL
Linetype	ByLayer
Linetype scale	1.0000
Plot style	ByColor
Lineweight	ByLayer
Transparency	ByLayer
Hyperlink	
Thickness	0.0000
Material	ByLayer
Current Vertex	4
Vertex X	-500.0000
Vertex Y	-500.0000
Start segment width	0.0000
End segment width	0.0000
Global width	0.0000
Elevation	0.0000
Area	1000000.0000
Length	4000.0000
Closed	Yes
Linetype generati...	Disabled

DUPLICATE SQUARE VIA MIRROR

1- Create a mirrored copy of square across mirror line that is 1000 micron away from the 3rd vertex.

Now we have two identical objects separated by 2000 micron

Mirror Line

3rd

Command: mirror 1 found
5.17, 6.17, 10.17, 10.17, 5.17, 5.17, 10.17, 10.17
MIRROR Specify second point of mirror line: 1000

Properties Panel:

Category	Property	Value
General	Color	ByLayer
	Layer	CONTROL
	Linetype	ByLayer
	Linetype scale	1.0000
	Lineweight	ByLayer
	Thickness	0.0000
3D Visualization	Material	ByLayer
	Plot style	ByColor
Plot style	Plot style table	None
	Plot table attache...	Model
	Plot table type	Not available
	Plot table type	Not available
View	Center X	468.0088
	Center Y	562.6725
	Center Z	0.0000
	Height	4801.3089
	Width	10651.6899
	Misc	Annotation scale
Misc	UCS icon On	Yes
Misc	UCS icon at origin	Yes
Misc	UCS per viewport	Yes
Misc	UCS Name	
Misc	Visual Style	2D Wireframe

MORE COPIES

The screenshot displays the Autodesk AutoCAD 2018 interface. The title bar reads "Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf". The ribbon includes tabs for Home, Insert, Annotate, Parametric, View, Manage, Output, Add-ins, A360, Express Tools, Featured Apps, and Raster Tools. The Properties palette is open on the left, showing the "General" tab with properties for Color (ByLayer), Layer (CONTROL), Linetype (ByLayer), Linetype scale (1.0000), Lineweight (ByLayer), Transparency (ByLayer), and Thickness (0.0000). The "3D Visualization" tab shows Material (ByLayer). The "Plot style" tab shows Plot style (ByColor), Plot style table (None), Plot table attache... (Model), and Plot table type (Not available). The "View" tab shows Center X (319.4329), Center Y (1600.9655), Center Z (0.0000), Height (7948.8517), and Width (17634.5045). The "Misc" tab shows Annotation scale (1:1), UCS icon On (Yes), UCS icon at origin (Yes), UCS per viewport (Yes), UCS Name, and Visual Style (2D Wireframe). The main workspace shows a 2D wireframe view of a grid with a vertical green mirror line. Two blue squares are positioned on either side of the mirror line, with their centers aligned horizontally. A red horizontal line is visible at the bottom of the workspace. The status bar at the bottom shows "MODEL" and "Type here to search".

1- Create a mirrored copy of two squares across mirror

ADD MORE OBJECTS

1- create more objects using "mirror" and "rectangle" tool

The screenshot displays the Autodesk AutoCAD 2018 - STUDENT VERSION interface. The main workspace shows a 2D wireframe drawing of a cross-like shape, which is a mirrored copy of a single object. A red text box is overlaid on the drawing, providing the instruction: "1- create more objects using 'mirror' and 'rectangle' tool". The Properties palette is open on the left, showing the following settings for the selected object:

General	
Color	ByLayer
Layer	CONTROL
Linetype	ByLayer
Linetype scale	1.0000
Lineweight	ByLayer
Transparency	ByLayer
Thickness	0.0000

3D Visualization	
Material	ByLayer

Plot style	
Plot style	ByColor
Plot style table	None
Plot table attache...	Model
Plot table type	Not available

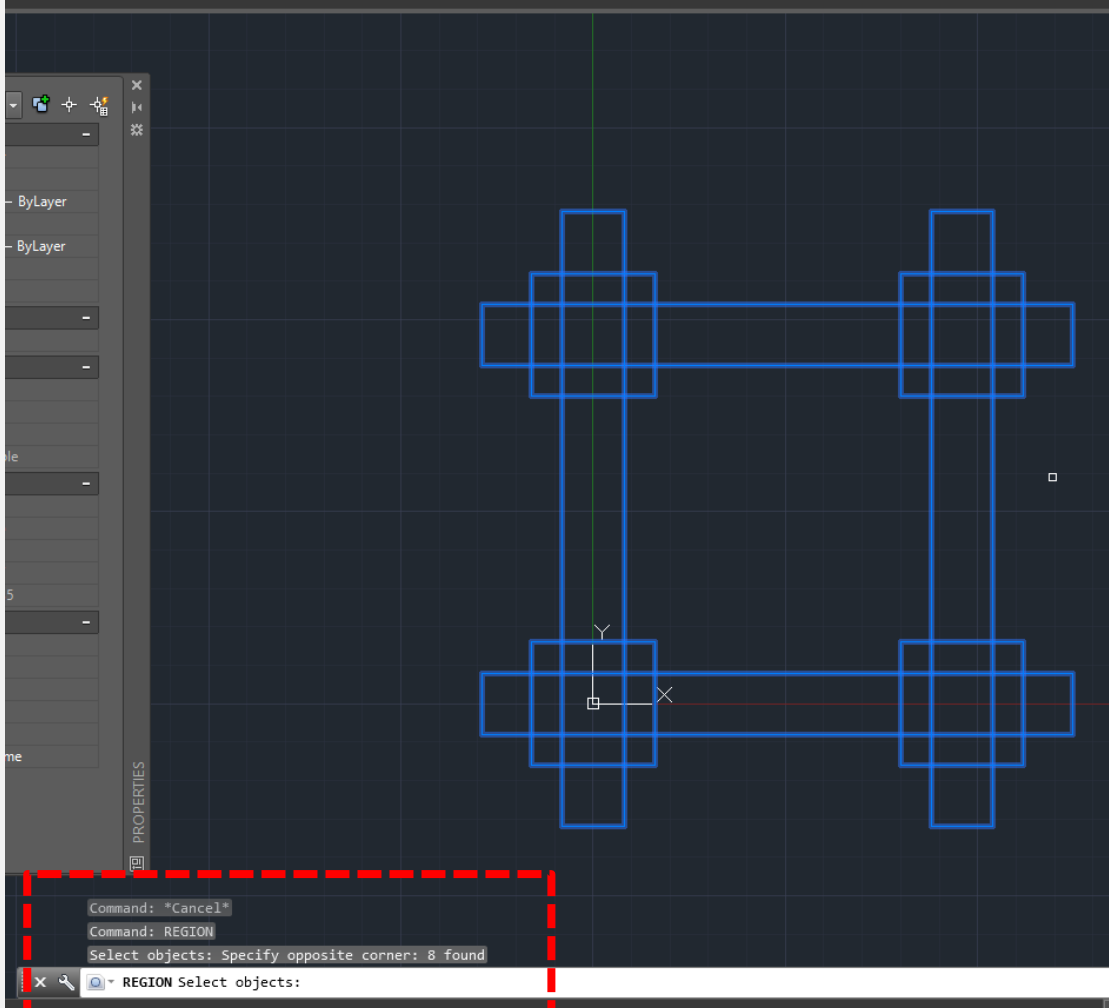
View	
Center X	689.3501
Center Y	1608.4946
Center Z	0.0000
Height	8003.5437
Width	17755.8385

Misc	
Annotation scale	1:1
UCS icon On	Yes
UCS icon at origin	Yes
UCS per viewport	Yes
UCS Name	
Visual Style	2D Wireframe

UNIFY ALL OBJECT

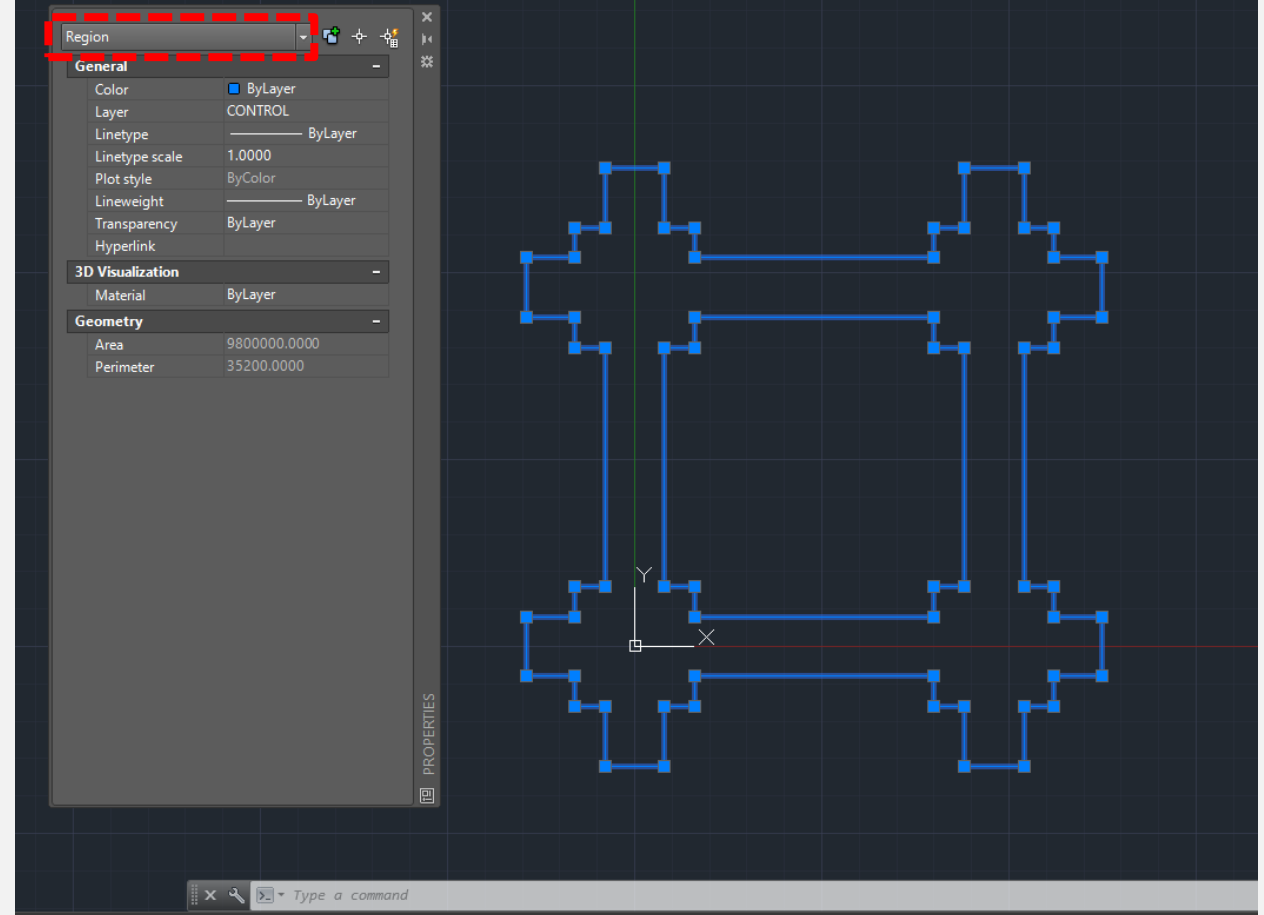
Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf

1- First, make all object (defined as polyline) regions using "region" command.



Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf

2 - Then, you can use "Union" command to combine all regions into single region.



FILL THE AREA

Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf

Home | Annotate | Parametric | View | Manage | Output | Add-ins | A360 | Express Tools | Featured Apps | Raster Tools

ARC | Move | Rotate | Trim | Fillet | Text | Dimension | Leader | Layer Properties | Make Current | Insert | Edit | Match Properties | ByLayer

Copy | Mirror | Fillet | Stretch | Scale | Array | Table | Annotation | Layers | Block | Properties

Fills an enclosed area or selected objects with a hatch pattern or fill.

Choose from several methods to specify the boundaries of a hatch.

- Specify a point in an area that is enclosed by objects.
- Select objects that enclose an area.
- Specify boundary points using the -HATCH Draw option.
- Drag a hatch pattern into an enclosed area from a tool palette or DesignCenter.

HATCH
Press F1 for more help

1- Fill the area using "Hatch" tool so that Heidelberg can recognize your design. In Heidelberg, the hatched area will be exposed.

PROPERTIES

Type a command

2- In Heidelberg, the hatched area will be exposed.

Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf

Home | Insert | Annotate | Parametric | View | Manage | Output | Add-ins | A360 | Express Tools | Featured Apps | Raster Tools | Hatch Editor

Select | Pick Points | Remove | Select Boundary Objects | Pattern | Hatch Transparency | Angle | Set Origin | Associative | Annotative | Match Properties

Determines a hatch boundary from selected objects that form an enclosed area.

Press F1 for more help

Start

[-] [Top] [2D Wireframe]

Hatch

General

- Color: ByLayer
- Layer: CONTROL
- Linetype: ByLayer
- Linetype scale: 1.0000
- Plot style: ByColor
- Lineweight: ByLayer
- Transparency: ByLayer
- Hyperlink:

Pattern

- Type: Predefined
- Pattern name: ANS131
- Annotative: No
- Angle: 0
- Scale: 10.0000
- Origin X: 0.0000
- Origin Y: 0.0000
- Spacing: 10.0000
- Double: No
- Associative: Yes
- Island detection s...: Outer
- Background color: None

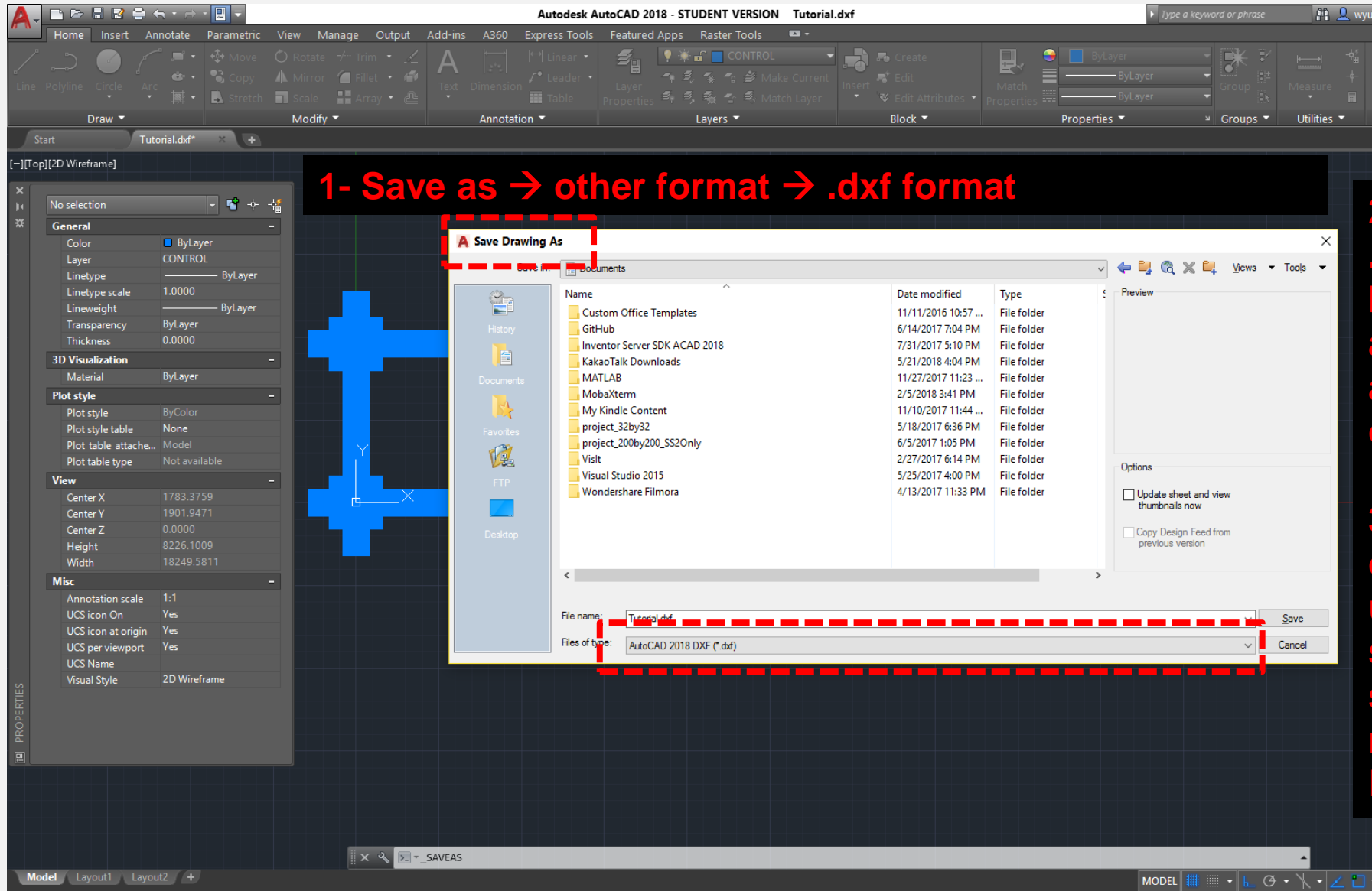
Geometry

- Elevation: 0.0000
- Area: 9800000.0000
- Cumulative Area: 9800000.0000

PROPERTIES

['_-hatchedit_pSOLID']_-hatchedit_pSOLID

EXPORT AS .DXF FORMAT



1- Save as → other format → .dxf format

2 – your design is in readable .dxf format for Heidelberg, but you can keep this file as a master file for the future adjustment or modifications on different layers.

3 – If you need the design only in certain layer for your upcoming exposure, next slides show how to create separate file with the necessary layers using Klayout.

FILE FORMAT CONVERSION

- This tutorial is to simplify and select layers from AutoCAD .dxf file using Open-Source software (Klayout)
- Klayout (installed in Heidelberg main PC) is a useful tool to quick check your design beforehand and remove unnecessary layers as it is needed.

FILE CONVERSION (.gds)

1- Drag and drop your .dxf file to open in Klayout
2- Close all unnecessary layers except "control" layer where your design is located.

2- Save as -> .gds format

The screenshot shows the KLayout 0.25.1 interface. The 'Save Layout Options' dialog box is open, with the following settings highlighted by red dashed lines and arrows:

- Format:** GDS2
- Layers to save:** Visible layers only
- Database unit:** 0.001 μm
- Scaling factor:** 1.0
- Cell tree:** Write non-empty cells only (skip empty cells), Write visible cells only (skip cells not shown with content), Keep instances for dropped cells (make ghost cells)
- Cell context:** Store PCell and library context information (format specific)
- GDS2 Writer Options:**
 - Multi-XY record mode for boundaries (enables infinitely large polygons/paths at the cost of compatibility)
 - cell layout properties (at the cost of compatibility)
 - Eliminate zero-length paths (convert to BOUNDARY)
 - Write current time to time stamps (BGNLIB, BGNSTR)

The 'Layer Properties' panel on the right shows the 'CONTROL' layer selected, with other layers like 'FLOW', 'hatch', and 'waferedge' visible. The 'Layer Toolbox' at the bottom shows a color palette and various tool options.

- Using free software (Klayout), you can make a simple file without all unnecessary layers from AutoCAD generated .dxf format master file.
- You can install your own computer or Heidelberg main PC has it already.
- Heidelberg can read .gds format

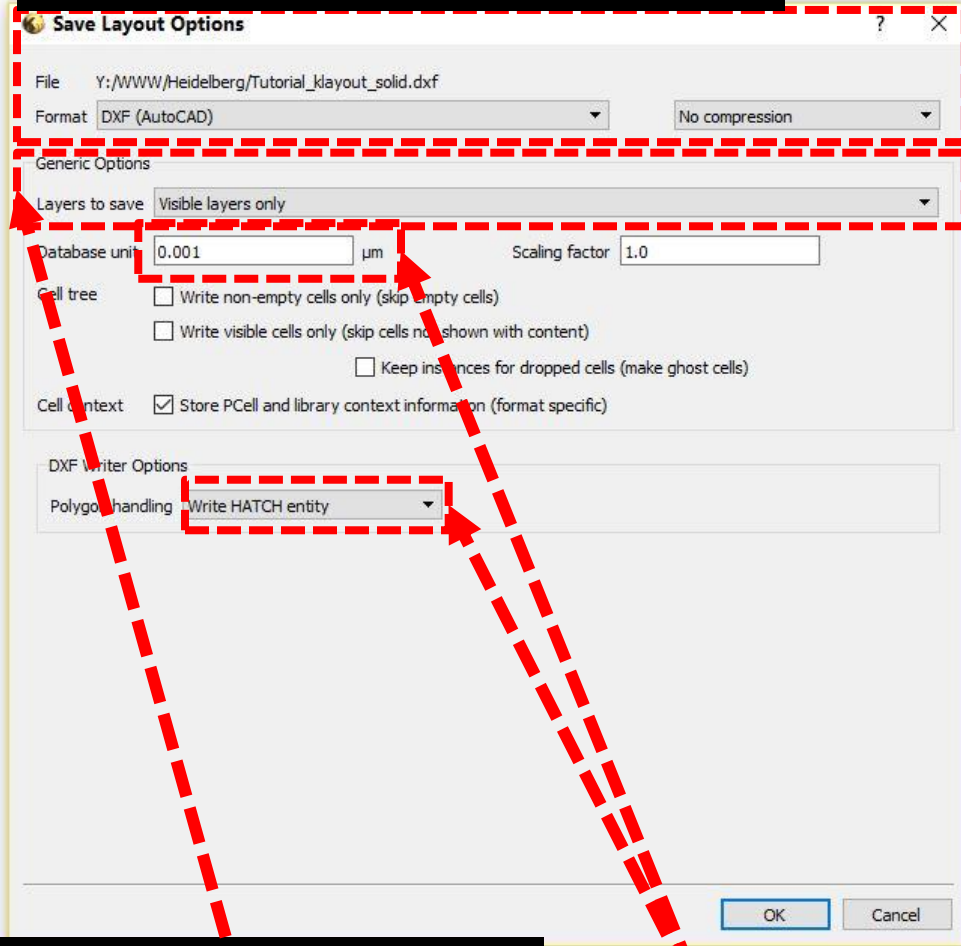
3- Visible layers only

4- check Multi-XY record mode

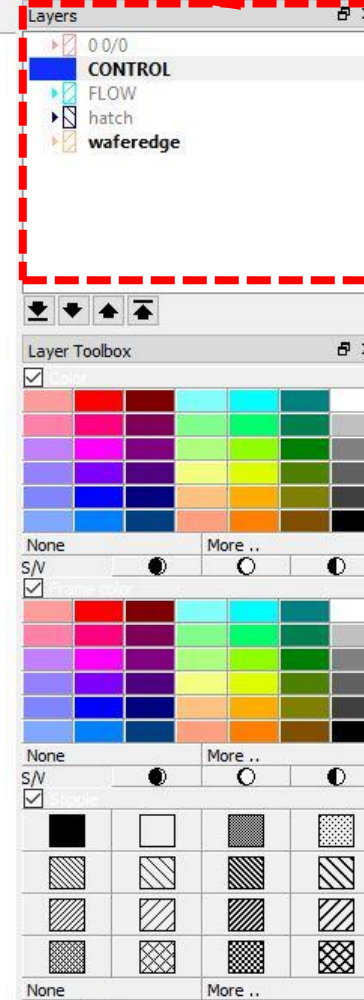
FILE CONVERSION (.dxf)

1- Close all unnecessary layers except "control" layer where your design you want to use.

2- Save as -> .dxf format



3- Visible layers only



3- Base unit is 0.001 micron

4- Select "Write HATCH entity or Decompose into SOLID entities"

- Using free software (Klayout), you can make a simple file without all unnecessary layers from master file.
- You can install your own computer or Heidelberg main PC has it already.
- Heidelberg can read .dxf format
- .dxf format is better choice for some design that has tremendous small polylines (e.g. vectorized rock image)

4. A USER GUIDE FOR MLA-150 (MASKLESS-EXPOSURE)

Step 1: File (design) conversion

Step 2: Loading wafer + parameter setting

Step 3: Exposure + unload wafer

STEP I : FILE (DESIGN) CONVERSION

- Transfer your design from your USB to Heidelberg Main PC directory (/home/convert/gdsii/):
 - **Do not use too long file name, this causes error.**
 - **Do not transfer your design into sub-folder that you created in the directory (/home/convert/gdsii/), this causes error.**

STEP I : FILE (DESIGN) CONVERSION

Screenshot of Main PC running MLA-I50 program

The screenshot shows the main interface of the MLA-I50 program. It includes a menu bar (File, Tools, User, About) and a sidebar with a tree view for 'Exposure Setup' (Info, Setup Job, Load Substrate, Expose Job, First Exposure, Alignment, Series, Draw Mode, Inspection). The main area is divided into several panels:

- Exposure Info:** A table with job details.
- Alignment Info:** Two tables for 'Expose Cross Positions' and 'Align Cross Positions'.
- Progress Info:** A table for 'Exposure Status'.
- Hardware Info:** A table for 'Status' and a 'Numeric Values' table.

Setup Job

1- Click for new job

The 'Setup Job' dialog box contains the following sections:

- Job:** Fields for Name (Job_11291), Number (11291), and Exposure Mode (Standard). Buttons: New Job (highlighted with a red dashed box), Restart Job, Load Job, Save Job.
- Substrate:** Fields for Substrate Template, Shape, Size X, Size Y, Diameter, and Thickness.
- Instructions:**
 - 1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.
 - 2) Substrate: Choose a Substrate template or shape.
 - 3) Layer: Select the Layer to expose. In the chosen Layer, select the Laser wavelength and load or create a Design. For overlay exposure, load Alignment template.

Optional: In the chosen Layer select a Resist template.

2 - double click to add your design

The 'Layer' table has the following columns: Layer, Laser, Design, Mode, Size X [mm], Size Y [mm], Expose Crosses, Align Crosses, Resist, Thickness, Comment, Status, Dose, Defoc, Duration, Angle, Date.

Layer	Laser	Design	Mode	Size X [mm]	Size Y [mm]	Expose Crosses	Align Crosses	Resist	Thickness	Comment	Status	Dose	Defoc	Duration	Angle	Date
FirstExposure	405										Prepared					

Buttons: Add Layer, Delete Layer

Proceed

Buttons: Load Substrate, FirstExposure, Unload Substrate

STEP I : FILE (DESIGN) CONVERSION

File Tools User About

Exposure Setup Info

Setup Job

- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_11291	No.	11291
Substrate Size [mm]		Height	
Design Name		Layer	FirstExp
Design Type		Convert	
Design Size [mm]		Mode	
Dose [mJ/cm ²]		Defoc	

Alignment Info

Expose Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Align Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Progress Info

Exposure Status		
Design Number		of
Stripe Number		of
Time [hh:mm]		of
Remaining Time [hh:mm]		

Hardware Info

X [mm]	0.092	Y [mm]	0.048
--------	-------	--------	-------

Status

DMD	OK
Interferometer	OK
Window	OK
Write Head	Initialized
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values

Z Motor [Steps]	0
Piezo [Steps]	65535
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.50
Chuck Vacuum [bar]	0.01
DMD Temperature [°C]	53
Laser Power [%]	100.0
Laser Wavelength [nm]	405

Double click to add your design

Load Design

Show all next 100 next 99 / 2039 loaded

Name	Date	Time	mode	size X	size Y	source format	source file	Layer / cell	magnification	mirror	XOR	inverted	CD bias X	CD bias Y	auto ce
01_Laura	5/19/2018	10:15:08 PM	Quality	0.900048	0.500048	structure	01_Laura	CM	1	off	off	off	0	0	off
01_wonjin_0519_loop	5/19/2018	9:35:38 PM	Quality	40.078099	29.98	structure	02_30micron	CM	1	off	off	off	0	0	off
bosch_dd2	5/19/2018	5:46:09 PM	Quality	11.9975	11.999	structure	bosch_dd2	CM	1	off	off	off	0	0	off
job_KD2	5/19/2018	3:57:49 PM	Fast	84.5	89.5	structure	KD_4inchlayout_20180518_pocket_flat	CM	1	off	off	off	0	0	off
nisi_strengthtest_scaled	5/19/2018	3:31:44 PM	Quality	85	90	structure	NIringWafer_strengthtest_2	CM	1	off	off	on	0	0	off
2_Stopper	5/19/2018	6:53:40 AM	Quality	104	104	structure	2_Stopper	CM	1	off	off	off	0	0	off
nisi_strengthtest2	5/19/2018	2:38:05 PM	Quality	85	90	structure	NIringWafer_strengthtest_2	CM	1	off	off	on	0	0	off
1_Gap_1st	5/19/2018	6:49:51 AM	Quality	104	104	structure	1_Gap_1st	CM	1	off	off	off	0	0	off
3_Gap_2nd	5/19/2018	6:55:47 AM	Quality	104	104	structure	3_Gap_2nd	CM	1	off	off	off	0	0	off
MMW_E241_6in_dense_v1	5/18/2018	7:49:04 PM	Fast	132.5	126.5	structure	MMW_E241_6in_dense	CM	1	off	off	off	0	0	off
MMW_E241_6in_v1	5/18/2018	7:13:27 PM	Fast	131.5	127.5	structure	MMW_E241_6in_new	CM	1	off	off	off	0	0	off
nisi_strengthtestwafer	5/18/2018	6:51:16 PM	Quality	85	90	structure	NIringWafer_strengthtest	CM	1	off	off	off	0	0	off
AL0518NiFePt	5/18/2018	5:30:59 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21_NiFePt	CM	1	off	off	on	0	0	off
AL0518V2	5/18/2018	4:48:54 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM	1	off	off	on	0	0	off
AL0518	5/18/2018	4:46:13 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM	1	off	off	off	0	0	off
Training_05181802	5/18/2018	3:22:09 PM	Quality	11.704	9.309	structure	Training_05181802	CM	1	off	off	off	0	0	off
Training_051818	5/18/2018	3:20:11 PM	Quality	11.704	9.309	structure	Training_051818	CM	1	off	off	off	0	0	off
L5_20180518	5/18/2018	12:33:59 PM	Quality	58	58.5	structure	SIGe_TFET	CM	1	off	off	off	0	0	off
180518_XMON02m2	5/18/2018	12:07:38 PM	Quality	30.021886	30.025432	structure	20180518_XMON02_m2pp	CM	1	off	off	on	0	0	off
Canti3_1st	5/18/2018	10:28:21 AM	Quality	65	45	structure	Cantilever3-1	CM	1	off	off	off	0	0	off
Canti3_2	5/18/2018	10:29:33 AM	Quality	65	45	structure	Cantilever3_2nd	CM	1	off	off	off	0	0	off
ytcheng_90G0F_V4	5/18/2018	9:19:59 AM	Quality	83.1	83.1	structure	GO_90keV_Front_V4	CM	1	off	off	off	0	0	off
diego	5/17/2018	9:07:40 PM	Quality	98.5	93	structure	current_collectors-v2	CM	1	off	off	off	0	0	off
L5_20180517	5/17/2018	8:26:16 PM	Quality	58	58.5	structure	SIGe_TFET	CM	1	off	off	off	0	0	off
test4	5/17/2018	6:21:32 PM	Quality	80.1	44.4525	structure	Karen_Test4_wafer	CM	1	off	off	off	0	0	off
180517_XMON02m1	5/17/2018	3:37:18 PM	Quality	30	30	structure	20180516_XMON02_m1pp	CM	1	off	off	off	0	0	on
job_1002	5/17/2018	2:39:14 PM	Quality	10.553	10.5575	structure	SAMLargealignment	CM	1	off	off	off	0	0	off
job_1001	5/17/2018	2:38:21 PM	Quality	9.823	9.82398	structure	SAMGRectennafinal	CM	1	off	off	off	0	0	off

Edit

New Edit Save Delete

Comment

STEP I : FILE (DESIGN) CONVERSION

posure S Whats's This? Shift+F1

St About F1

Load Substrate

	Job_11291	No.	11291
[mm]		Height	

Click file and New

GUI HMT CONVERT ... 1.181

File Tools Help

Inspection

Alignment Info

Expose Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Align Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Progress Info

Exposure Status	
Design Number	of
Stripe Number	of
Time [hh:mm]	of
Remaining Time [hh:mm]	

Load Design

Characteristics

Name	01_Laura	
Source	01_Laura	
Design Type	Binary	
Mode	Quality	online
Layer / Cell	CM	
Magnification	1	
Mirror	off	
XOR	off	
Inverted	off	
CD Bias [nm]	0	0
Size [mm]	0.900	0.500
Borders l/r [mm]	-0.326	0.574
Borders b/t [mm]	-0.302	0.198
Offset [mm]	-0.326	-0.302
Auto Centering	off	

Load

Convert Design Load Cancel Refresh

Search

Search Clear

Show

all next 100

Name	Date	Time	mode	size X	size Y	source format	source file	Layer
01_Laura	5/19/2018	10:15:08 PM	Quality	0.900048	0.500048	structure	01_Laura	CM
01_wonjin_0519_loop	5/19/2018	9:35:38 PM	Quality	40.078099	29.98	structure	02_30micron	CM
bosch_dd2	5/19/2018	5:46:09 PM	Quality	11.9975	11.999	structure	bosch_dd2	CM
job_KD2	5/19/2018	3:57:49 PM	Fast	84.5	89.5	structure	KD_4inchlayout_20180518_pocket_flat	CM
nisi_strengthtest_scaled	5/19/2018	3:31:44 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM
2_Stopper	5/19/2018	6:53:40 AM	Quality	104	104	structure	2_Stopper	CM
nisi_strengthtest2	5/19/2018	2:38:05 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM
1_Gap_1st	5/19/2018	6:49:51 AM	Quality	104	104	structure	1_Gap_1st	CM
3_Gap_2nd	5/19/2018	6:55:47 AM	Quality	104	104	structure	3_Gap_2nd	CM
MMW_E241_6in_dense_v1	5/18/2018	7:49:04 PM	Fast	132.5	126.5	structure	MMW_E241_6in_dense	CM
MMW_E241_6in_v1	5/18/2018	7:13:27 PM	Fast	131.5	127.5	structure	MMW_E241_6in_new	CM
nisi_strengthtestwafer	5/18/2018	6:51:16 PM	Quality	85	90	structure	NiRingWafer_strengthtest	CM
AL0518NiFePt	5/18/2018	5:30:59 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21_NiFePt	CM
AL0518V2	5/18/2018	4:48:54 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM
AL0518	5/18/2018	4:46:13 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM
Training_05181802	5/18/2018	3:22:09 PM	Quality	11.704	9.309	structure	Training_05181802	CM
Training_051818	5/18/2018	3:20:11 PM	Quality	11.704	9.309	structure	Training_051818	CM
L5_20180518	5/18/2018	12:33:59 PM	Quality	58	58.5	structure	SiGe_TFET	CM
180518_XMON02m2	5/18/2018	12:07:38 PM	Quality	30.021886	30.025432	structure	20180518_XMON02_m2pp	CM

Edit

STEP I : FILE (DESIGN) CONVERSION

The screenshot displays the HIMT Viewer software interface. On the left, the 'GUI HIMT CONVERT' window is open, showing the 'VIEWER' button highlighted with a red dashed box. A red arrow points from this button to a circular inset showing a circuit design. Below the 'VIEWER' button, the 'Complete Tasks' button is also highlighted with a red dashed box. A red arrow points from this button to a black text box at the bottom right. The main window shows 'Exposure Info' with job details and a 'VIEWER' button. The bottom right corner shows system information like 'Total 51.5 [GB]' and 'Avai. 50.5 [GB]'.

1- Hit "Viewer" to check your design. Viewer is showing one of my loop design.

2- Hit "complete Task" and save your job , e.g. 01_Wonjin_0519_loop

STEP I : FILE (DESIGN) CONVERSION

Job Name: Job_11291

No.: 11291

Substrate Size [mm]:

Design Name:

Design Type:

Design Size [mm]:

Dose [mJ/cm²]:

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Exposure Status

Design Number: of

Stripe Number: of

Time [hh:mm]: of

Remaining Time [hh:mm]:

DMD	OK
Interferometer	OK
Window	OK
Write Head	Initialized
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Z Motor [Steps]	0
Piezo [Steps]	655
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.5
Chuck Vacuum [bar]	0.0
DMD Temperature [°C]	53
Laser Power [%]	100
Laser Wavelength [nm]	40

2- hit "Load"

Design

all
 next

99 / 2040 loaded

01_wonjin_0519_loop	
02_30micron	
Type	Binary
Quality	online
Cell	CM
magnification	1
inverted	off
CD bias X	0
CD bias Y	0
size X	40.078
size Y	29.980
l/r [mm]	-15.000
b/t [mm]	-14.980
entering	off

Name	Date	Time	mode	size X	size Y	source format	source file	Layer / cell	magnification	mirror	XOR	inverted	CD bias X	CD bias Y
aa	5/19/2018	10:24:32 PM	Quality	40.078099	29.98	structure	02_30micron	CM	1	off	off	off	0	0
01_Laura	5/19/2018	10:15:08 PM	Quality	0.900048	0.500048	structure	01_Laura	CM	1	off	off	off	0	0
01_wonjin_0519_loop								CM	1	off	off	off	0	0
nisi_strengthtest_scaled	5/19/2018	3:31:44 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM	1	off	off	on	0	0
2_Stopper	5/19/2018	6:53:40 AM	Quality	104	104	structure	2_Stopper	CM	1	off	off	off	0	0
nisi_strengthtest2	5/19/2018	2:38:05 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM	1	off	off	on	0	0
1_Gap_1st	5/19/2018	6:49:51 AM	Quality	104	104	structure	1_Gap_1st	CM	1	off	off	off	0	0
3_Gap_2nd	5/19/2018	6:55:47 AM	Quality	104	104	structure	3_Gap_2nd	CM	1	off	off	off	0	0
MMW_E241_6in_dense_v1	5/18/2018	7:49:04 PM	Fast	132.5	126.5	structure	MMW_E241_6in_dense	CM	1	off	off	off	0	0
MMW_E241_6in_v1	5/18/2018	7:13:27 PM	Fast	131.5	127.5	structure	MMW_E241_6in_new	CM	1	off	off	off	0	0
nisi_strengthtestwafer	5/18/2018	6:51:16 PM	Quality	85	90	structure	NiRingWafer_strengthtest	CM	1	off	off	off	0	0
AL0518NiFePt	5/18/2018	5:30:59 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21_NiFePt	CM	1	off	off	on	0	0
AL0518V2	5/18/2018	4:48:54 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM	1	off	off	on	0	0
AL0518	5/18/2018	4:46:13 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM	1	off	off	off	0	0
Training_05181802	5/18/2018	3:22:09 PM	Quality	11.704	9.309	structure	Training_05181802	CM	1	off	off	off	0	0
Training_051818	5/18/2018	3:20:11 PM	Quality	11.704	9.309	structure	Training_051818	CM	1	off	off	off	0	0
L5_20180518	5/18/2018	12:33:59 PM	Quality	58	58.5	structure	SiGe_TFET	CM	1	off	off	off	0	0
180518_XMON02m2	5/18/2018	12:07:38 PM	Quality	30.021886	30.025432	structure	20180518_XMON02_m2pp	CM	1	off	off	on	0	0
Canti3_1st	5/18/2018	10:28:21 AM	Quality	65	45	structure	Cantilever3-1	CM	1	off	off	off	0	0
Canti3_2	5/18/2018	10:29:33 AM	Quality	65	45	structure	Cantilever3_2nd	CM	1	off	off	off	0	0
ytcheng_90G0F_V4	5/18/2018	9:19:59 AM	Quality	83.1	83.1	structure	G0_90keV_Front_V4	CM	1	off	off	off	0	0
diego	5/17/2018	9:07:40 PM	Quality	98.5	93	structure	current_collectors-v2	CM	1	off	off	off	0	0
L5_20180517	5/17/2018	8:26:16 PM	Quality	58	58.5	structure	SiGe_TFET	CM	1	off	off	off	0	0
test4	5/17/2018	6:21:32 PM	Quality	80.1	44.4525	structure	Karen_Test4_wafer	CM	1	off	off	off	0	0
180517_XMON02m1	5/17/2018	3:37:18 PM	Quality	30	30	structure	20180516_XMON02_m1pp	CM	1	off	off	off	0	0
job_1002	5/17/2018	2:39:14 PM	Quality	10.553	10.5575	structure	SAMLargealignment	CM	1	off	off	off	0	0

1- click your job just created

STEP I : FILE (DESIGN) CONVERSION

Exposure Setup Info

- Setup Job
- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_11291	No.	11291
Substrate Size [mm]		Height	
Design Name	01_wonjin_0519_loo	Layer	FirstExp
Design Type	Binary	Convert	online
Design Size [mm]	40.1 x 30.0	Mode	Quality
Dose [mJ/cm ²]		Defoc	

Alignment Info

Expose Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Align Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Progress Info

Exposure Status	
Design Number	of
Stripe Number	of
Time [hh:mm]	of
Remaining Time [hh:mm]	

Hardware Info

X [mm]	0.092	Y [mm]	0.048
--------	-------	--------	-------

Status

DMD	OK
Interferometer	OK
Window	OK
Write Head	Initialized
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values

Z Motor [Steps]	0
Piezo [Steps]	65535
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.50
Chuck Vacuum [bar]	0.01
DMD Temperature [°C]	53
Laser Power [%]	100.0
Laser Wavelength [nm]	405

Setup Job

2- double click to select/specify wafer we are going to load

Job

Name	Number	Exposure Mode	New Job	Restart Job
Job_11291	11291	Standard	Load Job	Save Job

Substrate

Substrate Template	Shape	Size X	Size Y	Diameter	Thickness

- 1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.
 - 2) Substrate: Choose a Substrate template or shape.
 - 3) Layer: Select the Layer to expose. In the chosen Layer, select the Laser wavelength and load or create a Design. For overlay exposure, load Alignment template.
- Optional: In the chosen Layer select a Resist template.

Layer

Layer	Laser	Design	Mode	Size X [mm]	Size Y [mm]	Expose Crosses	Align Crosses	Resist	Thickness	Comment	Status	Dose	Defoc	Duration	Angle	Date
FirstExposure	405	01_wonjin_0519_loop	Quality	40.078	29.980						Prepared					

Now, your design is added.

Add Layer Delete Layer

Proceed

Load Substrate FirstExposure Unload Substrate

STEP I : FILE (DESIGN) CONVERSION

Setup Job

- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_11292	No.	11292
Substrate Size [mm]		Height	
Design Name	01_wonjin_0519_loo	Layer	FirstExp
Design Type	Binary	Convert	online
Design Size [mm]	40.1 x 30.0	Mode	Quality
Dose [mJ/cm²]		Defoc	

Alignment Info

Pos	X [µm]	Y [µm]
1		
2		
3		
4		
Positions		

Pos	X [µm]	Y [µm]
1		
2		
3		
4		
Positions		

Progress Info

Exposure Status		
Design Number		
Stripe Number		
Time [hh:mm]		
Remaining Time [hh:mm]		

Hardware Info

Status	
DMD	OK
Interferometer	OK
Window	OK
Write Head	Initialized
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values	
Z Motor [Steps]	
Piezo [Steps]	65
Stage Air Pressure	0
AF Air Pressure [bar]	-2
Chuck Vacuum [bar]	0
DMD Temperature [°C]	5
Laser Power [%]	10
Laser Wavelength [nm]	4

2- load

Load Substrate

Characteristics

Name	Wafer 4 inch
Shape	Round
Small [5...12 mm]	Standard
Size X [mm]	0.0
Size Y [mm]	0.0
Diameter [mm]	100.0
Thickness [mm]	0.5
Detection Offset [mm]	0.00
Marks	

dit

New Edit Save Delete

comment

Name	Date	Time	Shape	Size Type	Size x	Size y	Diameter	Thickness	Detection Offset	Marks	Comment
_Automatic rectangular	6/23/2016	6:41:38 AM	Rectangular	Small	0	0	0	0	0	Undefined	
_Automatic round	7/7/2016	12:45:50 AM	Round	Small	0	0	0	0	0	Undefined	
1 inch round	2/16/2017	4:14:51 PM	Round	Standard	0	0	25	3.5	0	Undefined	
Mask 2.5 inch	4/11/2016	2:11:12 AM	Rectangular	Standard	62.8	62.8	0	1.3	-0.35	Undefined	
Mask 4 inch	3/9/2016	6:00:47 AM	Rectangular	Standard	100.4	100.4	0	2	0	Undefined	
Mask 5 inch	4/11/2016	2:12:06 AM	Rectangular	Standard	125.5	125.5	0	3	-0.5	Undefined	
Small	4/5/2016	1:33:51 AM	Rectangular	Small	5	5	0	0	0	Undefined	
Wafer 2 inch	4/5/2016	1:28:36 AM	Round	Standard	0	0	50.8	0.28	0	Undefined	
Wafer 3 inch	4/5/2016	1:29:13 AM	Round	Standard	0	0	76.2	0.38	0	Undefined	
Wafer 4 inch	1/12/2017	11:06:44 AM	Round	Standard	0	0	100	0.52	0	Undefined	
Wafer 5 inch	7/15/2016	1:57:18 AM	Round	Standard	0	0	127	0.625	0	Undefined	
Wafer 6 inch	7/15/2016	1:57:07 AM	Round	Standard	0	0	152.4	0	0	Undefined	
Wafer 7 inch	7/15/2016	1:57:46 AM	Round	Standard	0	0	177.8	0	0	Undefined	
Wafer 8 inch	6/17/2016	4:49:50 AM	Round	Large	0	0	200	0	0	Undefined	

Show

all next 100 next

14 / 14 loaded

1- select 4-inch wafer if you are going to load 4-inch wafer

STEP I : FILE (DESIGN) CONVERSION

Exposure Setup Info

- Setup Job
- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_11292	No.	11292
Substrate Size [mm]		Height	
Design Name	01_wonjin_0519_loo	Layer	FirstExp
Design Type	Binary	Convert	online
Design Size [mm]	40.1 x 30.0	Mode	Quality
Dose [mJ/cm ²]		Defoc	

Alignment Info

Expose Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		
Positions		

Align Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		
Positions		

Progress Info

Exposure Status		
Design Number		
Stripe Number		
Time [hh:mm]		
Remaining Time [hh:mm]		

Hardware Info

X [mm]	0.092	Y [mm]	0.048
--------	-------	--------	-------

DMD	OK
Interferometer	OK
Window	OK
Write Head	Initialized
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Z Motor [Steps]	0
Piezo [Steps]	65535
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.50
Chuck Vacuum [bar]	0.01
DMD Temperature [°C]	53
Laser Power [%]	100.0
Laser Wavelength [nm]	405

Setup Job

2- keep "standard"

Job: Name Job_11292, Number 11292, Exposure Mode **Standard**

Substrate: Substrate Template **Wafer 4 inch**, Shape Round, Diameter 100, Thickness 0.52

1- confirm "4-inch = 100 mm wafer"

Layer	Laser	Design	Mode	Size X [mm]	Size Y [mm]	Expose Crosses	Align Crosses	Resist	Thickness	Comment	Status	Dose	Defoc	Duration	Angle	Date
FirstExposure	405	01_wonjin_0519_loop	Quality	40.078	29.980						Prepared					

1) Job: Load a Job or enter the name for a new Job. Select the Exposure Mode.

2) Substrate: Choose a Substrate template or shape.

3) Layer: Select the Layer to expose. In the chosen Layer, select the Laser wavelength and load or create a Design. For overlay exposure, load Alignment template.

Optional: In the chosen Layer select a Resist template.

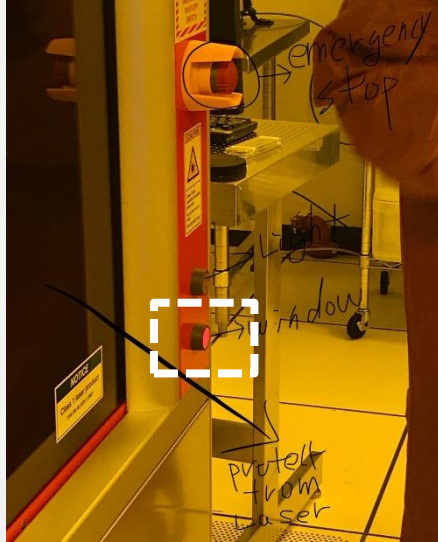
3- now you are ready to load wafer, do not hit "load substrate this step"

Proceed

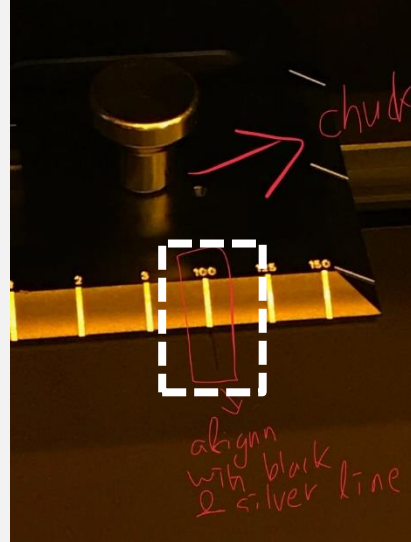
STEP 2 : LOADING WAFER + PARAMETER SETTING

- Material : 100 mm (4-inch) wafer
- Prerequisite :
 - Photoresist coating has been applied on the wafer
 - 2 mm EBR required

STEP 2 : LOADING WAFER + PARAMETER SETTING



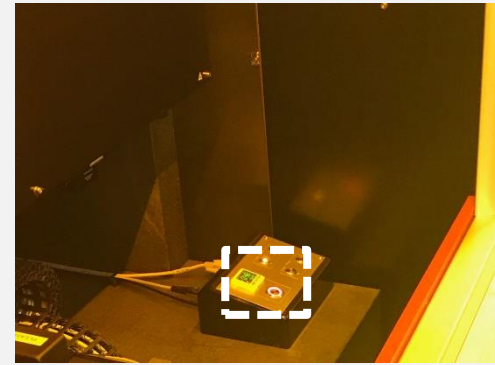
1- open window



2- place chuck (4inch = 100 mm mark aligned with mark on the stage)



3- load resist-coated wafer, flat bottom attached to the chuck , do not worried about precision of the wafer location (MLA-150 automatically detect the center of wafer)



4- push vacuum button to hold wafer in position



5 - get rid of chuck
6 - Close window



6 - Hit "load substrate" and hit "continue" in following screen so that the program automatically center the wafer.

STEP 2 : LOADING WAFER + PARAMETER SETTING

VILA 130I menu

File Tools User About

Exposure Setup Info

- Setup Job
- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_11300	No.	11300
Substrate Size [mm]	100.7	Height	0.5
Design Name	01_wonjin_0519_loo	Layer	FirstExp
Design Type	Binary	Convert	online
Design Size [mm]	40.1 x 30.0	Mode	Quality
Dose [mJ/cm ²]	90	Defoc	-2

Alignment Info

Expose Cross Positions		
Pos	X [μm]	Y [μm]
1	0	0
2		
3		
4		
Positions	1	

Align Cross Positions		
Pos	X [μm]	Y [μm]
1		
2		
3		
4		
Positions		

Progress Info

Exposure Status		Exposing	
Design Number	1	of	1
Stripe Number	262	of	409
Time [hh:mm]	0:03	of	0:04
Remaining Time [hh:mm]	0:01		

Hardware Info

Status	
DMD	OK
Interferometer	OK
Window	OK
Write Head	OK
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values	
Z Motor [Steps]	49812
Piezo [Steps]	34556
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.50
Chuck Vacuum [bar]	-0.48
DMD Temperature [°C]	54
Laser Power [%]	100.0
Laser Wavelength [nm]	405

First Exposure

Required

Design Name: 01_wonjin_0519_loop

Light Source [nm]: 405

Dose [mJ/cm²]: 90

Defoc [-10...10]: -2

Expose with substrate angle (13.89 mRad)

Expose Cross Positions

Expose the crosses

Auto-Unload Unload

Expose the first Layer:

- 1) Double-check Design Name, Light Source, Dose and Defoc.
- 2) Optional: To expose the design with the substrate angle, check 'Expose with substrate angle'.
- 3) Optional: Double-check the Expose Cross positions.
- 4) Start the exposure.

The design will be exposed at the zero position of the stage.
To set the current stage position to zero, click the 'Set Zero' button.

To expose the design with the found substrate angle, activate the

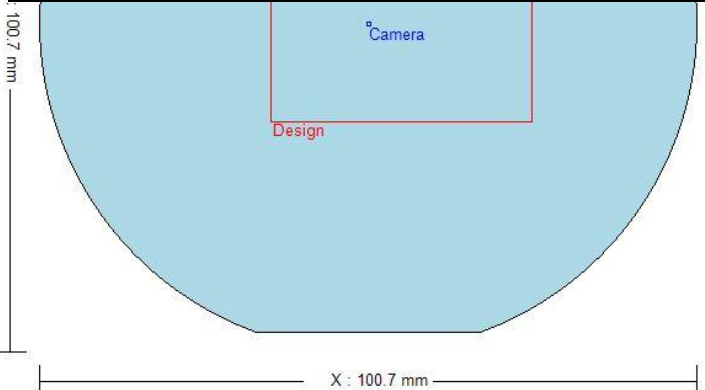
Comment

Proceed

▶ Start Exposure ◀ Back ✖ Cancel

1- Choose critical parameters, "dose" and Defocus.
For 1.6 μm thickness 3612 photoresist coating:
Light : 405 nm
Dose : 90
Defoc : -2

You can take a look at the log-book to see what settings lab member used for different photoresist and thickness.



2- optional, check if you want

3- Hit to start exposure

STEP 3 : EXPOSURE + UNLOAD

Exposure Setup | Info

- Setup Job
- Load Substrate
- Expose Job
 - First Exposure
 - Alignment
 - Series
 - Draw Mode
 - Inspection

Exposure Info

Job Name	Job_8939	No.	8939
Substrate Size [mm]	100.7	Height	0.6
Design Name	job_won	Layer	FirstExp
Design Type	Binary	Convert	online
Design Size [mm]	64.4 x 60.0	Mode	Quality
Dose [mJ/cm ²]	95	Defoc	-2

Alignment Info

Expose Cross Positions

Pos	X [μm]	Y [μm]
1	0	0
2		
3		
4		

Align Cross Positions

Pos	X [μm]	Y [μm]
1		
2		
3		
4		

Progress Info

Exposure Status	Exposing		
Design Number	1	of	1
Stripe Number	591	of	654
Time [hh:mm]	0:08	of	0:09
Remaining Time [hh:mm]	0:01		

Hardware Info

X [mm]	Y [mm]
0.000	0.000

Status

DMD	OK
Interferometer	OK
Window	OK
Write Head	OK
Stage	OK
Cameras	OK
Laser	OK
Conversion	OK

Numeric Values

Z Motor [Steps]	49539
Piezo [Steps]	33632
Stage Air Pressure	OK
AF Air Pressure [bar]	-2.50
Chuck Vacuum [bar]	-0.50
DMD Temperature [°C]	54
Laser Power [%]	100.0
Laser Wavelength [nm]	405

1- Exposure in progress

First Exposure

Required

Design Name: job_won
Light Source [nm]: 405
Dose [mJ/cm²]: 95
Defoc [-10...10]: -2

Expose with substrate angle (2.80 mRad)

Expose Cross Positions

Expose the crosses

Auto-Unload

Expose the first Layer:

- 1) Double-check Design Name, Light Source, Dose and Defoc.
- 2) Optional: To expose the design with the substrate angle, check 'Expose with substrate angle'.
- 3) Optional: Double-check the Expose Cross positions.
- 4) Start the exposure.

The design will be exposed at the zero position of the stage. To set the current stage position to zero, click the 'Set Zero' button.

Comment

Substrate

Y : 100.7 mm

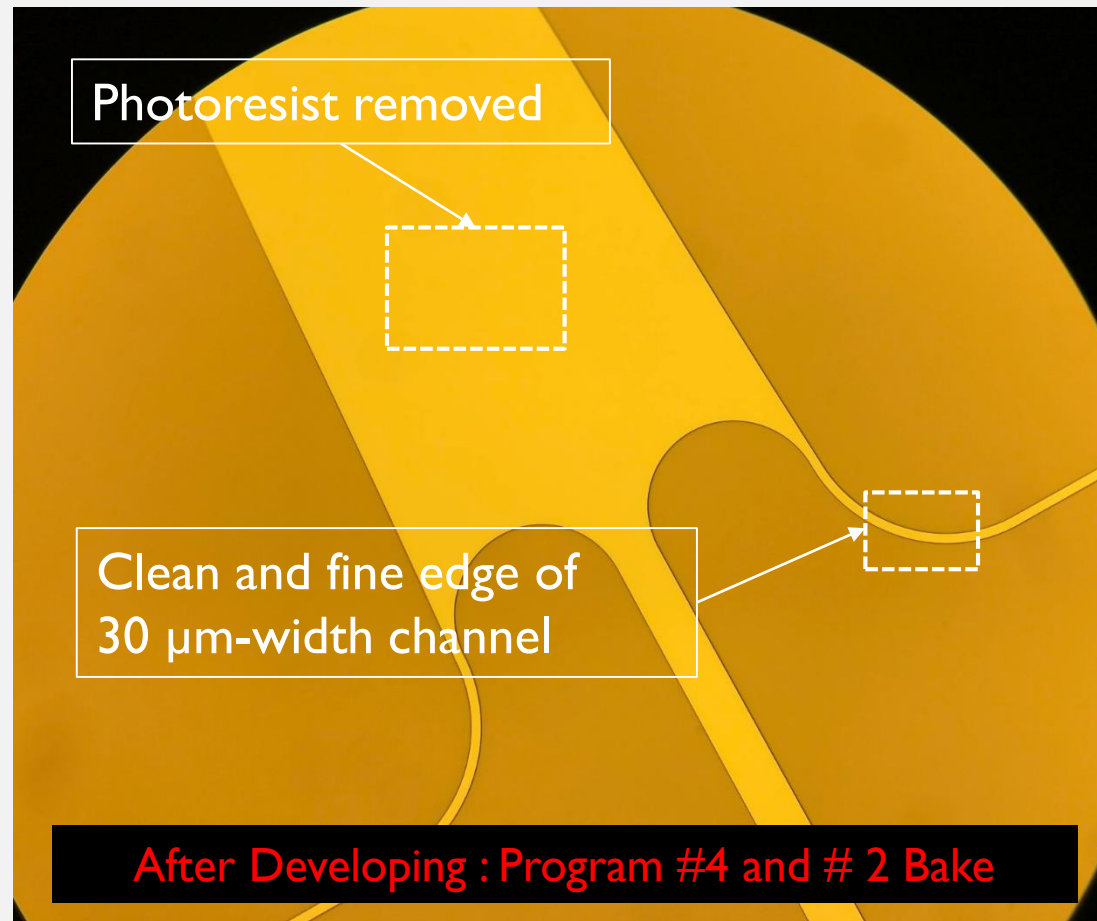
Camera

Design

Proceed

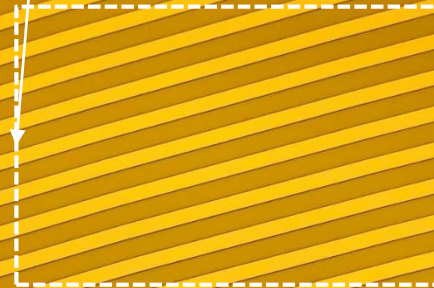
2- After exposure process is done, release vacuum and unload wafer
3- your wafer is now ready for the normal developing process

QUALITY CHECK OF EXPOSURE & DEVELOPING



QUALITY CHECK OF EXPOSURE & DEVELOPING

Successfully developed 30 μm -width loop
channel without any channel blocking



After Developing : Program # 4 and # 2 Bake