R·I·T

Title: ASML Stepper

Semiconductor & Microsystems Fabrication Laboratory **Revision: D** **Rev Date: 05/23/2022**

Approved by:

____________________/ / ______________________/ /

Process Engineer Equipment Engineer

1 SCOPE

The purpose of this document is to detail the use of the ASML PAS 5500 Stepper. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS

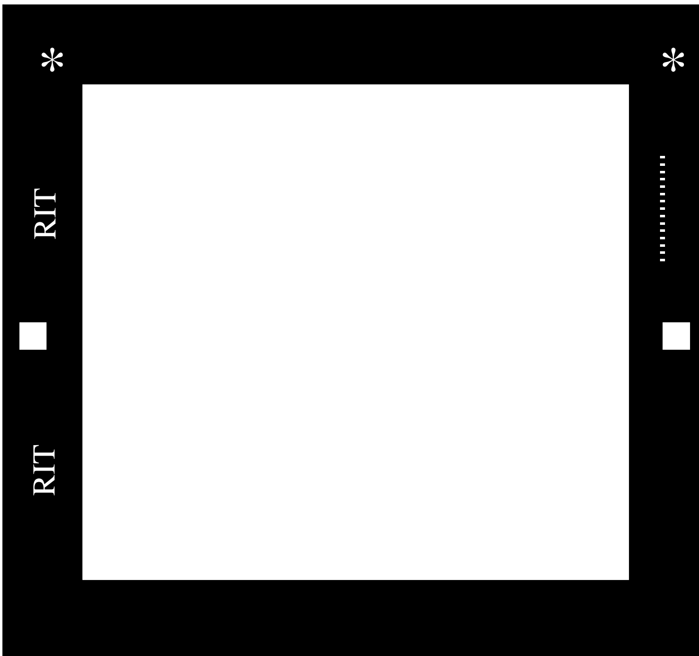
Batch Control PAS 5500 Training Module
Reticle Design Manual
PAS 5500 User Guide
PAS 5500 Job Definition
PAS Global Alignment Strategies
PAS 5500 Steppers up to and including /300 Stepper Introduction

3 DEFINITIONS

n/a

4 TOOLS AND MATERIALS

4.1 **General Description -** The ASML PAS 5500/200 is a 5x reduction, i-line stepper set up for exposure of 6 inch wafers using 6 inch reticles. The system has 350nm resolution with a 0.48-0.60 variable numerical aperture. The maximum field size on the wafer is 22x22mm. Overlay capability is better than 50nm. All lithography levels for a particular design are included in a single stepper job.



← Reticle Pre-Alignment Marks

← Reticle Barcode

← Reticle Alignment Marks

4.2 **Reticle Bar Code** – The reticle barcode is read as the reticle is removed from the reticle carrier. Reticle bar code information is specified in the stepper job.

4.3 **Reticle Pre-Alignment Marks –** Two Pre-alignment Marks are located 135.5mm apart near the corners of the reticle. They are used to pre-align the reticle to the reticle table.

4.4 **Reticle Alignment Marks** - Two Reticle Alignment Marks, M1 and M2, are located 139mm apart near the left and right edges of the reticle. After the reticle is pre-aligned on the reticle table, the Reticle Alignment Marks are aligned to the permanent fiducial marks F1 and F2, located on the fiducial plate on the wafer table.

4.5 **Wafer Zero Level –** The ASML Stepper utilizes zero level marks that are patterned and etched into the wafer before any other steps. An etch depth of 1200A +/- 10% allows the stepper to recognize the marks. It is possible to pattern the zero level at the same time as the first level, but overlay accuracy will be reduced since the first level is not aligned to the zero level. This is because the zero level is defined by a separate reticle.

4.6 **Wafer Global Alignment** - The wafer alignment marks W1, W2, etc, are exposed on the zero layer and etched into the wafer. Two of these marks are sufficient but up to 25 may be used on a single wafer. If more than two marks are used, the stepper will find a best alignment and expose all die using the same settings. The stepper uses through the lens alignment of the wafer and the reticle.

4.7 **Wafer Field by Field Alignment** – This method uses marks that are part of the CAD data for each mask layer; they are not exposed individually. These marks may be placed in the scribe lanes. Field by field alignment takes longer than global alignment because each die is aligned.

5 SAFETY PRECAUTIONS

5.1 Hazards to the Operator

5.1.1 **Ultraviolet Light** - The ASML uses ultraviolet light as well as lasers, and should only be operated with all of the covers closed. Safety glasses should be worn at all times.

5.1.2 **Mechanical Hazards** - The ASML stepper has mechanical hazards. Do not operate with open covers and do not open any covers during operation.

5.2 Hazards to the Tool

5.2.1 **Stage Damage** - Never open or service the wafer stage since serious damage to the tool can occur.

5.2.2 **Stuck Wafers** - Never manually remove stuck wafers from the system. Please contact the tool technician.

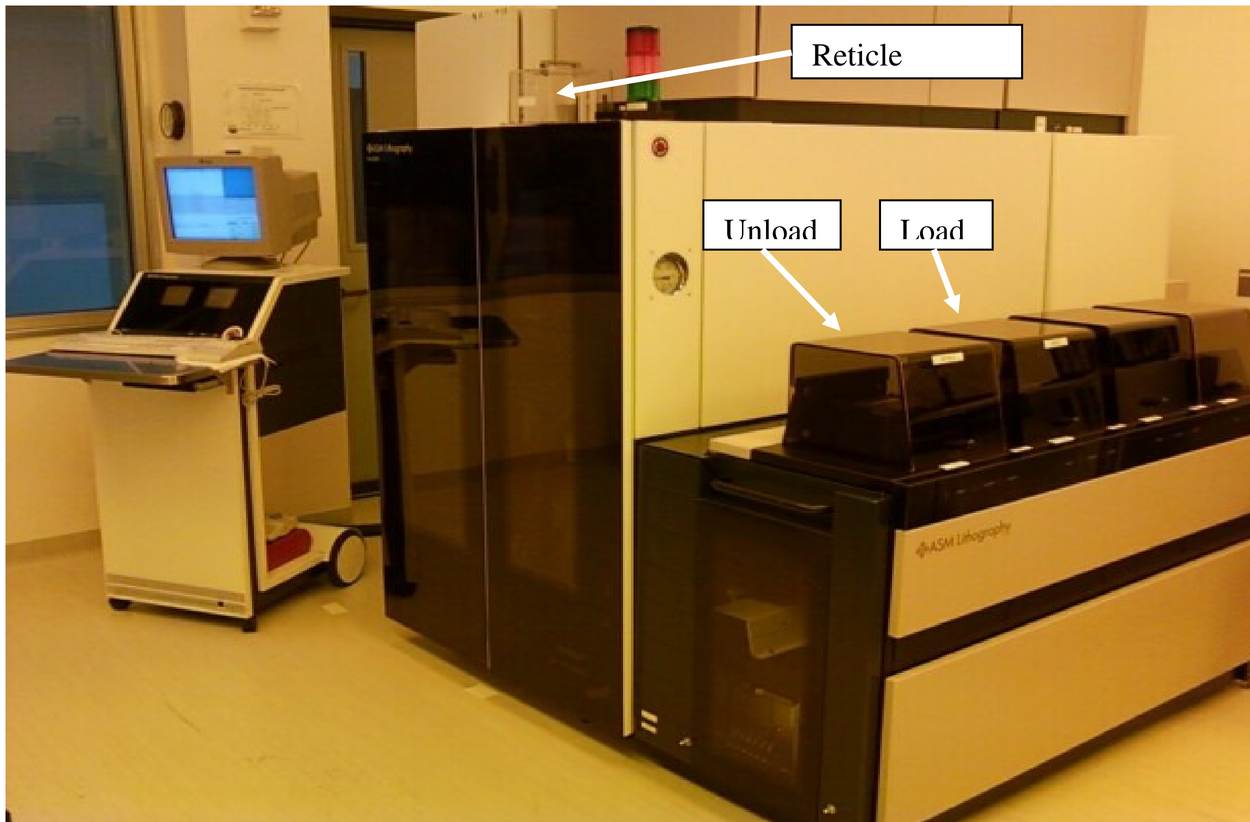
5.2.3 **Reticle Loading** - Reticle changing should only be done by a certified user. Use care not to touch the surface of the reticle. If alignment marks become obscured, the stepper will not be able to find them. Additionally the reticle pod must be correctly closed.

5.2.4 **Reticle Pod Placement** – Use care to support the reticle pod when placing it on the tool. If not properly clamped, the top can separate from the base and end up on the floor.

5.2.5 **Combi Reticle** - Do not remove the Combi reticle from the SMIF pod. It is fragile and expensive to replace.

5.2.6 **Contamination** - Wafers must have clean backs. This will keep the stage clean and prevent errors.

5.2.7 **Wafer Handler Damage** - Do not remove a carrier that is not fully raised.



6 INSTRUCTIONS

6.1 Starting the System

6.1.1 Swipe the tool in on the Card Swipe System.

6.1.2 In the service chase behind the tool, make sure the ASML N2 is on and the ASML vacuum pump is on.

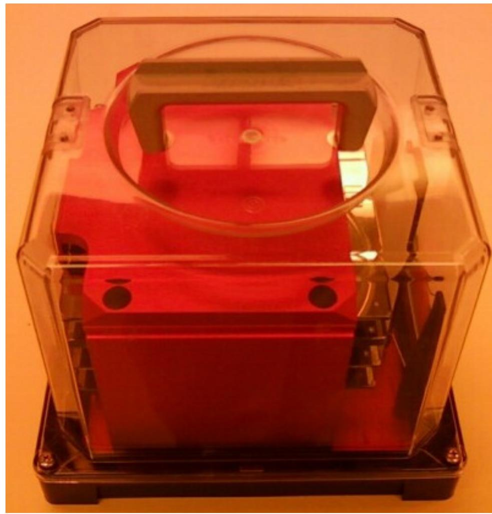
6.1.3 Make sure that the computer is on the **Main Menu**, if not select **0 Exit**. Do *not* exit from the **Main Menu**.

6.1.4 The first person to use the tool should do a **Full Shutdown** and then a **Full Startup** to clear out any errors in the system.

1-Start-Up/ Shut-Down

3-Shut-Down (Full) and select **Start**

2-Start-Up (Full) and select **Start**



6.2 Loading the Reticles

6.2.1 To remove the reticle box from the machine, under select **Mat Hdl** from the top of the screen and then **3 – Exchange Reticle Box**. Click the **Unlock** button in the middle of the screen to unlock the reticle box.

6.2.2 Remove the box by lifting straight up 2 cm, tilting the front up and moving it away from the stepper at a 45 degree angle. *Always support the reticle box on the bottom to prevent reticles from falling out*.

6.2.3 Carefully open the reticle box. The clear top is released from the base by sliding the 4 clamps underneath the base. Load the reticles chrome side down with the pre-alignment stars facing out. Never touch the surface of a reticle. Close the reticle box and make sure it is secured before lifting. Do not remove the Combi Reticle from the top slot. The bar that holds the reticles in place must be in the down position or an error will result.

6.2.4 To load the reticle box, lower it straight down without tilting it. The open side of the internal cassette should be towards the stepper.

6.2.5 Select the **Read 1** button to read the barcodes and display the reticle IDs.

6.2.6 If your reticles do not have bar codes, use the **Specify** button to enter reticle IDs and then the **Apply** button to confirm. This will have to be done each time the reticles are loaded into the machine.

6.2.7 When finished, the reticle box should be stored on the stepper.

6.2.8 Press **Cancel** and **Exit** back to the **Main Menu**.

6.3 Loading Wafers

6.3.1 Lift the cover to the loader and place the cassette of wafers on the stage. Make sure that the cassette is properly seated. The loader and receiver stations will be labeled and may occasionally vary.

6.3.2 Place an empty cassette on the receiver. All 4 stations must have a cassette.

6.4 Defining a Batch and Running a Stepper Job

6.4.1 From the **Main Menu**, select **2- Batch Control** and **1 – Define Batch**.

6.4.2 The **Batch ID** is the name that you use to identify your wafers.

6.4.3 The **Job Name** is the name of the stepper job that you want to use. Click the **Select** button, scroll down, select the job and **Accept** at the top of the screen. Writing a stepper job is detailed in a separate document.

6.4.4 Click on the line to the right of **Layer ID**. Select the Layer Number that you want to expose when the box comes up. Layer number zero is used for exposing the alignment marks onto the wafer. See attachments for more information on the zero level.

6.4.5 The **Control Mode** may be set to **W** or **C**. A setting of **C** will expose all of the wafers in the cassette. A setting of **W** will only expose the number of wafers that you specify.

6.4.6 The **Batch Size** is the number of wafers or cassettes that you want to expose.

6.4.7 Under **Batch Type** select **P** for production. **F** will allow you to do a focus meander, **E** will allow you to do an energy meander and **M** will allow you to do a matrix.

6.4.8 Under **Process Data** you may adjust exposure energy, focus and tilt settings. The minimum energy is $40 mJ/cm^2$. Under **Illumination Mode** select either conventional or annular. Numerical aperture and sigma may be specified. After changing any of these values you must select the **Apply** button for the changes to take effect.

6.4.9 The **Clear** button at the bottom of the screen will clear all of the entries and allow you to start over.

6.4.10 The **Run** button will start the batch. Wafers will automatically load, align, expose and unload.

6.4.11 If you would like to expose a coated test wafer without alignment, select **F**, **E** or **M** under **Batch Type** to enter a non-production mode. If you do not want any variation, set the increment to zero. Next select the **Alignment Button** and choose **None** for alignment. When you run the job, the stepper will expose a blank wafer with no marks. This is useful to verify a stepper job or new reticle on test wafer.

6.5 Unloading Wafers

6.5.1 Lift the cover on the output cassette and remove the wafers. *Do not remove a carrier that is not fully raised.*

6.5.2 Place the empty cassette back on the tool. All 4 stations should have a cassette.

6.6 Unloading Reticles

6.6.1 To remove the reticle box from the machine, under **Main Menu**, select **Mat Hdl** from the top of the screen and then **3 – Exchange Reticle Box**. Click the **Unlock** button in the middle of the screen to unlock the reticle box.

6.6.2 Remove the box by lifting straight up 2 cm, tilting the front up and moving it away from the stepper at a 45 degree angle. *Always support the reticle box on the bottom to prevent reticles from falling out.*

6.6.3 Carefully open the reticle box. Unload the reticles. Never touch the surface of a reticle. Close the reticle box and make sure it is secured before lifting.

6.6.4 Replace the reticle box on the stepper by lowering it straight down without tilting it. The open side of the internal cassette should be towards the stepper. The reticle box should be stored on the stepper when finished.

6.6.5 Exit back to the **Main Menu**.

6.7 Resetting the System

6.7.1 To remove all wafers from the machine, select **Batch Control** from the **Main Menu**, select **Mat Hdl** from the top of the screen and then **2 – Remove Wafers from Machine**. Never manually remove stuck wafers from the machine.

6.8 Errors during Run

6.8.1 If any errors occur contact the equipment engineer.

6.9 Introducing a Layer Shift

6.9.1 Select **Process Data** in your stepper job to enter a layer shift in microns. See Section 6.8 of the **ASML PASS 5500 Job Creation Manual.**

7 APPROPRIATE USES OF THE TOOL

7.1 No backside coated wafers, only wafers with clean backs may be processed in this tool.

7.2 No polyimide or SU8 may be processed in this tool.

8 ATTACHMENTS

8.1 Dose to Clear Test (Exposure Matrix)

8.1.1 This is a quick test that is done without a job. A mask is optional and can be specified at the prompt.

8.1.2 From the **Main Menu** select **6-Test Manager**.

8.1.3 Select **1-Run Test**.

8.1.4 Move to the top of the directory by clicking **Up**.

8.1.5 Select **Illumination System**.

8.1.6 Select **Performance Tests**.

8.1.7 Select **Resist Uniformity**.

8.1.8 Select **Accept** at the top of the screen.

8.1.9 Input the **Nominal Energy**, the **Energy Increment** and the **Window Size**. Be sure to hit return after each entry.

8.1.10 Select **Accept**.

8.1.11 One wafer will be exposed with the nominal exposure in the center of the wafer. The remaining exposures will be divided up above and below this. When the wafer is finished, a report will come up and show the exposure pattern.

8.1.12 When finished select **Exit** twice to return to the **Main Menu**.

8.1.13 A dose to clear test can also be done in the screen used to define a batch.

8.2 FEM (Focus/ Exposure Matrix)

8.2.1 The **FEM** is a special test that uses one of the Resolve reticles. The **Resolve-21** is usually left in the reticle pod. Other reticles will not work with this test.

8.2.2 From the **Main Menu** select **6-Test Manager.**

8.2.3 Select **1-Run Test.**

8.2.4 Move to the top of the directory by clicking **Up**.

8.2.5 Select **Projection Systems**.

8.2.6 Select **FEM Developer/Customer**.

8.2.7 Select **Accept** at the top of the screen.

8.2.8 Input desired values for matrix size, energy, increment, focus and the number of die to be exposed. Each die is a complete focus/ exposure matrix.

8.2.9 Select **Accept**.

8.2.10 When finished select **Exit** twice to return to the **Main Menu**.

8.2.11 A Focus/Exposure test can also be done in the screen used to define a batch.

8.3 Running RIT Daily

8.3.1 From the **Main Menu** select **6-Test Manager**.

8.3.2 At the top of the dialog screen select **CMD HDL**.

8.3.3 From this screen select **8-Contamination and Temperature Control**.

8.3.4 Select **2-Sensor Module Commands**.

8.3.5 Select **4-Monitor All Sensor Values**.

8.3.6 Ensure that the **Lens Temperature** is 22.01C (+/- 0.02C).

8.3.7 Select **Cancel** at the top of the screen.

8.3.8 Select **Exit** 3 times to return to the **Test Manager** menu.

8.3.9 Select **3 - Run Test Que**.

8.3.10 Select **Select**.

8.3.11 Scroll down until you see **daily RIT**. Characters are case sensitive.

8.3.12 Select **Accept** at the top of the screen.

8.3.13 Select **Accept** again and the test will run.

8.3.14 Select **Exit** twice to return to the **Main Menu**.

8.4 Procedure for Creating a Zero Level

8.4.1 The Zero Level is usually created with the Combi Reticle. Some customer reticles will have the appropriate marks for the zero level included.

8.4.2 Select your stepper job.

8.4.3 Select **Layer ID**.

8.4.4 Select **Zero Layer** to expose your marks.

8.4.5 Develop and bake the resist.

8.4.6 Plasma etch the zero level marks using the ZEROETCH recipe on one of the dry etchers. The marks should be 1200Å +/- 10%.

8.4.7 Strip the photoresist.

REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	Sean O'Brien	A-07/20/2010
Clarified some of the instructions	Sean O'Brien	B-12/21/2010
Improved format and clarified some sections, added 6.4.11	O'Brien/Meller	C-04/20/2020
Clarified shutdown/ startup procedure	O'Brien	D-05/23/2022