Canon

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FPA-2500i3

(With Auto Iris Aperture)

STANDARD SPECIFICATION

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Canon Europa N.V.

Semiconductor Equipment Division
Application Engineering Department

Canon FPA-2500i3 Standard Specifications

[1] Function Features

Item	Specifications	Remarks
1. Reticle		
1) Size	□ 6", 0.25"t	□ 5", 0.09"t (Option)
2) Material	Quartz	
3) Film	2-layerd Cr, or 3-layerd Cr	
4)Pellicle Frame	Pattern side attachable Frame height Max. 6.3 mm (Pattern side)	
2. Wafer		
1) Size	6", 8"	SEMI standard. (JEIDA ; 6") 4"and 5" ; Option
3. Projection Optics		
1) Magnification	x 1/5	
2) NA	0.60 – 0.45	3 pre-set positions, Switchable from Console.
3) Image Field Size	a) 6" Reticle ϕ 28.28 mm (□ 20 mm to 26.0(V) x 11.1 (H) mm) b) 5" Reticle □ 20.0 mm to 22.5(V) x 17.1(H) mm □ 20.0 mm to 20.6(V) x 19.4(H) mm	 Without pellicle With pellicle
4) Exposure Light	i-line	
5) Lens Magnification auto compensation range	Nominal Pressure ±30 mb	
4. Illuminator		
1) Light Source	1.5KW super high pressure Hg Lamp	
2) Coherent Factor	0.3 – 0.7	
2) Exposure time control	Light Integrator	
3) Masking Function	Variable with 4 independent blade	
4) Illumination mode	Normal SIA (Super Illumination Type A) SIB (Super Illumination Type B)	 Option Option
5. Reticle Auto Alignment		
1) Light Source	i-line	
2) Method	i-line Illumination TV image processing	
6. Wafer Auto Alignment		
1) Light Source	a) HeNe Laser b) Broad Band (Halogen Lamp)	
2) Method	TTL Off Axis Auto Alignment	
3) Mode	AGA	

Item	Specifications	Remarks
7. Auto Focus		
1)Method	Optical Auto Focus Method (CCD OPTF)	
8. Wafer Leveling	a) Die by Die Leveling b) Global Leveling	
9. Mechanical Prealignment	Non edge contact method.	
10. TV Prealignment	TV Image processing method.	
11. Wafer Feeding		
1) Method	Non edge contact, back side holding Wafer In-Out method.	Type-IV AF
2) Carrier	Double cassetes.	
12. Reticle Changer		
1) Type	6" Reticle changer	5" R/C ; Option
2) Capacity	14 reticles (+15 reticles using optional library)	6" R/C only.

[2] Performance Specifications

Item	Specifications	Remarks
1. Exposure Performance		
1) Resolution		PFI-26, 1.025 μmt
Normal Illumination	0.40 μm or better	
SIA Illumination	0.35 μm or better	
SIB illumination	0.40 μm or better	
2) CD Depth of Focus		
Normal Illumination	≥ 1.0 μm (Range)	0.40μm L&S
SIA Illumination	≥ 1.2 μm (Range)	
SIB Illumination	≥ 1.4 μm (Range)	
3) Image Surface Width (Normal Illumination)	≤ 0.50 μm	
4) Distortion		Including magnification
Normal Illumination	Within ±0.07 μm	
SIA Illumination	Within ±0.08 μm	
SIB Illumination	Within ±0.08 μm	
2. Illuminator		
1) Illumination Intensity		
Normal Illumination	≥ 550 mw/cm2	
SIA Illumination	≥ 330 mw/cm2	
SIB Illumination	≥ 330 mw/cm2	
2) Illumination Uniformity		
Normal Illumination	Within ±1.2%	
SIA Illumination	Within ±1.5%	
SIB Illumination	Within ±1.5%	
3) Dose control accuracy	≤ ±1.2%	
4) Masking Accuracy	≤ ±100 μm	On wafer except grey zone.
3. Alignment Accuracy		
1) Reticle Rotation Accuracy	≤ ±0.02 μm	
2) Reticle Rotation Repeatability	≤ ± 0.03 μm (Range)	
3) Alignment Accuracy		
a) HeNe TV AGA	≤ 0.07 μm (| m | + 3s)	With AGA improvement kit
b) Broad Band TV AGA	≤ 0.07 μm (| m | + 3s)	
4. Auto Focus		
1) Repeatability	≤ 0.12 μm (3s)	
5. Die by Die Leveling		
1) Repeatability	≤ 10 ppm (3s)	
2) Compensation Range	≤ ± 100 ppm	

Item	Specifications	Remarks
6. XY Stage Accuracy		
1) Stepping Accuracy	≤ 0.06 μm (3s)	
2) Scaling	≤ ± 1.0 ppm	
3) Orthogonality	≤ ± 1.0 ppm	
7. Prealignment Accuracy		
1) Mechanical PA Accuracy	≤ ± 40 μm	
8. Throughput		Expo time = 0.16 sec.
1) L-Type Auto Feeder		AGA Sub=4, Main=8
a) With D/D Leveling OFF	6" (45shots) : 62 wafers/Hr or more	No. of shots = 44 shots
	8" (78shots) : 44 wafers/Hr or more	
b) With D/D Leveling ON	6" (45shots) : 57 wafers/Hr or more	
	8" (78shots) : 40 wafers/Hr or more	
2) R-Type Auto Feeder		
a) With D/D Leveling OFF	6" (45shots) : 61 wafers/Hr or more	
	8" (78shots) : 44 wafers/Hr or more	
b) With D/D Leveling ON	6" (45shots) : 56 wafers/Hr or more	
	8" (78shots) : 40 wafers/Hr or more	
11. Reliability		
1) Reticle Handling	No trouble with 50 cycles.	
2) Wafer Handling	No trouble with 300 cycles.	
12.Compact Chamber		
1) Temperature control	Booth ; 21°C, Stage ; 23 °C	
2) Cleanliness	Within ±0.1°C	

1. Image Optical System

(1). *Resolution*

0.40μm line and space pattern must be resolved in both H and V directions over the entire field. To be confirmed according to D.O.F. result in 1-(2).

(2). *Depth of Focus*

Nominal 0.40 μm lines and spaces must be resolved with a depth of focus of 1.0 μm range or more. (Common depth of focus for 9 points in □ 20 mm.)

1). Reticle : Canon No. 710 (or equiv.)
2). Wafer : Bare Silicon
Flatness : less than 0.2 μm in any □ 20 mm area
3). Resist : Positive resist PFI-26 1.025 ± 0.005μmt
4). PEB : 110°C x 60 sec.
5). Develop : NMD-W (or equiv.)
6). Exposure Dose : Minimum line-width should be 0.40 ± 0.01 μm (Nominal 0.40 μm) within a shot at best focus.
7). Method :

1. Find an optimum exposure amount with a sample wafer.
2. Expose another wafer in a Focus Exposure Matrix, in which the focus in each shot is incremented by 0.2 μm for five different exposures, two on either side of the exposure .
3. After development, select the optimum exposure dose and measure the bottom line width of 0.40 μm line pattern (Island) at 9 points in the field, at each of the focus values.
4. Plot the CD value against focus and obtain 4th order fitting curve at all of image height.
5. Determine DOF at each point by slicing the curve at Min. line width + 0.08 μm.
6. Determine common DOF of all measurement points (9points).

(3). *Image Surface Width*

1). Condition : Same as Depth of Focus Test
2). Method :

1. Use the DOF sample wafer.
2. Measure both bottom and top line width of 0.40 μm line pattern (island) then calculate the T/B value.
   T/B = (Top line width) / (Bottom line width)
3. Plot the T/B value against focus and obtain 4th order fitting curve at all of image height.
4. Determine the best focus value at each point by slicing the curve at T/B=45%.
5. Calculate range of the best focus value as image surface width.

(4). *Distortion (including magnification)*

± 0.07 μm (Δ x, Δ y) or less for 25 points (Pitch 4.725 mm) in shot of □ 20 mm image size.

1). Reticle	: Canon No. 605–01 (or equiv.)
2). Wafer	: Bare Silicon Flatness : less than 1.0 μm / □ 20 mm
3). Resist	: PFI–26 1.025 ± 0.02μmt
4). PEB	: 110°C x 60 sec.
5). Develop	: NMD–W (or equiv.)
6). Measurement	: Vernier reading (or auto measurement tool) 25 points/ □ 20 mm, 4shots average
7). Method	: 1st expose the full 20mm x 20 mm field. 2nd expose using only the vernier of the reticle centre. The 1st and 2nd exposures to be made using a patch job.

2. Illumination Optical System

(1). Uniformity

± 1.2% or less for □20 mm at the wafer surface.

1). Measuring instrument	: Illumination uniformity checker built in FPA–2500i3. (AUX IUC Command.)
2). Measuring area	: X = ±10 mm, Y= ±13 mm
3). Measuring pitch	: X = 1.0 mm, Y = 1.3 mm

(2). Image Surface Illumination Intensity

Intensity at the wafer surface must be 550 mW/cm^2 or more.

1). Measuring instrument	: Illumination uniformity checker built in FPA–2500i3 (AUX IUC Command.).
2). Lamp	: Within 50 hours of use after installation of a new lamp.

(3). Integrated Exposure Light Control Accuracy

Total accuracy of the integrated exposure light accuracy on the wafer is within 1.2% when LI value is set so that the actual exposure time is 80, 250,500 and 1000 msec.

1). Measuring equipment : Illumination uniformity checker built in FPA-2500i3.
2). Measuring point : Center of the exposure effective area.
3). Measuring Method : Illumination measurement program to be used (LIRC command).

4). LI setting value : Illumination intensity (mw/cm^2) x Actual exposure time.

5). Calculation formula : $\text{Repeatability} = \frac{Emax - Emin}{Emax + Emin}$

$$\text{Error} = \frac{Emean}{LI} - 1 \times 100$$

Emax = maximum value of measured exposure amount (mj/cm^2)

Emin = minimum value of measured exposure amount (mj/cm^2)

Emean = average value of measured exposure amount (mj/cm^2)

LI = LI setting value (mj/cm^2)

$$\text{Linearity} = \frac{\text{Max. Error} - \text{Min. Error}}{2}$$

Total accuracy = Repeatability + Linearity

(4). Masking Accuracy

Masking blade edge should be within ± 100 μm of target, when four independent masking blades are set on vernier on reticle (placed 4.4 mm, 5.5 mm, and 9.0 mm from reticle center on wafer) and when the edges of each blade are exposed on the wafer and read using the two verniers on each side of the ±4.4 mm, ±5.5, and ±9.0 mm respectively.

Reticle	: Canon made 605-01 (or equiv.)
Wafer	: Bare Silicon
Resist	: PFI-15. 1.025 ± 0.02 μmt
Setting values of blades	: Bl = -2.2, -5.5, -9.0
	Br = +2.2, +5.5, +9.0
	Bu = +2.2, +5.5, +9.0
	Bd = -2.2, -5.5, -9.0
Measuring points	: Two verniers on each side of □4.4 mm, □11.0 mm □18.0 mm.

3. Auto Alignment

(1). Auto Alignment Accuracy / AGA

Carry out auto alignment exposure of Resist to Resist in AGA mode, then measure the shift in X and Y by verniers or an auto measurement tool.

1). Reticle	: Canon No605-01 (or equiv.)
2). Wafer	: Bare Silicon. Flatness ≦ 1.0 mm / □20 mm
3). Resist	: PFI-15 1.025 μm t.
4). Alignment mode and mark	: He-Ne ; Multi mark with θ Compensation OFF.
	: B^2 ; Multi mark with θ Compensation OFF.
5). Measuring shot (AGA)	: Sub = 4, Main = 8.
6). Measuring points	: 2 points / shot, 28 shots / wafer. (6" wafer)
	2 points / shot, 52 shots / wafer. (8" wafer)
7). Number of wafers	: 5 wafers
8). Judgement	: Obtain mean and 3σ value of (xl+xr)/2, and (yl+yr)/2 of 5wafers total.
	The | m | + 3σ must be ≦ 0.07 μm.

4. Auto Focus System

(1). Auto Focus Repeatability

The deviation of the focus value of each shot must be ≤ 0.12 μm (3σ), when remeasuring the focus value after focus compensation and 100 msec delay time.

1). Reticle : Any.
2). Wafer : Bare Silicon without P.R. Flatness ≤ 1.0 μm / □20 mm
3). Measuring points : 5 points in a shot, and taking average of 5 data as focus data , but only data from shots where the five focus sensors are in the valid area are used for the calculation.
Number of shots ≥ 32 shots.
4). Measuring methods : Data Acquisition mode. (Auto focus data)

(2). Die by Die Leveling Repeatability

Use 1st mask mode to expose the wafer. Perform auto focussing and after 100 msec delay time, remeasure the remaining tilt for each shot in both X and Y directions. The 3s X and Y must be ≤ 10 ppm.

1). Reticle : Any.
2). Wafer : Bare Silicon without P.R. Flatness ≤ 1.0 μm / □20 mm
3). Measuring points : 5 points in a shot, and taking average of 5 data as focus data , but only data from shots where the five focus sensors are in the valid area are used for the calculation.
Number of shots ≥ 32 shots.
4). Measuring methods : Data Acquisition mode. (Auto focus data)
5). Method : Obtain 3σ of tilt amount in X and Y directions using data from shots where all five focus sensors are inside the valid area.

5. X-Y Stage

(1). Accuracy (Adjacent shots over-lapping method)

Check XY stage driving accuracy by adjacent shot overlapping method.

1) Reticle	: No. 605-01 (or equiv.)
2) wafer	: Bare Si. Flatness $\leq$1.0 μm / □15 mm
3). Layout	: 11 x 11 Matrix. Sx, Sy 12.5 mm.
4). Exposure Method	: Adjacent shot over-lapping method.
5). Measuring method	: Read the difference of each X and Y by vernier (or equiv.).
6). Measuring points	: X value of vernier A which is over-lapped by right and left shot. Y value of vernier B which is over-lapped by upper and lower shot.
7). Number of Wafer	: 3 wafers.
8). Judgement	: Obtain each 3σx and 3σy of each wafer. The maximum value must be $\leq$ 0.06 μm.

6. Reticle Setting Accuracy

(1). Reticle Rotation Accuracy

After setting the reticle, perform one line step exposure in X-direction such that verniers of each shot overlap with the adjacent shot in the X-direction. Set the reticle again and perform same exposure 5 times.

Then read verniers for Y-difference. Take the average of the Y-difference for each line. When the average of Y1 – Y5 is defined as Y and maximum or minimum value of Y1 – Y5 is defined as $Y_{max.}$ or $Y_{min.}$

Reticle rotation accuracy : $Y / 2 \leq \pm 0.02\ \mu m$
Reticle rotation repeatability : $(Y_{max} - Y_{min})/2 \leq 0.03\ \mu m$.

1). Reticle	: Canon No. 605-01 (or equiv.)
2). Wafer	: Bare Silicon
3). Shot Layout	: Clm 6 x Row 5, Sx = 17.5 mm, Sy = 5.0 mm

7. Prealignment Accuracy

(1). Mechanical Prealignment Accuracy

Running one photo resist printed wafer repeatedly, which was exposed on the same machine, and measure shift value using TV prealignment.
The deviation of measured values (xl+xr)/2, yl, and yr should be 40 μm (3σ) or less respectively .

1). Reticle : Canon No. 605-01 (or equiv.)
2). Wafer : Bare Silicon.
3). Measuring shot : 2 shots / wafer
4). Number of measurements : 25 times.

8. Throughput

The following throughput must be achieved when processing wafers continuously.

a) L-Type Auto Feeder
1) Without D/D Leveling : 6" (45 shots) : 62 wafers / hr. or more.
2) With D/D Leveling : 6" (45 shots) : 57 wafers / hr. or more.

b) R-Type Auto Feeder
1) Without D/D Leveling : 6" (45 shots) : 61 wafers / hr. or more.
2) With D/D Leveling : 6" (45 shots) : 40 wafers / hr. or more.

(1). Measuring method : Process 10 wafers or more continuously and find the index time. (Index time : Mean time to process one wafer which results from having processed wafers continuously.)

(2). Evaluation : $\frac{3600}{\text{Index Time}}$ (wafers / H)

Exposure time : 0.16 sec.
Reticle : Canon No. 605-01 (or equiv.)
Wafer : Resist to Resist (1st exposed on same machine)
PFI-15 1.025 μm t.
Alignment mode : He-Ne TV AGA (Multi Mark / Chip Rotation Comp. OFF.) sub = 4 shots, main = 8 shots.
Shot layout : Step size 20 mm.
Number of shots = 45 shots (6" Wafer)

Appendix A.

Standard Exposure condition.

Exposure condition should be as follows when the detail is not specified in this specification.

a) Wafer	: Si bare. Flatness ≦ 1.0 μm / □20 mm
b) Resist	: PFI-15 1.025 μmt
Prebake	: 90°C, 60 sec
PEB	: 110°C, 60 sec
c) Develop	: NMD-3
d) Exposure Dose	: 0.40 μm L&S is exposed as 1 : 1.
e) Focus	: Best Focus at lens center.
f) Exposure Area	: ⊟20 mm