



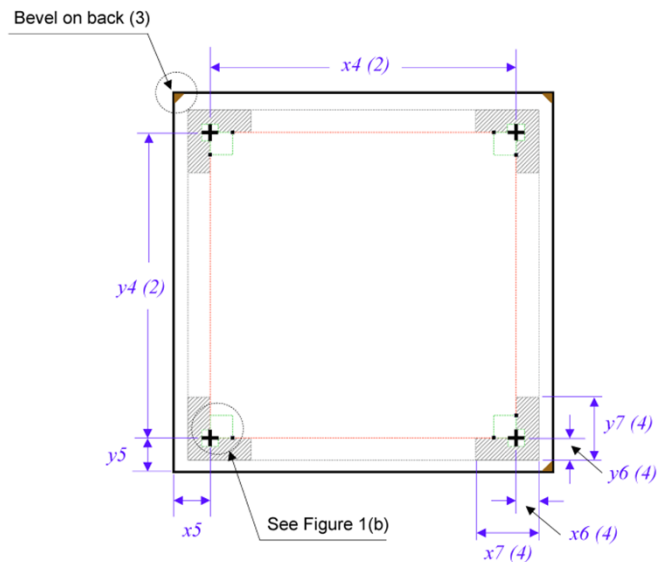
# EB alignment function of fiducial mark

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# Agenda

- ◆ Fiducial mark (FM) requirements
- ◆ Specification of EB alignment function
- ◆ Development schedule



**Figure 2**  
**Placement of Fiducial Marks on EUV Blank, in Frontside View**  
Note that figure is not drawn to scale; the dotted red, green, and gray lines are guides to eyes; and symbol of  $x4 (2)$  is a short form of  $x4$  (Typical, 2 places), etc...

## EB alignment functions;

- Measure four large FMs prior to pattern writing
- Align the coordinate system of EB mask writer to FMs (Shift and rotation)



# Fiducial mark (FM) requirements

- ◆ NFT comply with SEMI standard 4580B.
  - Larger mark size than 550  $\mu\text{m}$  is preferable at early stage.
    - ▶ General operation of EB alignment with 550  $\mu\text{m}$  FM marks requires to minimize the offset between mark location information and the coordinate system of EB writer.
    - ▶ Larger marks ensure to detect the edges by first EB scanning.
  - Mark width of 4  $\mu\text{m}$  or narrower is preferable for FM.
    - ▶ Mark width of 8 $\mu\text{m}$  may be too large for the current scanning range.

Large marks are used for EB alignment.

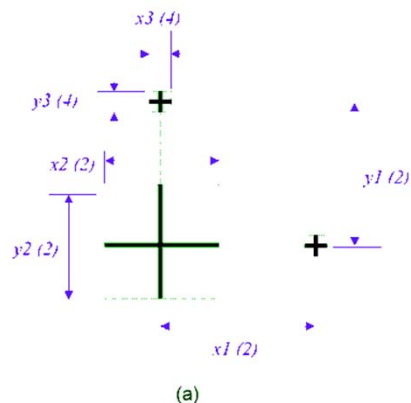


Table 1 Fiducial Mark Specification

Symbol Used	Figure	Value (mm unless specified)	Tolerance (mm unless specified)	Reference Measured From	Feature Measured To
x1, y1	1	1.500	$\pm 0.010$	Center of the large cross	Centers of small crosses
x2, y2	1	0.550	$\pm 0.050$	One line end of large crosses	The other line end of the large crosses
x3, y3	1	0.100	$\pm 0.010$	One line end of small crosses	The other line end of the small crosses
x4, y4	2	136.000	$\pm 0.010$	Centers of large crosses	Centers of adjacent large crosses
x5, y5	2	8.000	$\pm 0.050$	Centers of large crosses	The two closest blank edges
x6, y6	2	$\leq 2.700$		Centers of large crosses	Outer lines of exclusion areas
x7, y7	2	$\leq 5.700$		Outer lines of exclusion areas	Inner / opposing lines of the areas
FMPS Orthogonality		$\leq 0.015/136.000$ ( $\leq 110 \mu\text{rad}$ )		Any one side of FMPS	Any adjacent side of FMPS
FMPS Parallelism		$\leq 0.200/136.000$ ( $\leq 14.7 \text{ mrad}$ )		Any one side of FMPS	The closest edge of EUV blank
CD		Any value $\geq 0.004$ and $\leq 0.008$		One side of lines	The other side of the lines



# Specification of EB alignment function

- ◆ Expected EB alignment accuracy: 20 ~ 30 nm ( $3\sigma$ )\*
  - It can be confirmed by the overlay accuracy w/ and w/o EB alignment.
  - It may vary with the structure of FM.
  - Precise FM location information will be required.
    - ▶ FM location information should be measured by the metrology tool for positioning accuracy qualification of masks.
- ◆ Contributors for defect mitigation strategy to align the defects to absorber pattern

Position error	Tool	Expected accuracy
Pattern writing accuracy	EB	4.3 nm
Position measurement accuracy	Metrology tool	Less than 1.0 nm
Defect location coordinate accuracy*	Inspection tool	200 nm**

\* incl. the tool-to-tool matching between defect inspection tool and position metrology tool

\*\* U. Okoroanyanwu et al., EMLC 2012



# EB alignment function for EUV mask

- ◆ EB alignment function is under-development.
  - Basic function of 2<sup>nd</sup> layer alignment was carried over to FM alignment.
- ◆ The rough schedule is the followings;

	Feb.		Mar.					Apr.				May				Jun.				
	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Development	[Blue bar from Feb 07 to Apr 16]																			
Evaluation		[Green bar from Feb 08 to Apr 17]																		
Verification									[Yellow bar from Apr 14 to May 20]											
Release																				●