

Development of EUV patterned mask inspection technologies for the 16 nm - 11 nm half pitch generation

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Summary

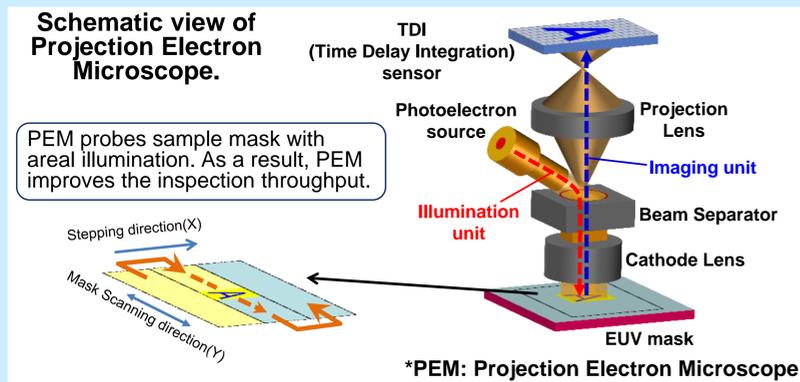
We are developing a novel projection electron microscope (PEM) inspection system for smaller than 16 nm sized defect detection.

- ◆ PEM system design and performance evaluation are executed and have achieved 16 nm inspection sensitivity.
- ◆ Target specification of our developing inspection tool defect size: >11 nm, inspection time:<8 hours.
- ◆ Applying the I²U correction to the captured image, the targeted defects are clearly identified without false defects.
- ◆ Defect detection sensitivity of 12 nm sized intrusion defect in hp 64 nm on the mask was clearly identified.

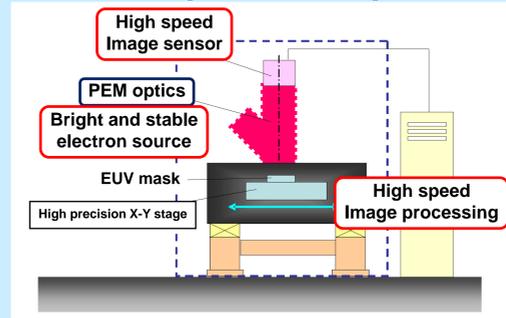
Introduction

Detecting the defects of smaller than 15 nm in size is required for hp 11 nm EUV mask as described in ITRS 2013 Edition. In order to achieve the inspection sensitivity and the extendibility to sub-16-nm node defect detection, Projection Electron Microscope (PEM) technique with high-resolution and high-throughput Electron Optics (EO) are developed.

Concept of the Patterned mask Inspection (PI) tool development.



Defect inspection requirement for hp 11 nm.



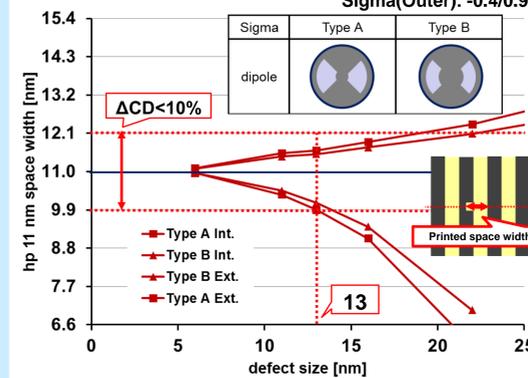
High speed image sensor, high speed image processing circuit and bright/stable electron source are necessary for hp 11 nm defect inspection.

Specification of the Developing PI.

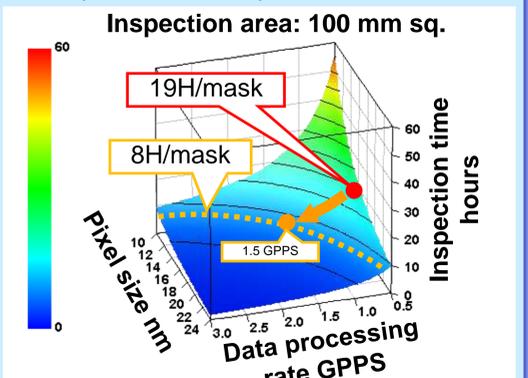
	Phase1 2011.4~2014.3	Phase2 2014.4~2016.3
Target node	hp 16 nm	hp 11 nm
Capability	16 nm isolated 16 nm edge	11 nm isolated 11 nm edge
Scan time	19 hrs /100mm sq.	<8 hrs /100mm sq.
Processing rate	600 MPPS	>1.5 GPPS
Inspection mode	Die-Die	Die-Die

We determine the specification of developing PI tool to fit the requirements of hp 16 nm and hp 11 nm HVM.

Luminescent LAIPH™ Defect Printability Simulator

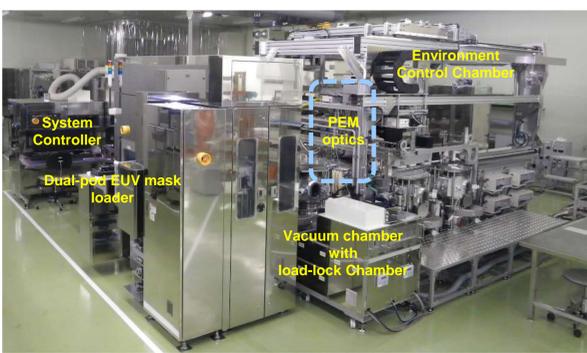


From the simulation result of defect pattern size vs. hp 11 nm L/S printed pattern size on wafer, more than 13 nm extrusion defect or more than 20 nm intrusion cause more than 10% Critical Dimension (CD) error for hp 11 nm EUV lithography.



To improve the inspection throughput for hp 11 nm node defect detection, >1.5 GPPS data processing rate realizes less than 8 hours of inspection time.

Schematic view of the pattern inspection system Model EBEYE-V30.



"Model EBEYE" is an EBARA's model code.

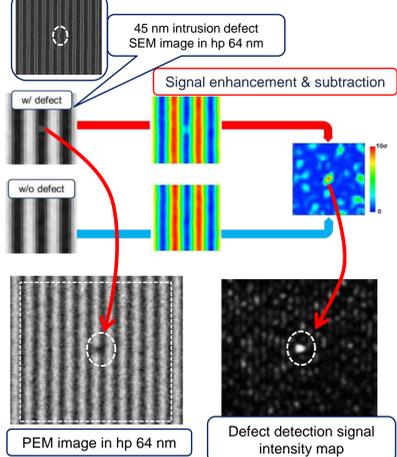
19 hrs. Inspection throughput for 100 mm sq. of full mask area inspection was actually confirmed by measuring the mask scanning time.

16 nm sized intrusion defect, which is our target for hp 16 nm defect detection requirement, was identified without false defects.

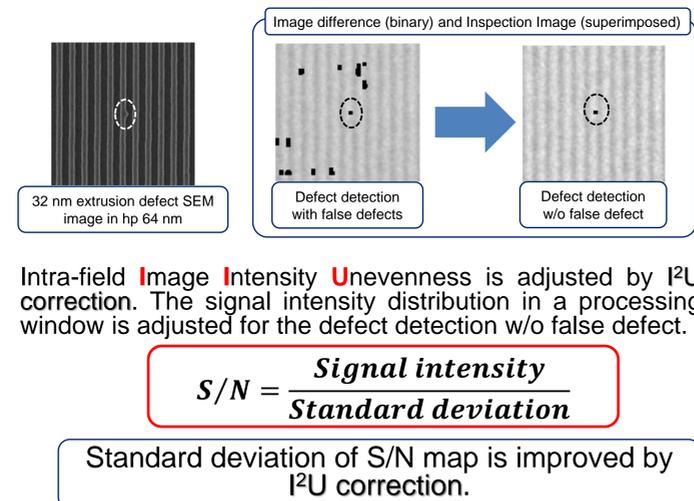
Defect size & configuration	16 nm Intrusion
SEM Image	
Defect detection Result	

Defect detection extendibility for hp 11nm node.

Defect detection signal intensity map analysis



Defect detection capability enhancement -I²U correction-



The signal intensity increases at the position of the defect, and if the signal intensity value exceeds a threshold level set for the defect detection of the targeted defect size, the defect is then identified.

Defect detection sensitivity evaluation results

Defect size & configuration	13 nm extrusion	12nm intrusion
Defect SEM image in hp 64 nm		
Image difference (binary) and captured PEM image (superimposed)		

Applying the die-to-die defect inspection to the captured image, the targeted defects are clearly identified.

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