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Study of post-develop defect on typical EUV resist

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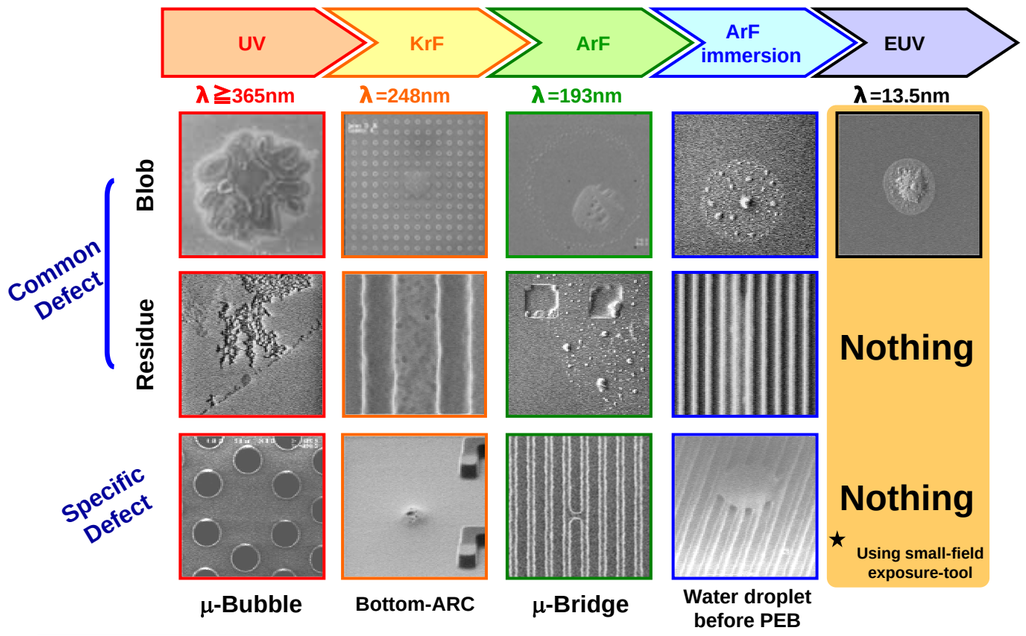
1. INTRODUCTION



Goal of this study

- What defect appear using EUV full-field exposure tool ?
- What defect appear using TBAH compared with TMAH ?
- Can develop process and rinse process reduce defect ?

2. EXPERIMENTAL

2.1 Conditions

Process Condition

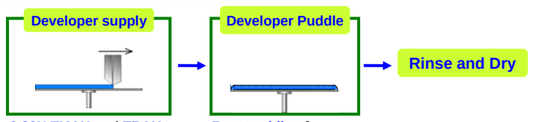
Photo resist	SSR4 (Selete standard resist 4) : 60nm[t] SSR5 (Selete standard resist 5) : 60nm[t]
Substrate	300mm bare-Si
Develop	SOKUDO Track
Exposure	EUV1 (Selete)

Metrology

Defect inspection	KLA2365	KLA-Tencor
Defect observation	RS-3000	Hitachi

2.2 Develop process

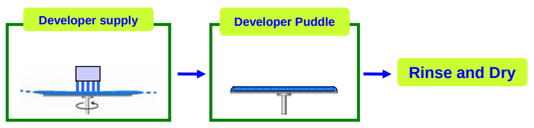
Standard develop process



0.26N TMAH and TBAH was supplied by Slit-scan nozzle.

Rest-puddle of developer was formed and kept for 30 sec.

Improved develop process (Dynamic-puddle)

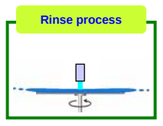


0.26N TMAH was supplied by ECO nozzle, during Substrate rotation.

Rest-puddle of developer was formed and kept for 15 sec.

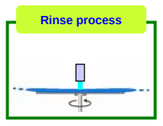
2.3 Rinse process

Standard rinse process



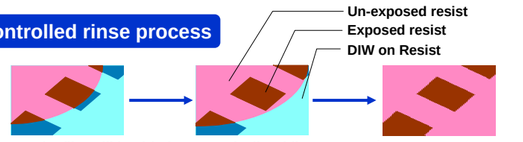
Substrate covered with DIW for 15 sec after developer puddle. At the same time, Substrate rotated.

ACID-rinse process



Substrate covered with DIW including CO_2 for 15 sec after developer puddle. At the same time, Substrate rotated.

Dry controlled rinse process

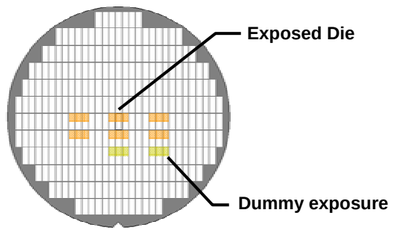


Resist film will be dried concentrically while Dry controlled rinse method will keep the interface between dry and liquid regardless of exposed and un-exposed area.

Liquid will not remain on resist film.

2.4 Exposed Die-location

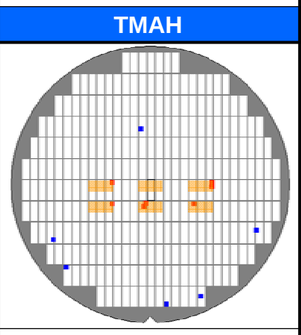
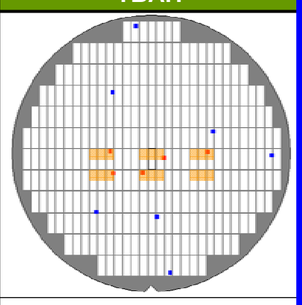
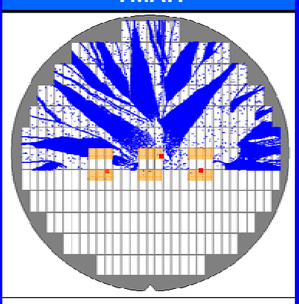
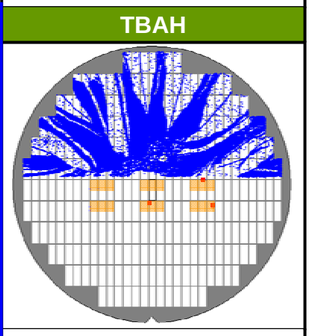
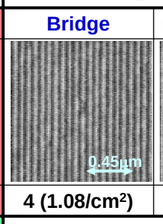
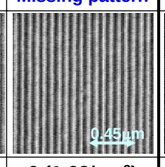
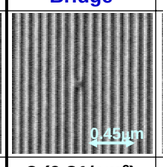
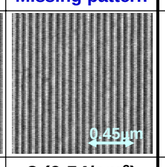
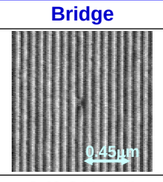
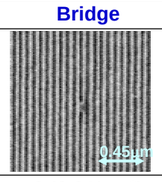
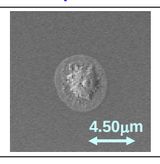
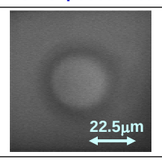
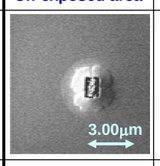
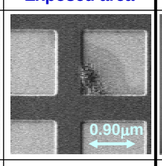
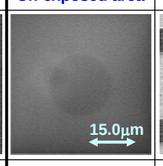
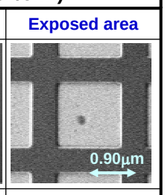
Die pitch : 26 x 11mm (6-dies)
L/S-Pattern : 35nm ~ 43nm-hp



3. RESULTS and DISCUSSION

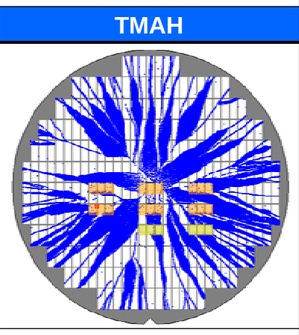
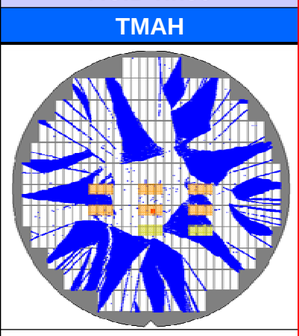
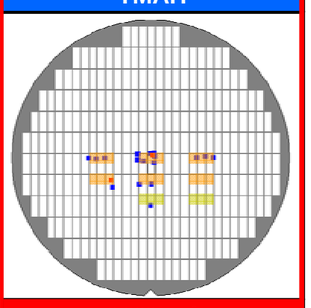
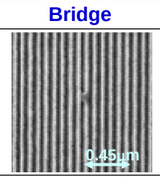
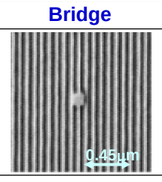
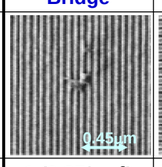
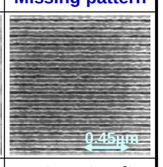
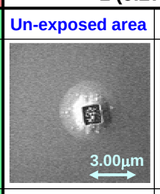
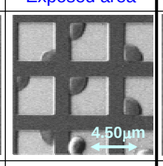
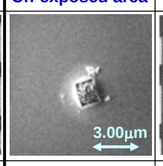
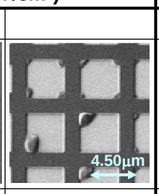
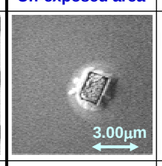
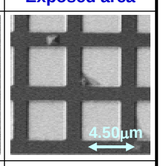
3.1 Defect map and SEM review

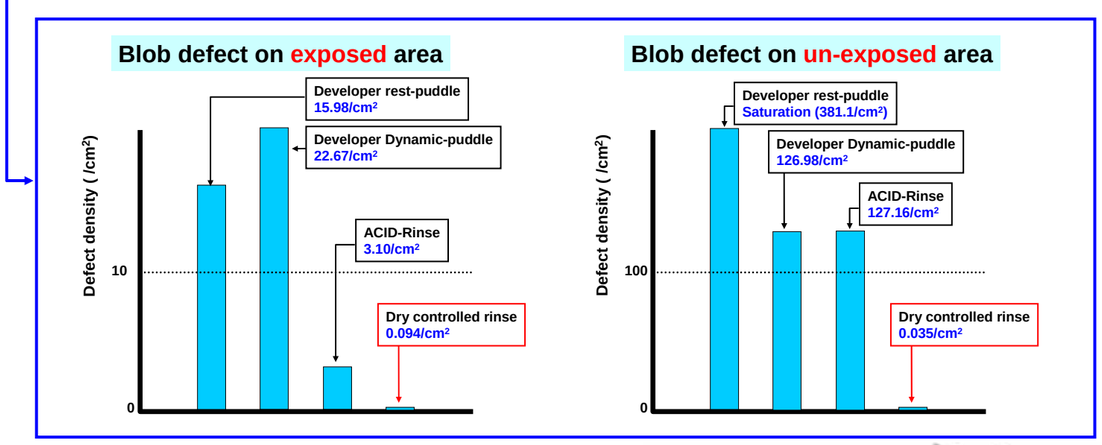
■ Red dots :Bridge and Missing pattern defects
■ Blue dots :Blob defect

Resist	SSR4				SSR5			
Develop process	Standard		Standard		Standard		Standard	
Rinse process	Standard		Standard		Standard		Standard	
Developer	TMAH		TBAH		TMAH		TBAH	
Defect map								
D.D. (Defect density)	0.023/cm²		0.020/cm²		381.1/cm²		458.0/cm²	
Pattern defect	Bridge	Missing pattern	Bridge	Missing pattern	Bridge		Bridge	
SEM image								
Count (D.D.)	4 (1.08/cm²)	6 (1.62/cm²)	3 (0.81/cm²)	2 (0.54/cm²)	3 (0.81/cm²)		3 (0.81/cm²)	
Blob defect	Un-exposed area		Un-exposed area		Un-exposed area	Exposed area	Un-exposed area	Exposed area
SEM image								
Count (D.D.)	6 (0.015/cm²)		7 (0.018/cm²)		Saturation	170 (15.98/cm²)	Saturation	13 (1.22/cm²)

3.2 Process improvement for SSR5

■ Red dots :Bridge and Missing pattern defect
■ Blue dots :Blob defect

Resist	SSR5				
Develop process	Dynamic-puddle	Dynamic-puddle	Dynamic-puddle		
Rinse process	Standard	ACID-rinse	Dry controlled rinse		
Developer	TMAH	TMAH	TMAH		
Defect map					
D.D. (Defect density)	112.87/cm²	117.21/cm²	0.039/cm²		
Pattern defect	Bridge	Bridge	Bridge	Missing pattern	
SEM image					
Count (D.D.)	1 (0.27/cm²)	1 (0.27/cm²)	1 (0.27/cm²)	1 (0.27/cm²)	
Blob defect	Un-exposed area	Exposed area	Un-exposed area		Un-exposed area	Exposed area
SEM image						
Count (D.D.)	68639 (126.98/cm²)	241 (22.67/cm²)	69816 (127.16/cm²)	33 (3.10/cm²)	21 (0.035/cm²)	1 (0.094/cm²)



4. SUMMARY and FUTURE

Summary

- What defect appear using EUV full-field exposure tool ?
  - No EUV specific defect was observed.
  - Three types of defects were observed.
    - Bridge : on L/S-pattern area
    - Missing pattern : on L/S-pattern area
    - Blob : on both exposed and un-exposed area
  - SSR4 defect density was 0.02/cm², SSR5 defect density was over 300/cm².
- What defect appear using TBAH compared with TMAH ?
  - The same defect compared with TMAH.
- Can develop process and rinse process reduce defect?
  - 99% blob defect on SSR5 can be reduced by improving develop process and rinse process compared with standard develop process.
    - Dynamic-puddle : 90% blob reduction on only un-exposed area.
    - ACID-rinse : 80% blob reduction on only exposed area, no effective on un-exposed area.
    - Dry controlled rinse : 99% blob reduction on both exposed and un-exposed area.

Future

- Defect evaluation using chemical rinse process will be conducted.
- Defect appearing and eliminating model is based on defect analysis and various process results will be showed.

Selete

SOKUDO