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Study of post-develop defect on typical EUV resist

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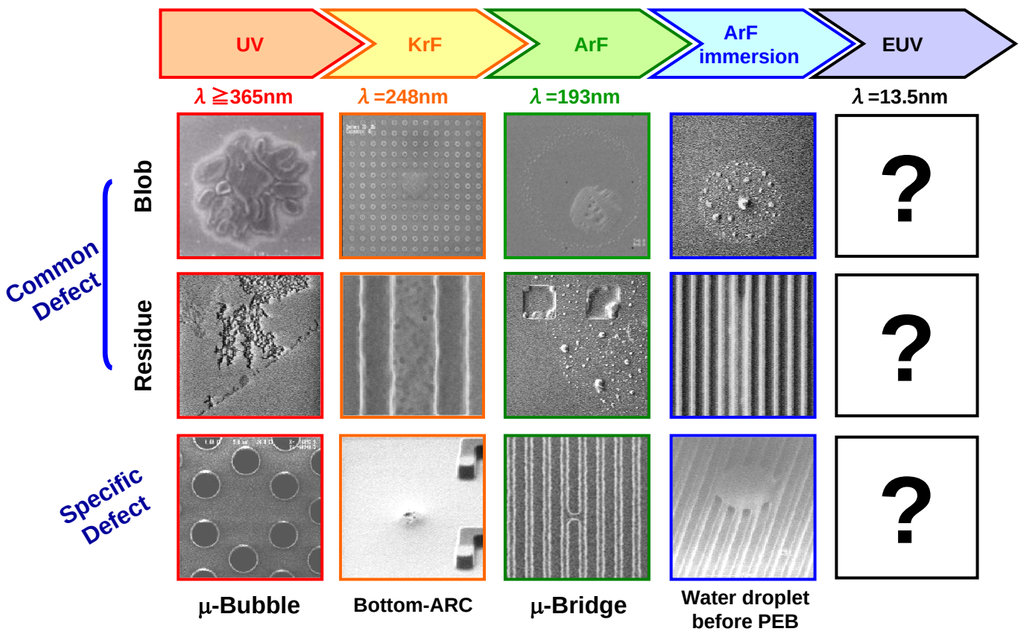
1. INTRODUCTION



Blob and Residue are common defect for each generation resist.
How about EUV?

There are specific defects for each generation resist.
How about EUV?

Goal of this study is to understand common/specific defect on EUV resist processing.

2. EXPERIMENTAL

2.1 Conditions

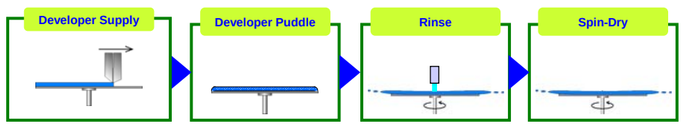
Process Condition

Photoresist	EUV Resist A EUV Resist B
Substrate	300mm bare-Si
Develop	SOKUDO Track
Exposure	λ=248nm, NA0.60

Metrology

Defect Inspection	KLA-2365	KLA
Defect Observation	RS-3000	Hitachi
Analysis of Component	Nicolet Almega-XR (Raman-spectroscopy)	Thermo Fisher Scientific

Develop Process



2.38wt% TMAH was supplied by Slit-scan nozzle.

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

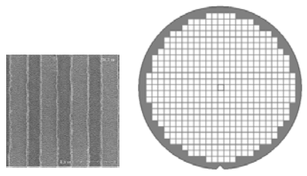
Substrate covered with DIW rinse for 15 sec after developer puddle. At the same time, Substrate rotated.

Substrate rotated and then DIW rinse was dried.

2.2 Pattern and location of exposed area

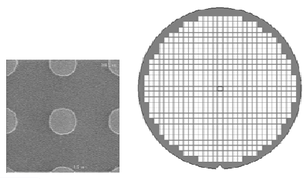
Condition 1: Line

Die :11 x 11mm pitch
Pattern :Line 180nm-hp



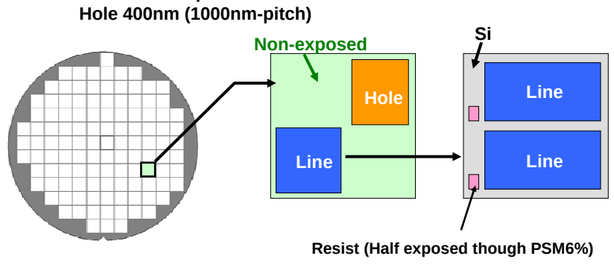
Condition 2: Hole

Die : 9 x 10mm pitch
Pattern : Hole 400nm (1000nm-pitch)



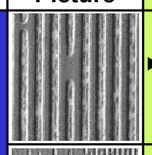
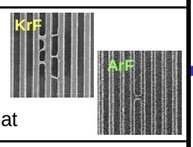
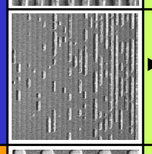
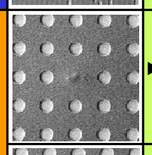
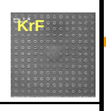
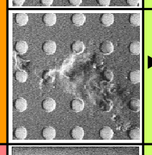
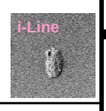
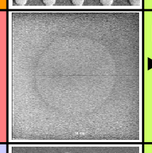
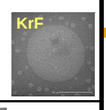
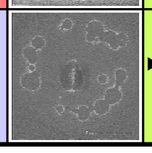
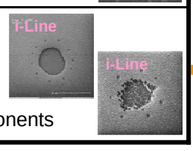
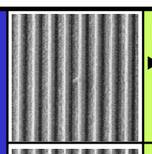
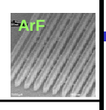
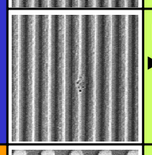
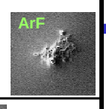
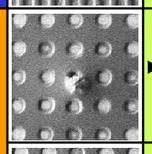
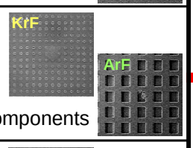
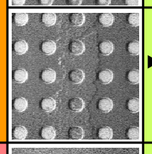
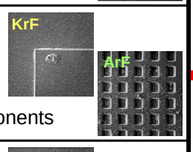
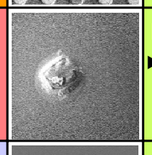
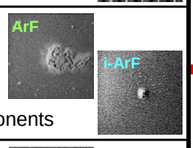
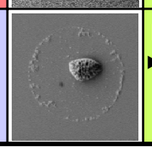
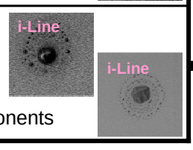
Condition 3: Mixed Line and Hole

Die : 22 x 22mm pitch
Pattern : Line 180nm-hp
Hole 400nm (1000nm-pitch)



3. RESULTS and DISCUSSION

3.1 Results of defect-type

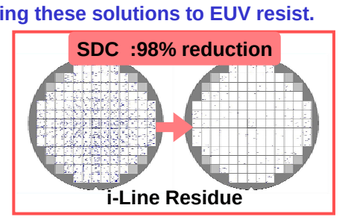
	Area	Picture	Defect-type and Analysis	Assumed Cause
EUV Resist A	Line		**Bridge** ▶Components from Raman-spectroscopy: NA	**Similar case : KrF, ArF, i-ArF** **Cause:** ▶Chemical-flare during PEB ▶ununiformly-distributed Resin during coat 
			**Un-resolving** ▶Components : Resist	**Similar case : KrF, ArF, i-ArF** **Cause:** ▶Chemical-flare during PEB ▶ununiformly-distributed Resin during coat
	Hole		**Blob** ▶ Components : Resist	**Similar case : i-Line, KrF** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 
			**Residue** ▶Components : NA	**Similar case : i-Line, KrF** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 
	on Resist		**Blob** ▶Components : Resist	**Similar case : KrF, i-ArF** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 
	on Si		**Blob** ▶Components : Resist	**Similar case : i-Line** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 
EUV Resist B	Line		**Bridge** ▶Components : NA	**Similar case : ArF, i-ArF** **Cause:** ▶Chemical-flare during PEB ▶ununiformly-distributed Resin during coat 
			**Bubble** ▶Components : NA	**Similar case : KrF, ArF, i-ArF** **Cause:** ▶Bubbles in the Resist-piping or Filter 
	Hole		**Blob** ▶ Components : Developer	**Similar case : KrF, ArF, i-ArF** **Cause:** ▶Resist surface condition after develop ▶Water Droplet containing Developer Components 
			**Residue** ▶Components : NA	**Similar case : i-Line, KrF, ArF** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 
	on Resist		**Blob** ▶Components : Developer	**Similar case : KrF, ArF, i-ArF** **Cause:** ▶Resist surface condition after develop ▶Water Droplet containing Resist Components 
	on Si		**Blob** ▶Components : NA	**Similar case : i-Line** **Cause:** ▶Rinse Shortage ▶Water Droplet containing Resist Components 

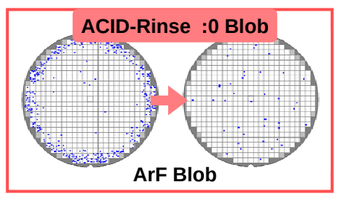
3.2 Assumed cause and countermeasure

Defect-Type	Cause	Countermeasure
Blob	Rinse Shortage Water Droplet containing Resist	Rinse process improvement *Rinse Time : longer* *Flow-rate : higher* *Wafer rotational speed : faster* SDC-Rinse (SOKUDO-Defect-Cleaning)
	Resist Surface Condition after Dev. Water Droplet containing Developer	Develop process improvement ACID-Rinse (CO_2-water)
Residue	Rinse Shortage Water Droplet containing Resist	Rinse process improvement SDC-Rinse ACID-Rinse
Bubble	Bubbles in the Resist-piping or Filter	Resist-filter Coating process improvement
Bridge Un-resolving	Chemical-flare during PEB Un-uniformly-distributed Resin	Resist-filter Coating process improvement Baking process improvement

3.3 Countermeasure from i-Line to immersion-ArF resist

Next step, we try applying these solutions to EUV resist.





4. Summary and Future

- **Post-develop defect on typical EUV resist were evaluated with KrF-exposure-tool.**
- **No EUV specific defect was observed.**
  We confirmed the defects on EUV resist processing, these defects were Blob, Residue and Bridging defect as well known.
- **Three types of defects were observed.**
  There are three types of defects we observed, these are Blob, Residue and Bridging defect.
  - ➢Blob
    - ✓Components: Resist and Developer components were detected by Raman
    - ✓Similar Case: i-Line, KrF, ArF, i-ArF
  - ➢Residue
    - ✓Components: Resist
    - ✓Similar Case: i-Line, i-ArF
  - ➢Bridge and Bubble
    - ✓Components: Resist
    - ✓Similar Case: KrF, ArF, i-ArF
- **Future**
  - ◆ Next step, we will confirm the defects with EUV-exposure-tool.
  - ◆ We will try reducing Blob and Residue by applying solution and improvement from i-Line to immersion-ArF.
    - ➢Blob : Develop and Rinse-process improvement
    - ➢Residue : Rinse-process improvement

5. Acknowledgement

We would like to thank Rika Harui, Thermo Fisher Scientific K.K., for Raman analysis.

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SOKUDO