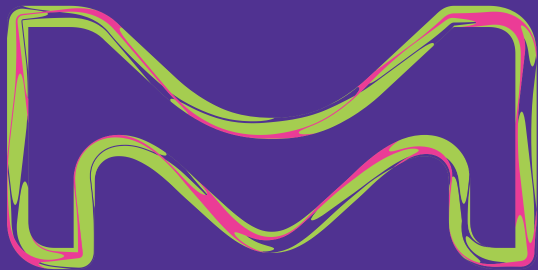
Tatsuro Nagahara
Feb 21, 2016



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EMD Performance Materials is a business
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Content

1. Benefit to use Rinse material
2. Comparison of current STD and **new rinse**
3. New idea to overcome RLS limitation
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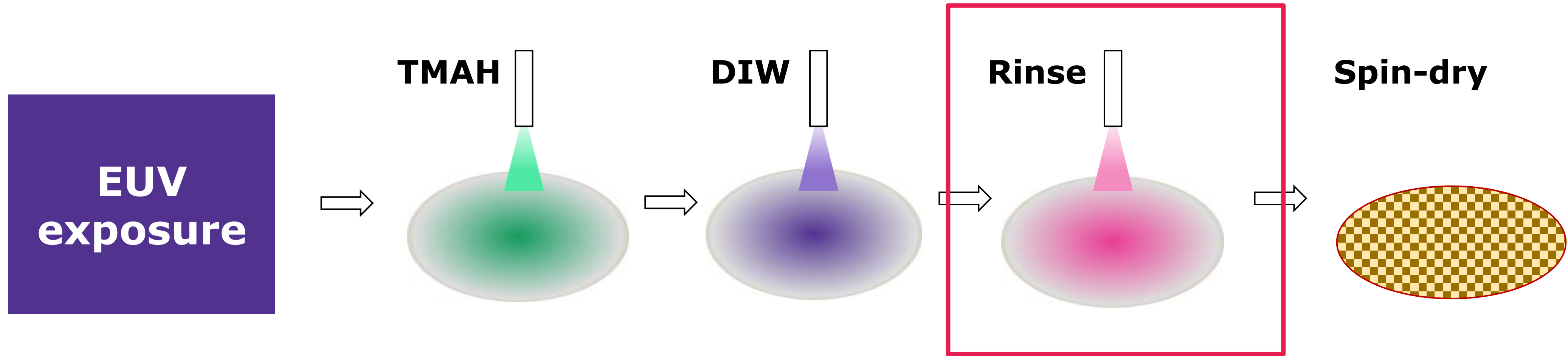
Benefit to use rinse material



Benefit of rinse process

✓ **Better defectivity**

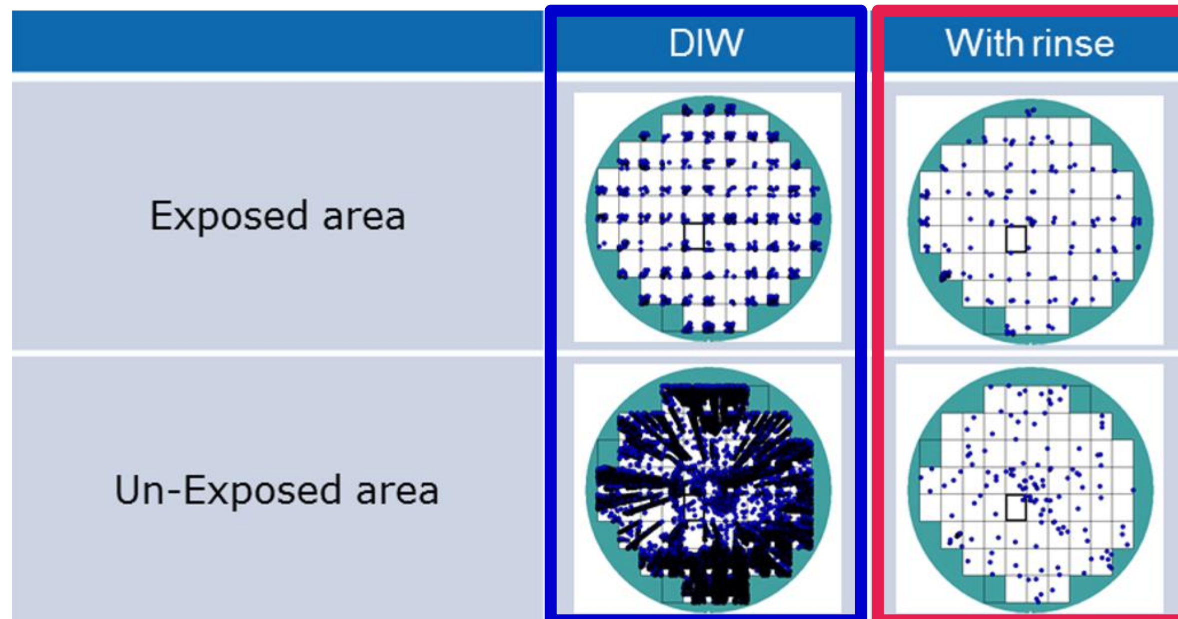
✓ **Wider process window**

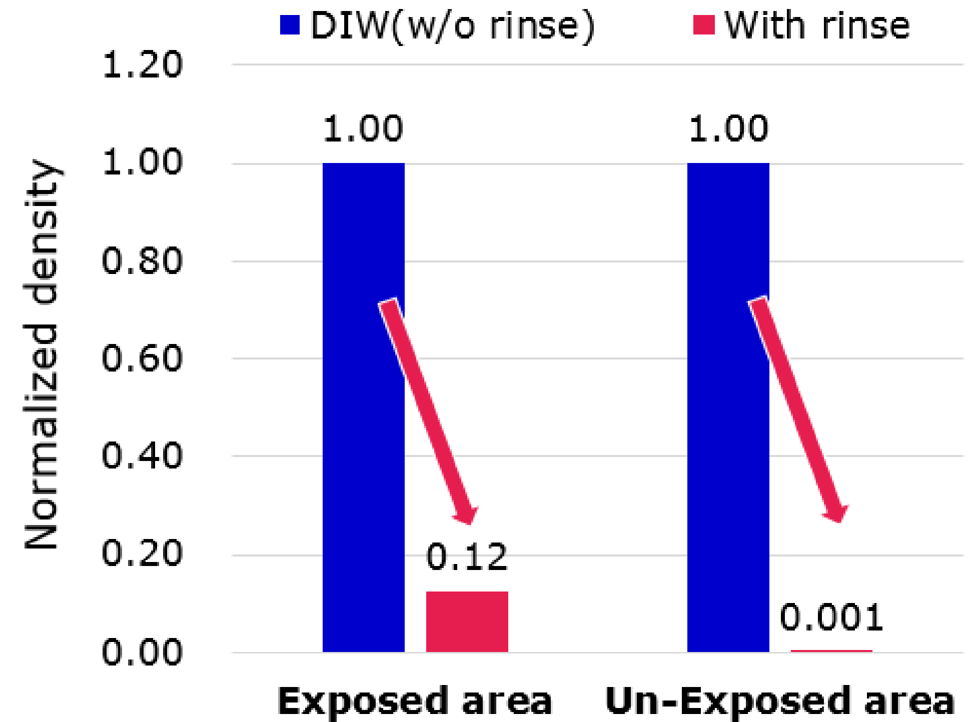
Better defectivity

Process condition
Exposure tool: NXE3100
Resist: Resist A / 50nm thick
Substrate: bare-Si with HMDS
Process: 2.38%TMAH ➔ DIW ➔ **Rinse**

Inspection area
Exposed area: 70.3cm²/wafer
Un-Exposed area: 451.3cm²/wafer

Evaluation with NXE3100 at 28nmhp





Mechanism to widen process window

Ideal patterning

exposure energy

Reality (without rinse)

Bridge defect

Process window

Pattern collapse

Surface tension
DIW ~ 72mN/m

With rinse

Rinse

Cleaning effect

Reduction of surface tension

Process window comparison with NXE3100

Process condition
Exposure tool: NXE3100 (0.25NA)
Resist: Resist-B / 50nm thick
Dose: 40.0mJ/cm2 center, 2mJ/cm2 step
Focus: -0.06um center / 0.06um step
Substrate: bare-Si with HMDS
Process: 2.38wt%TMAH ➔ DIW rinse ➔ **Rinse**

LS 22nm hp

Dose
Low ↔ High

Focus
Plus
Minus

6→ 7→ 9→

OK
NG

DIW	Current STD rinse	New rinse
29 blocks	31 blocks	41 blocks

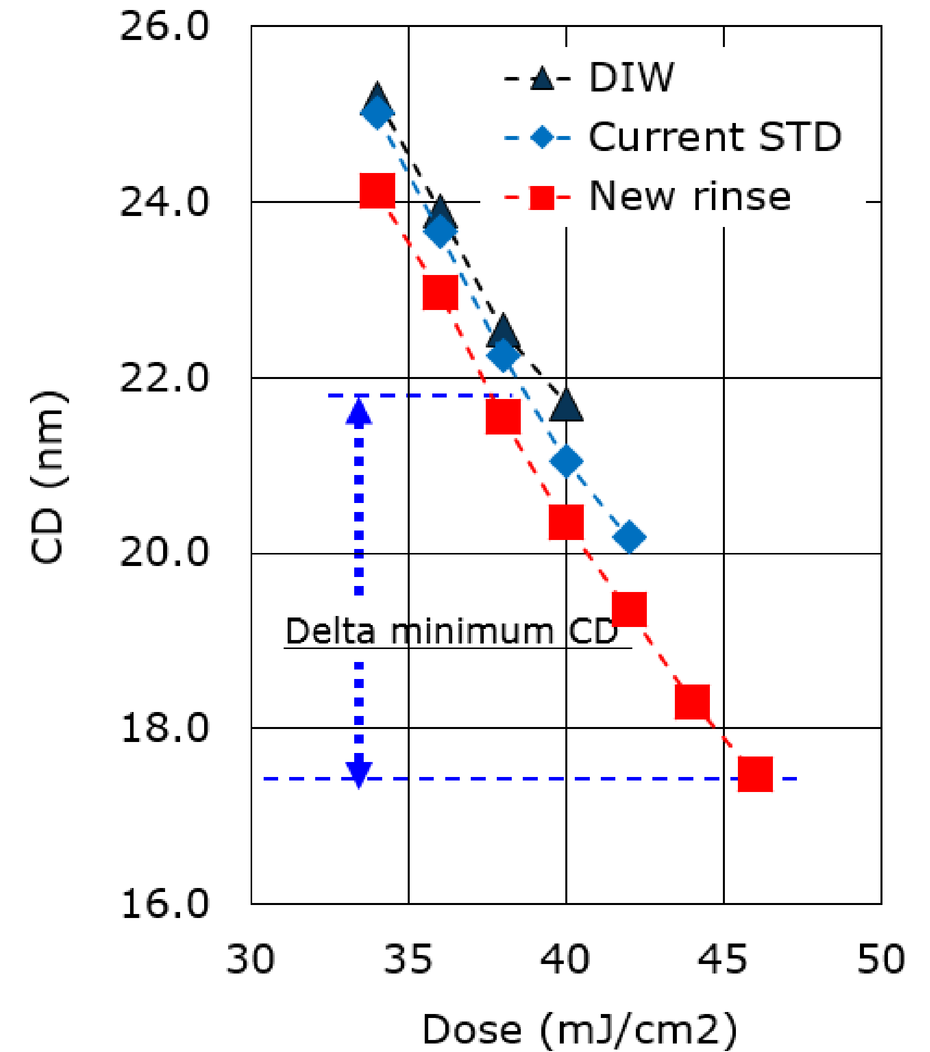
Process window: Dose margin

Process condition
Exposure tool: NXE3100 (0.25NA / Dipole)
Resist: Resist-B / 50nm thick
Substrate: bare-Si with HMDS
Process: 2.38wt%TMAH ➔ DIW ➔ Rinse

Evaluation with NXE3100 at 22nm hp

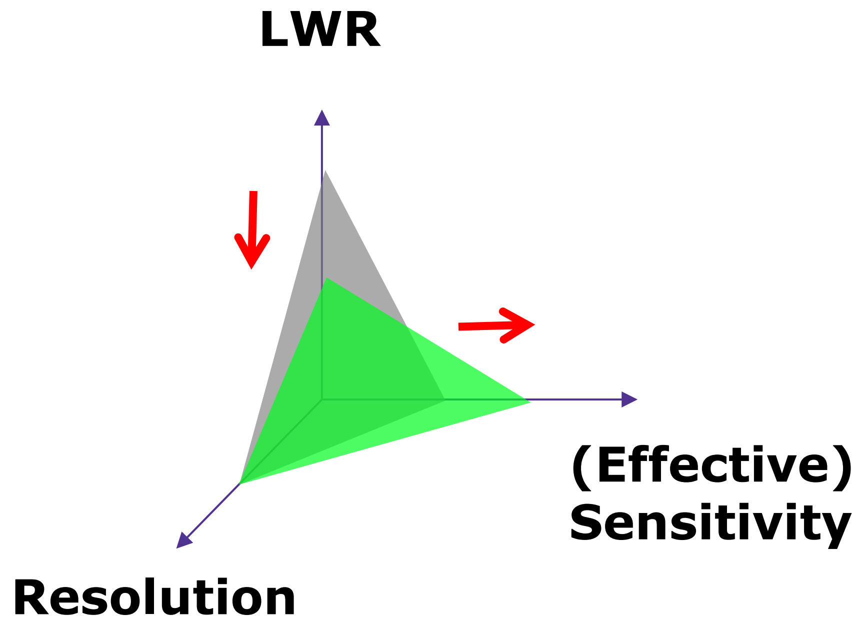
	DIW	Current standard	New rinse
Sensitivity* (mJ/cm2)	39.3	38.7	37.5
Effective sensitivity impr.	Ref	+1.5%	+4.6%
Minimum CD(nm)	21.7	20.2	17.5
Delta Minimum CD(nm)	Ref	1.5	4.2
LWR (nm)	4.9	4.9	4.9

Sensitivity*: Dose to 22nm

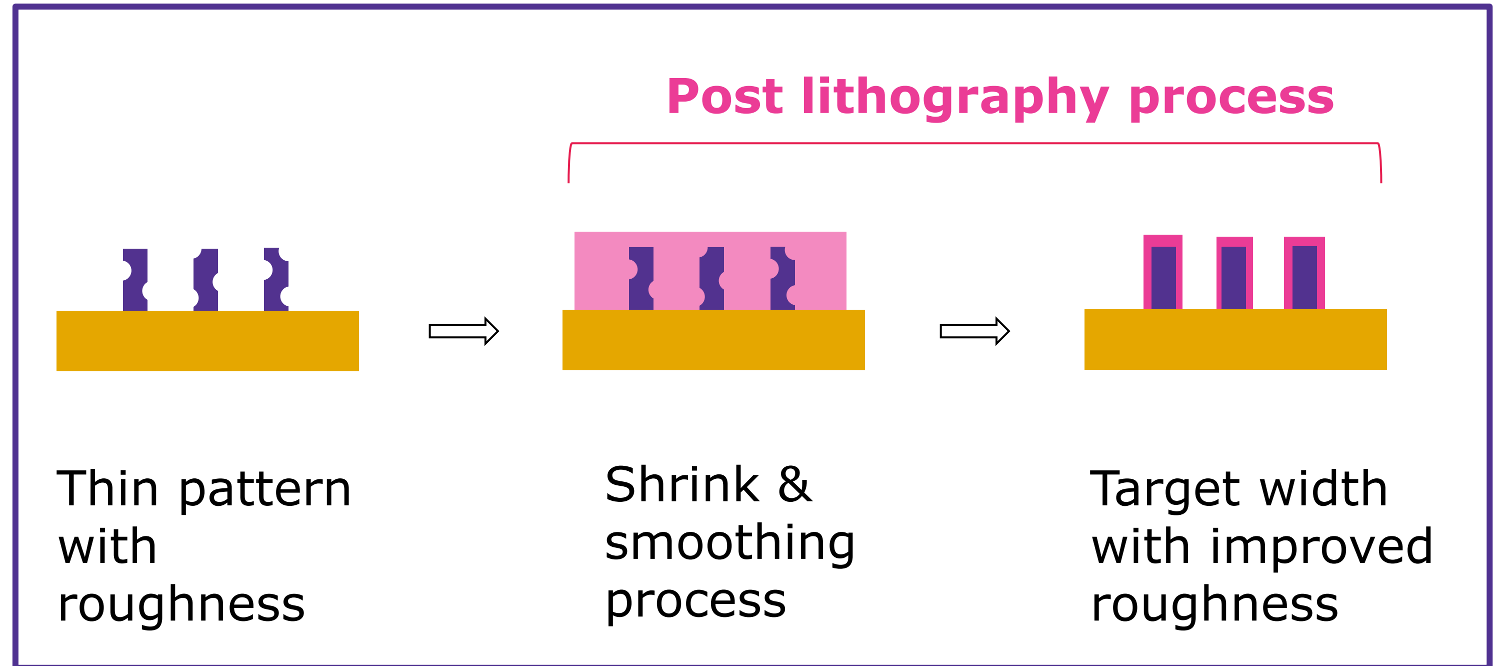


- ✓ New rinse exhibits the smallest minimum CD.
- ✓ Additionally, increase of effective sensitivity is observed.

New idea to overcome RLS limitation



EUV + "Shrink & smoothing"



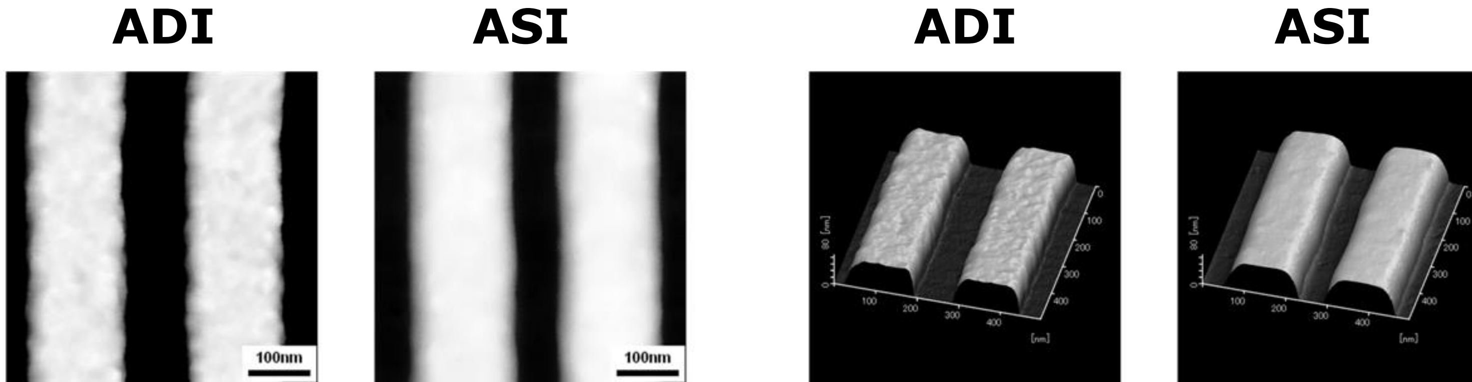
- ✓ **Post lithography process to improve roughness of resist pattern.**
- ✓ **Increase of (effective) resist sensitivity will be also achieved. (NTD)**

Proof of concept on ArF NTD

"Resist roughness improvement by a chemical shrink process"

[9777-55] TUE 23 Feb, 6:00 to 8:00 PM

Surface roughness (SPM observation)



	Surface roughness (Sa)	Improvement ratio
ADI*	0.97 nm	-
ASI**	0.74 nm	23.7%

Pattern roughness

	Improvement ratio
LWR	>16%
LCDU	>60%

ADI*: After Develop Inspection
ASI**: After Shrink Inspection

Summary

1. **Benefit to use Rinse material**
   - **Better defectivity**
   - **Wider process window**
2. **Performance of new rinse**
3. **New idea to overcome RLS limitation**
   - **Proof of concept with ArF NTD**

Acknowledgement

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thank you!