RE-P30

Study of High Adhesion Under Layer material for EUV Lithography

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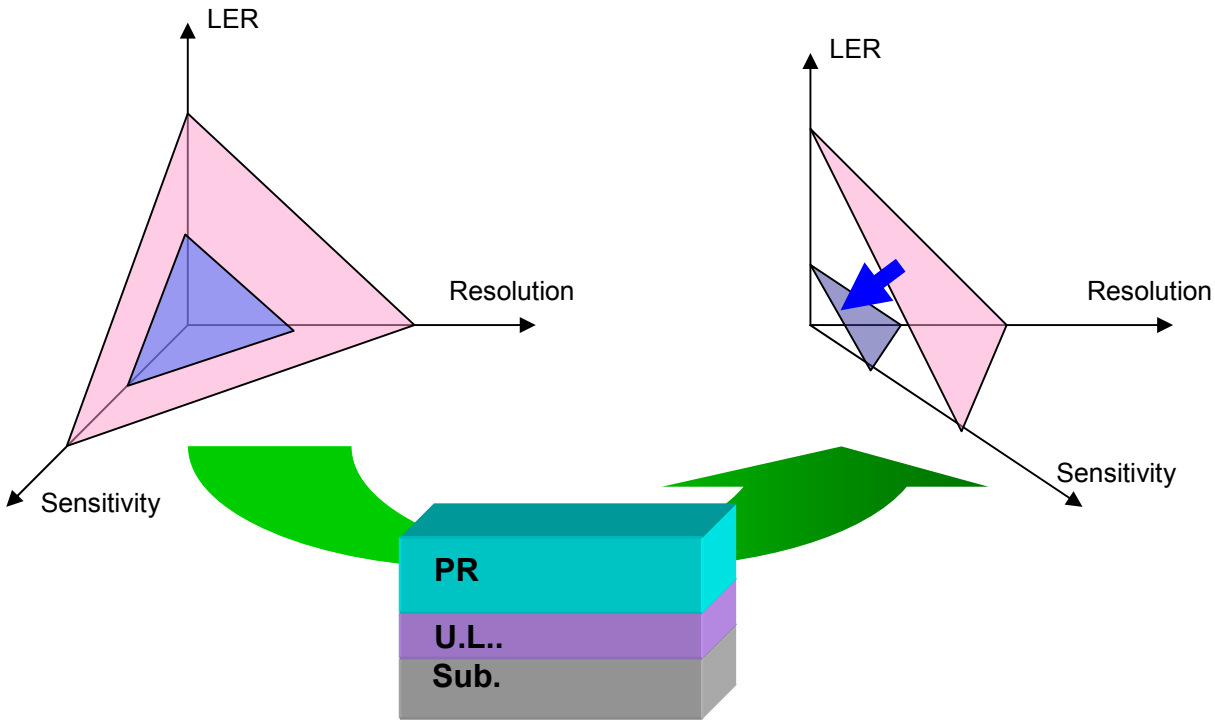
Purpose of Under Layer for EUVL

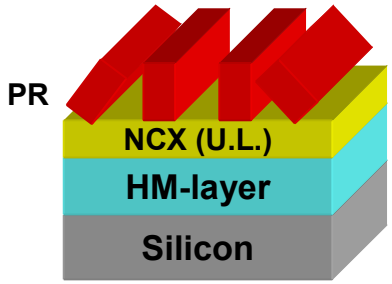
RLS trade off



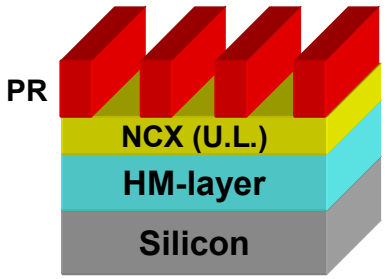
Adding Functional-underlayer into between PR and substrate, Underlayer is targeting make RLS trade-off smaller by supporting underlayer effect.

Requirements for EUV Under-layer

- **High adhesion with PR (Prevent pattern collapse)**
- Resist profile control
- Block the contamination from substrate (Barrier film)
- Good performance with thin film (~10nm)
- No out gas
- Photo speed, resolution enhancement
- Reduce LWR, LER

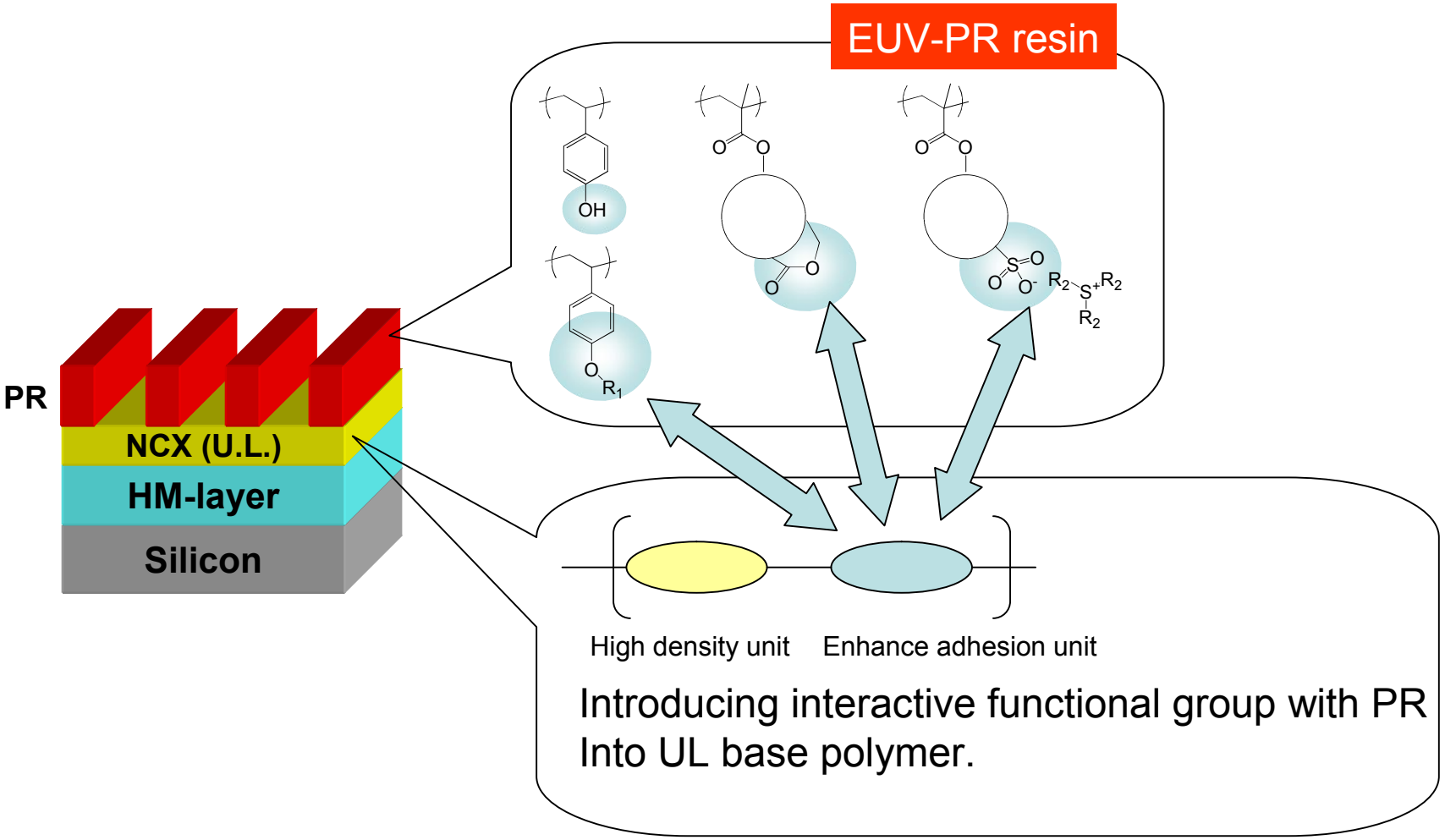


Pattern collapse improvement



Pattern profile control with thin film UL.

Pattern collapse improvement concept



Introducing interactive functional group with PR
Into UL base polymer.

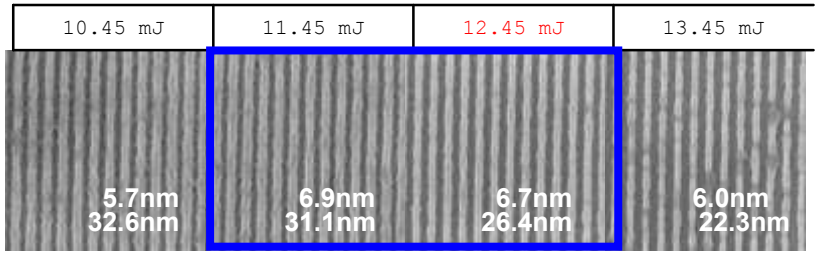
Pattern collapse improvement concept

EUV
Challenging and Solution by x-layer

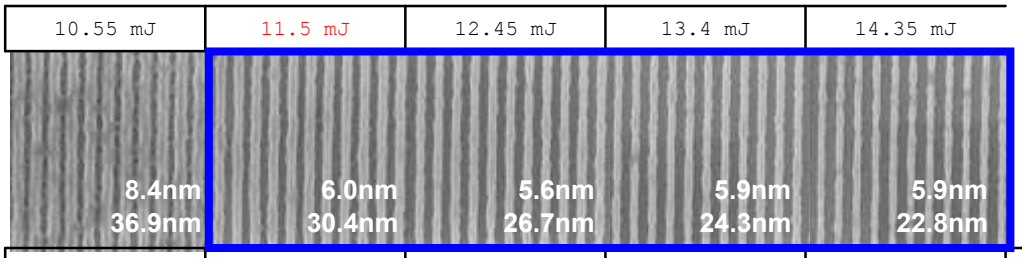
Compare to EL margin

Exposure tool :
MET, EUV-PR

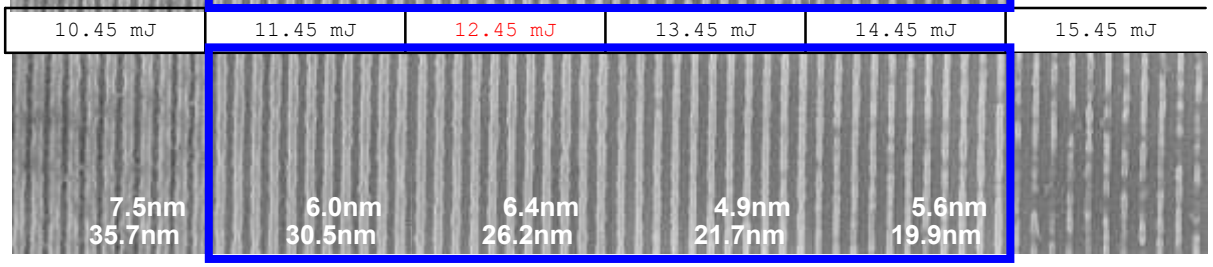
Ref.



UL-1
（Unit-1）



UL-2
（Unit-2）



Improvement for EL Margin on UL using interactive functional group was confirmed.
~ 20nm L/S at over dose was observed.

Development of UL for polymer PR

Evaluation objective

Introduction of Interactive functional unit with PR could improve adhesion property and got wider EL margin.
The material formulation was investigated for further improvement of PR/UL adhesion.
Especially, functional additive for surface modification was tested in EB Lithography.

Evaluation condition

Substrate: Si wafer
UL sample: UL-A, UL-B,
HMDS (Reference)
UL thickness: 10nm
PR: PR A
PR thickness: 70nm

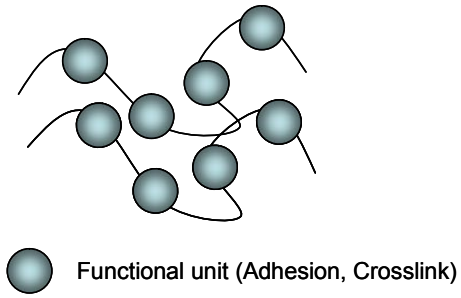
Evaluation tool: EB
Accelerating voltage: 50keV
CD: 40, 35nm (Line:Space = 1:1)

UL sample concept

UL-A

Concept:
High crosslink density polyester UL

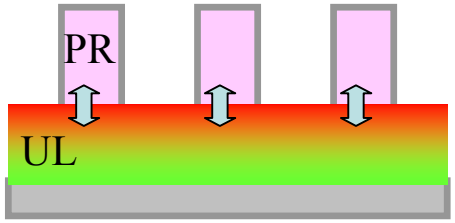
- Very low outgassing
- High film density and high crosslink density
- Good coating property ~20nm on various Substrate
- Good Litho performance. Good pattern collapse margin.



UL-B

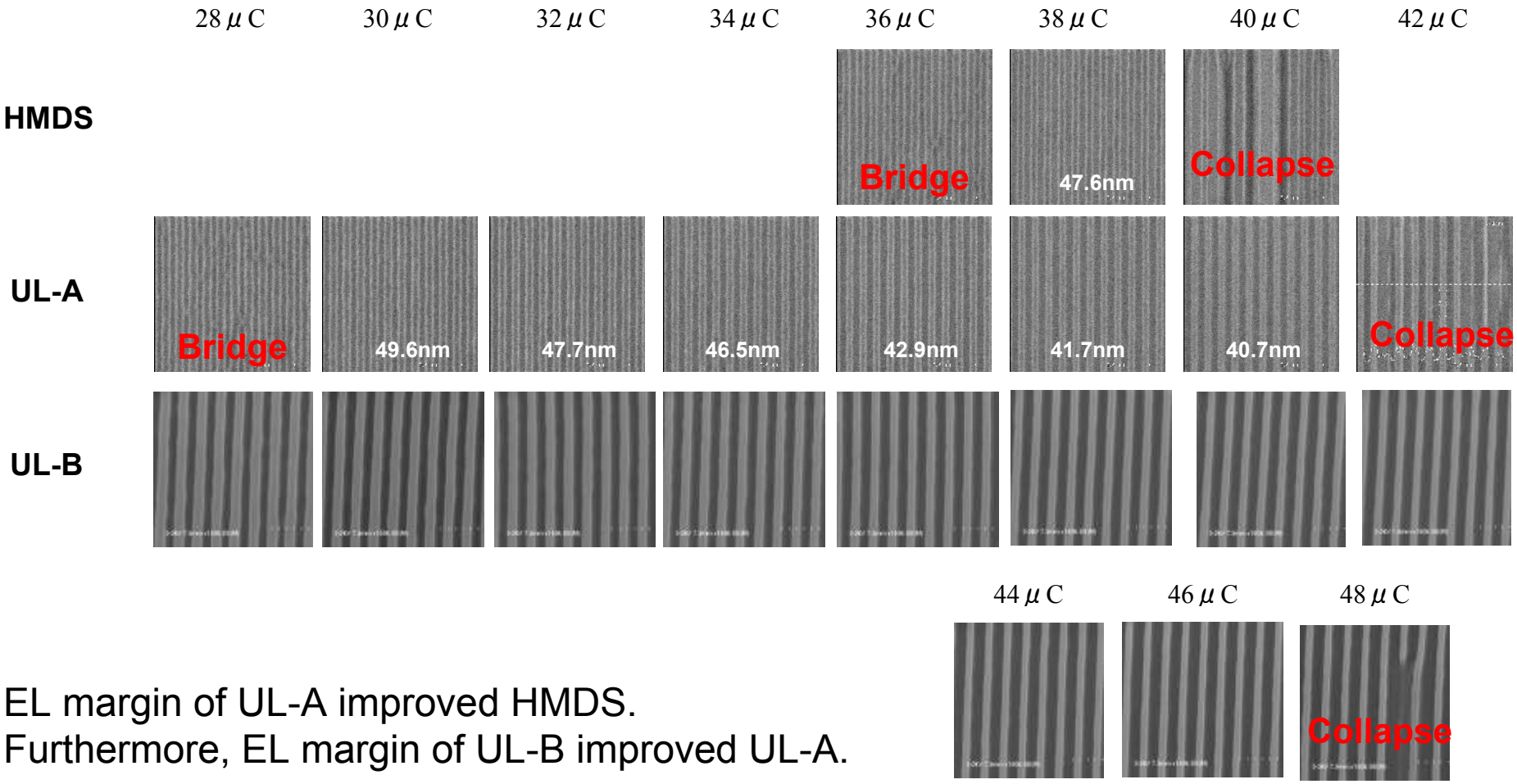
Concept:
High interaction for PR

- Base UL resin: UL-A
- Including functional additive
- Enhance adhesion for resist.



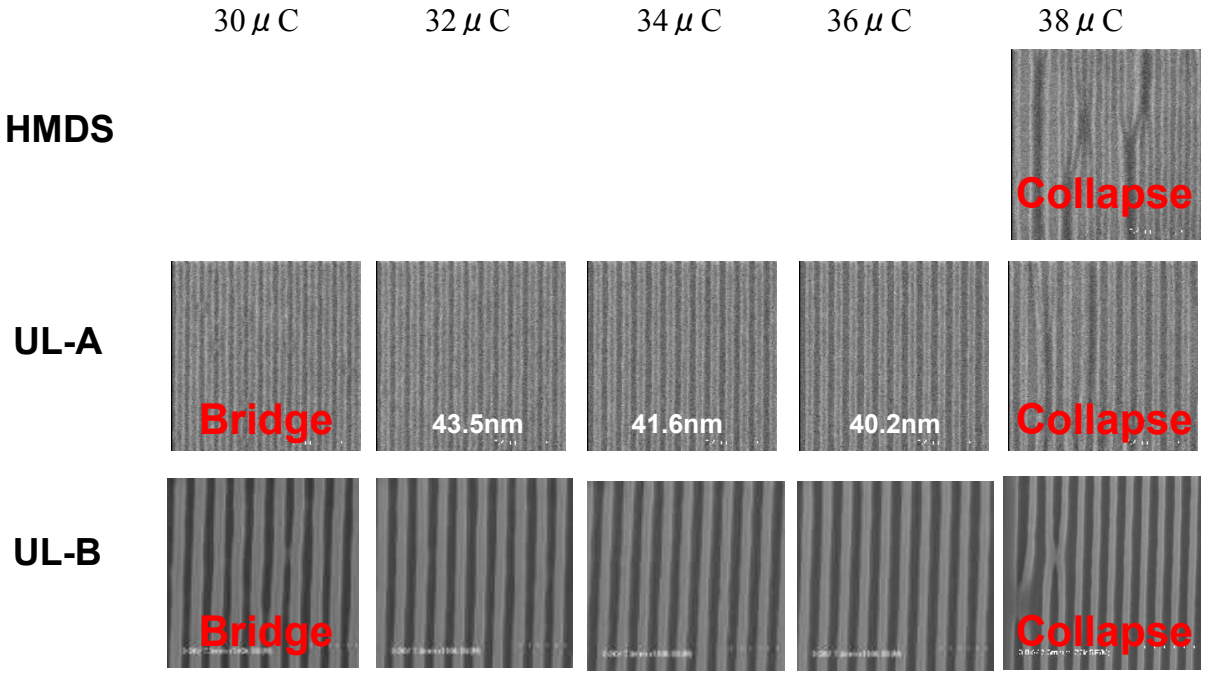
Adhesion performance (CD 40nm)

EUV
Challenging and Solution by x-layer



EL margin of UL-A improved HMDS.
Furthermore, EL margin of UL-B improved UL-A.

Adhesion performance (CD 35nm)



EL margin of UL-B don’t improve for UL-A

Development of UL for molecular PR

Experiment objective

Structure of molecular resist is greatly different from polymer resist.
Adhesion unit of UL is different for each of resist structure.
Adhesion unit effect of UL for molecular resist was investigated with EL margin of EB Lithography.

Evaluation condition

Substrate: Si wafer
UL sample: UL-C, UL-D,
HMDS (Reference)
UL thickness: 10nm
PR: PR B（Idemitsu Molecular Resists）
PR thickness: 40nm

Evaluation tool: EB
Accelerating voltage: 50keV
CD: 35, 30nm (Line:Space = 1:1)

UL sample concept

UL-C

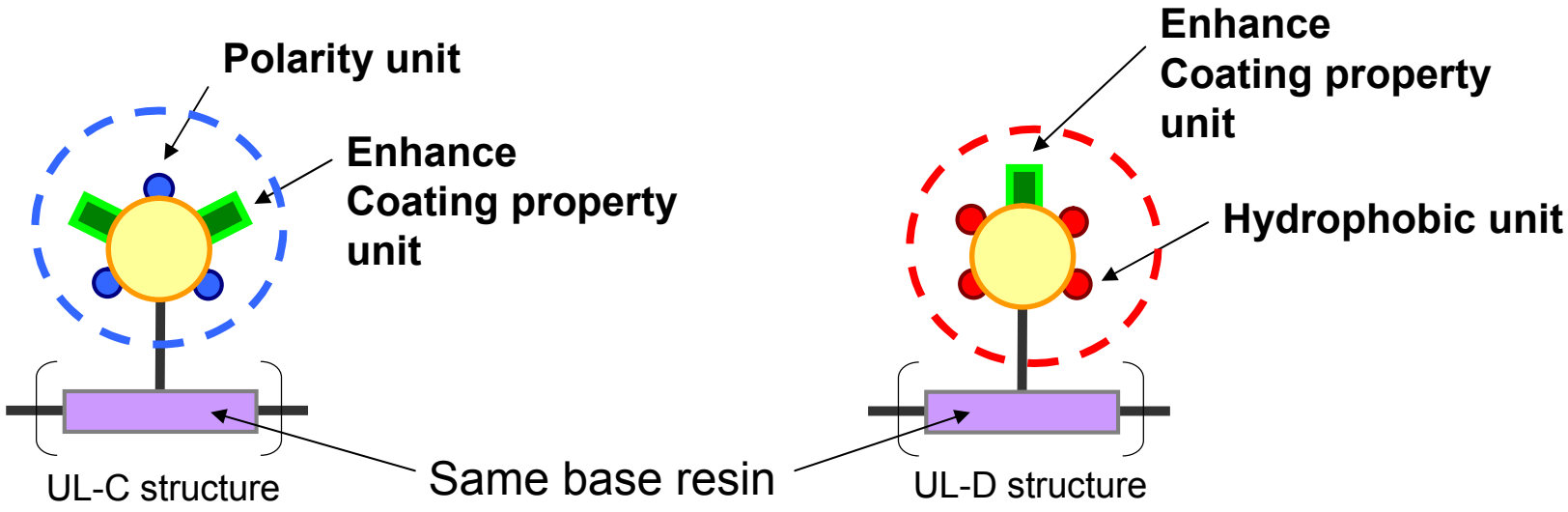
Concept: High polarity unit

- High polarity unit
- Good Litho and adhesion performance for polymer EUV PR and ArF PR

UL-D

Concept: Hydrophobic unit

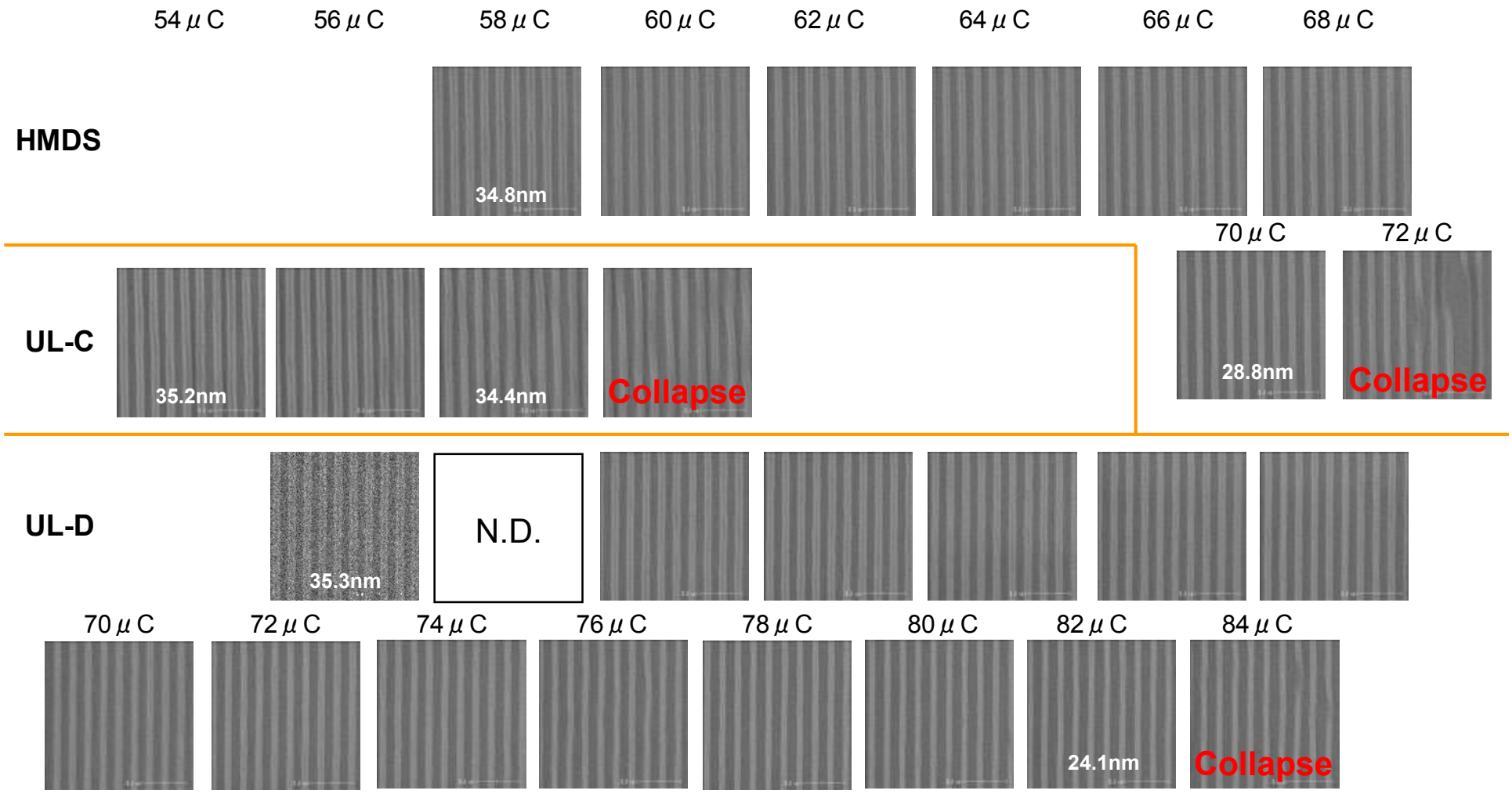
- Low electron attraction unit
- Hydrophobic unit
- Low Litho performance for polymer PR



Adhesion performance (CD 35nm)

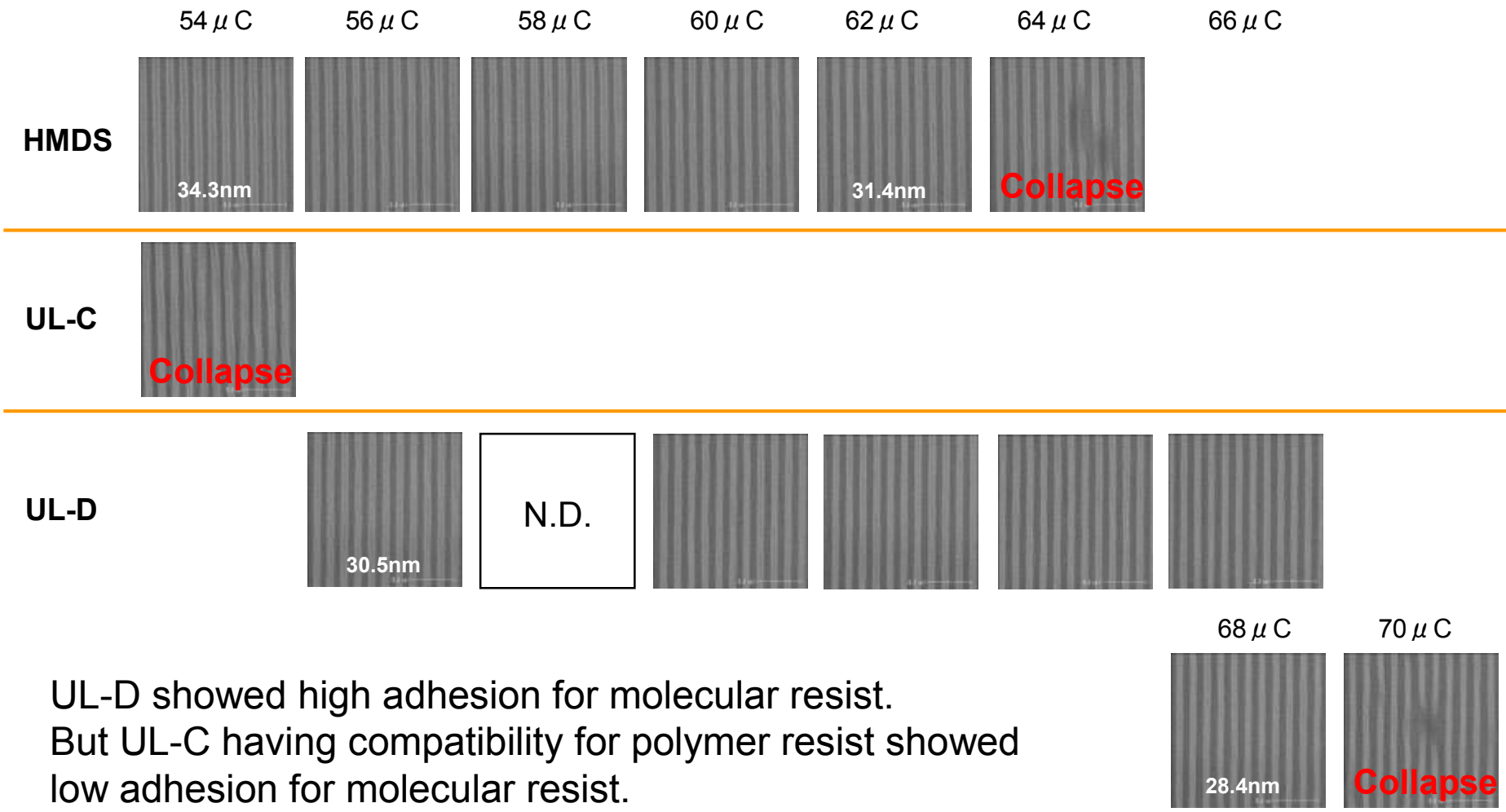
EUV

Challenging and Solution by x-layer



Adhesion performance (CD 30nm)

EUV
Challenging and Solution by x-layer



UL-D showed high adhesion for molecular resist.
But UL-C having compatibility for polymer resist showed low adhesion for molecular resist.

Conclusion

1. We investigated adhesion function unit of UL with EL margin of EB Lithography.

2. Higher adhesion was confirmed with using UL compare with HMDS treated Si-sub.

3. Regarding UL for polymer PR, EL margin on UL including interaction unit was improved.

4. Regarding UL for molecular PR, UL having compatible unit for polymer resist showed poor adhesion for molecular resist.
But UL having hydrophobic unit showed higher adhesion.

Acknowledgement
We'd like to thank for Idemitu Kosan Corporation: Providing resist.