DuPont Electronics & Imaging

October 2018

Advanced Patterning Technologies

George Lu, China Business Director
Litho Technologies, DuPont Electronics & Imaging

Outline

- FinFET Implant
- Multiple Patterning
- 3D NAND
- EUVL
- DowDuPont™ Merger Update

Innovative Solutions for Industry Challenges

Lithography	Challenges	Our Solutions
FinFET Implant	Gap filling & planarization Wet etch compatibility Small CD <80nm	KrF/ArF BARC or UL KrF/ArF Resist
SADP or SAQP LELE or LELELE	LWR, PW, Defectivity, Cost reduction	193i Resist NTD BARC/HT-SOC TC/CTO
3D NAND	Staircase Patterning, channel hole CDU	Thick DUV Resist PTD/NTD BARC 193i Resist
EUV Lithography	PW, LWR, Sensitivity, Defectivity	EUV Interlayer EUV Trimming OC

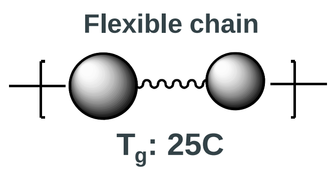
FinFET Implant

Material Solutions

Improving Gap Fill/Planarization & Wet Etch Resistance

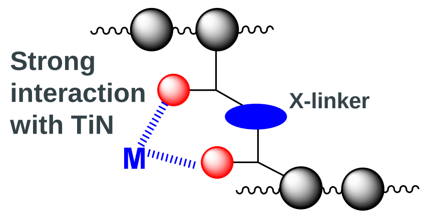
Low T_g polymer

- Flexible chain to reduce Tg
- Small Mw for gap fill and planarization



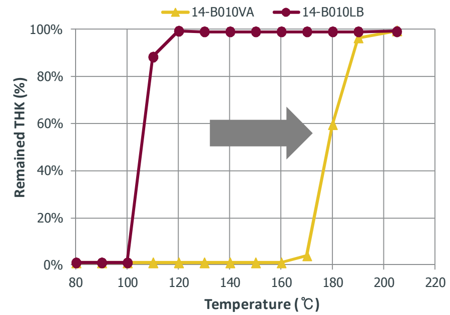
New X-linker

- No by-product → less shrinkage
- Lower CA & better adhesion on metal sub.



New TAG

- High decomposition temp. → slow X-linking
- Maximize thermal mobility during curing



Sample	Film shrink	Contact Angle	X-linking temp	GF @10nm gap, TiN	Wet etch resistance (peel off time)		
					$NH_4OH:H_2O_2:H_2O$ = 1:1:2, 50 ˚C, TiN	H_3PO_4 :H_2O_2= 1:1, 60˚C, TiN	HCl:H_2O_2=1:1 60˚C, TiN
B101LB	240A	70º	100C	Void	30sec	1.5min	-
AR™ 274	52A	65º	170C	No void	65sec	6min	>10min

AR™ 274 BARC: <10nm Gap Fill & Resistance to SC-1

- **Excellent gap fill w/o void for <10nm gap on TiN substrate**
- **Good wet etch resistance : SC-1, H_3PO_4 /H_2O_2, HCl/H_2O_2**
- Good planarization
- Optimal optical property (n/k) compatible with KrF and ArF lithography

Curing temp.	n/k	Etch rate to UV™ 1610	Reflectivity (1200A on Si)	Gap fill	Planarization	Compatibility with RRC thinner
205C~215C	1.72/0.18 @248nm 1.77/0.17 @193nm	x 1.7 (H_2/N_2)	<3.0%	**No void <10nm gap**	Small I-D THK bias	Good w/OK73

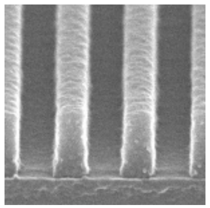
Wet etch resistance

Adhesion on TiN wet etch

$NH_4OH:H_2O_2:H_2O$ = 1:1:2, 50˚C	65sec
H_3PO_4 :H_2O_2 = 1:1, 60˚C	6min
HCl:H_2O_2 =1:1, 60˚C	>10min

Litho performance

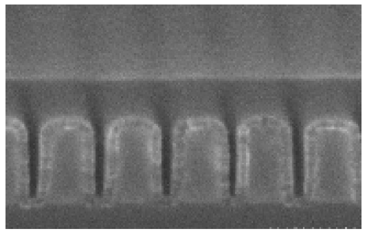
100nmTrench / 240nm Pitch



UV™1660, ASML/850, 0.80NA, 0.70/0.35s, Annular, Binary

Gap fill @10nm trench

TiN on oxide /
Depth=100nm/Gap CD=10nm



AR™ 277 BARC: Further Improvement in Gap Fill (<7nm) & Wet Etch Resistance

- **Excellent gap fill w/o void for <7nm gap on TiN substrate**
- **Excellent wet etch resistance : SC-1. H_3PO_4 /H_2O_2, HCl/H_2O_2**
- Good planarization
- Optimal optical property (n/k) compatible ArF lithography

Curing temp.	n/k	Etch rate to UV™ 1610	Reflectivity (1200A on Si)	Gap fill	Planarization	Compatibility with RRC thinner
205C~215C	1.69/0.00 @248nm 1.71/0.40 @193nm	x 1.3 (H_2/N_2)	<3.0%	**No void at <7nm gap**	Small I-D THK bias	Good w/OK73

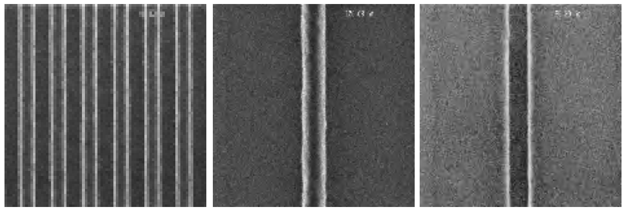
Etch Rate

Adhesion on TiN wet etch

NH_4OH:H_2O_2:H_2O = 1:1:2, 50˚C	190sec
H_3PO_4 :H_2O_2 = 1:1, 60˚C	>10min
HCl:H_2O_2 =1:1, 60˚C	>10min

Litho Performance

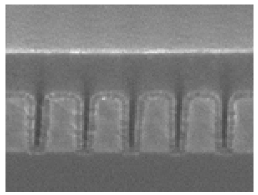
Nikon 610C, 1.35NA, Annular, 0.835/0.589s



100nmTrench / 210nm Pitch — 110nm Line / 700nm Pitch — 80nm Trench / 700nm Pitch

Gap fill

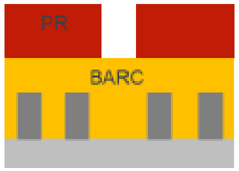
TiN on oxide
Depth=100nm
Gap CD=10nm



No void

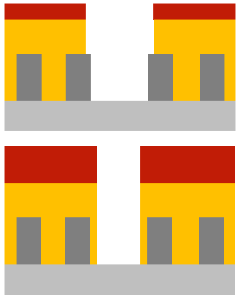
Reducing Etch Bias by Developing Fast Etching BARCs

Post-Development



Thick BARC to cover high topography

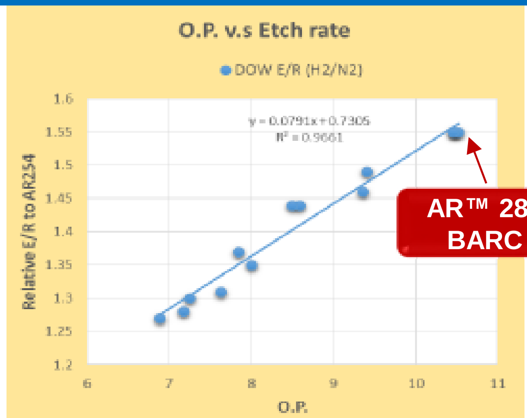
Post-BARC Open



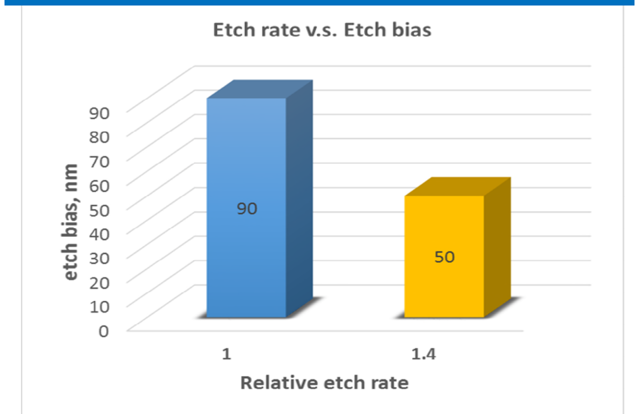
- **Slow etch rate**: Large etch bias
- Need narrower ADI CD to hit ACI CD target

- **Fast etch rate**: Small etch bias
- Able to relax ADI CD

High Ohnishi parameter for fast etch rate



Fast etch rate reduces etch bias



AR™ 284 BARC: Super-Fast Etching Rate

- **Super-fast etch rate : x 3.2 compared to UV™ 1610 KrF resist**
- Small etch bias
- Good gap fill and planarization
- Optimal optical property (n/k) for ArF lithography

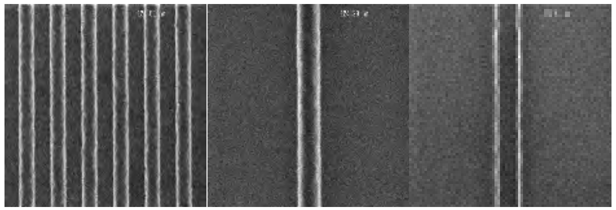
Curing temp.	n/k	Etch rate to UV™ 1610	Reflectivity (1200A on Si)	Gap fill	planarization	Compatibility with RRC thinner
205C~215C	1.79/0.23 @193nm	x 3.2 (H_2/N_2)	<3.0%	No void at <20nm gap	Small I-D THK bias	Good w/OK73

Etch Rate

Material	Etch gas H_2/N_2
UV™ 1610 KrF resist	x 1.0
AR™ 254 BARC	x 2.1
AR™ 274 BARC	x 1.7
AR™ 284 BARC	**x 3.2**

Litho Performance

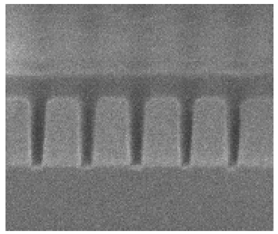
Nikon 610C, 1.35NA, Annular, 0.835/0.589s



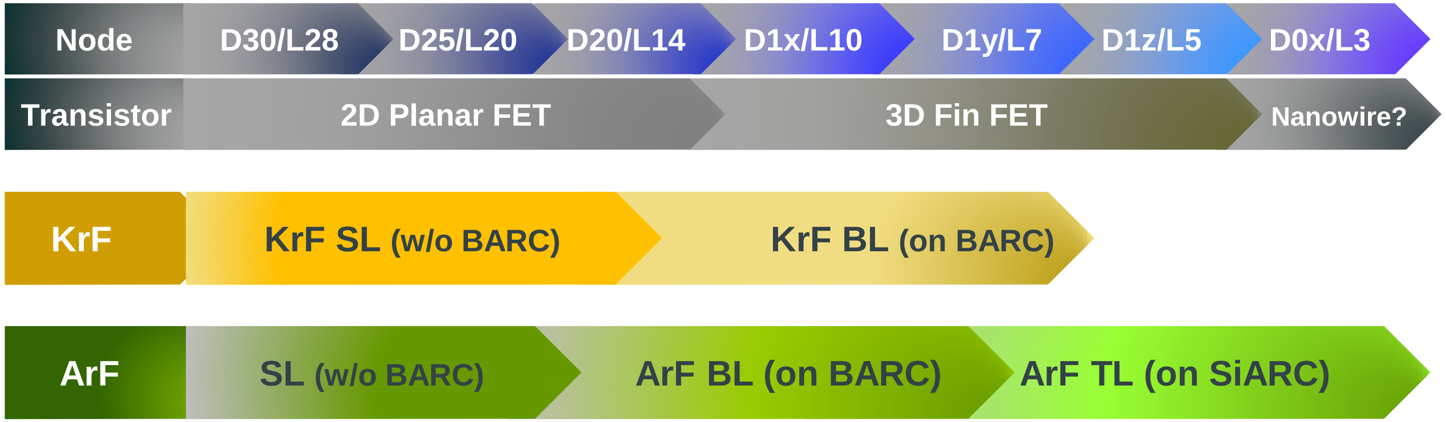
100nmTrench / 210nm Pitch | 110nm Line / 700nm Pitch | 80nm Trench / 700nm Pitch

Gap Fill

SiO_2, Depth=100nm, Gap CD=20nm



248nm/193nm Implant Resists for FinFET



- 193nm implant being extensively adopted from 7nm and below
- Resolution (small pitch and iso space), LWR and 2D features
- Tool availability (248 or 193nm scanner)
- Cost (scanner and materials)

DowDuPont’s KrF Implant Resist Portfolio

65nm | 45nm | 28nm | 20nm | 16/14nm | 10nm 7nm

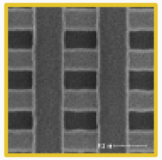
Feature size	180-200nm	140-180nm	100-140nm

KrF SLR w/o BARC

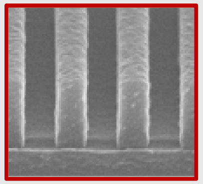
UV™ 168G
- Wide process window
- Low CD Swing

UV™ 1610
- Good scum performance on poly topography
- FT=180-400nm

UV™ 1630
- Improved scum performance and line distortion on FinFET topography.



KrF Bilayer w/ BARC

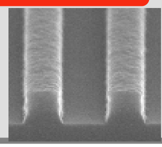


UV™ 1660 ★
- **Good performance on AR™254**
- **Improved resolution/DOF /profile at 100nm trench**

KrF SLR Negative

UVN™ 2300
- General 248nm Negative tone Resist

UVN™ 2310 / 2320
- FT=300-1000nm



UVN™ 2330 ★
- **FT=200-6000nm**
- **High resolution and wide PW**

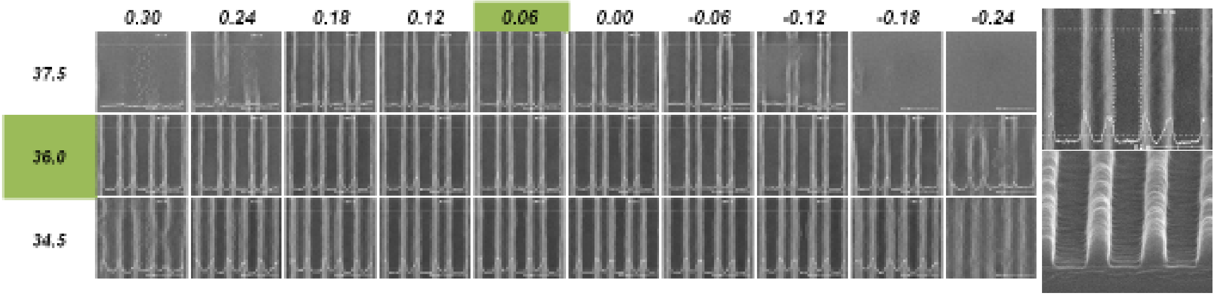
UV™ 1660 KrF Resist: Wider DOF & Better Profile on BARC

100nm dense trench (240nmP) on BARC (AR™254) / 0.80NA, 0.70/0.35s Ann.

UV™ 1610

SB/PEB
=100C/120C

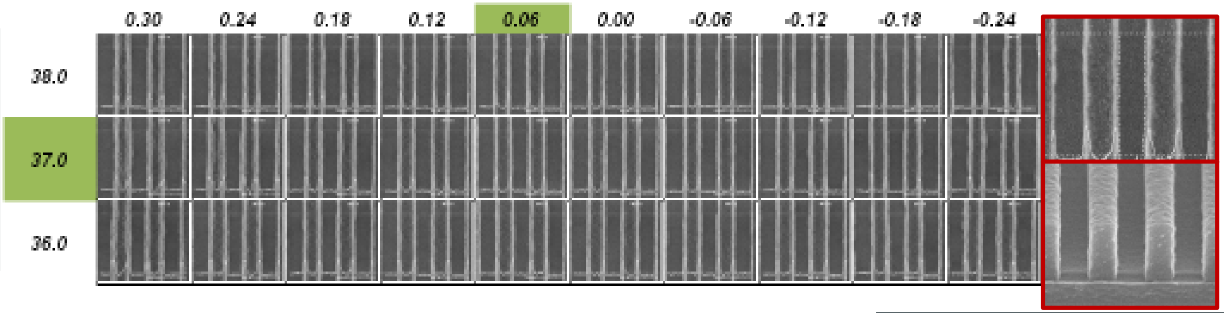
Mask CD = 120nm



UV™ 1660

SB/PEB
=100C/120C

Mask CD = 120nm



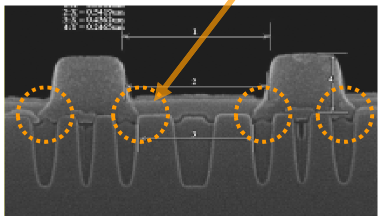
- **UV™ 1610 Resist designed for no BARC**
- **UV™ 1660 Resist designed with BARC**

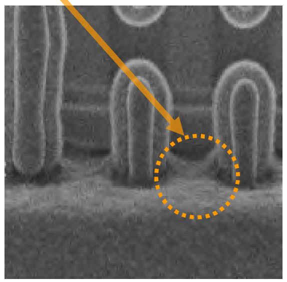
Process Condition

Substrate:	AR™254 BARC (120nm, 205C/60s)
Thickness:	280nm
SB:	**100ºC,**
Exposure:	NA=0.80, Sigma=0.70/0.35 Ann.
PEB:	**120ºC,**
Develop:	MF CD-26, 60s, LD-Nozzle

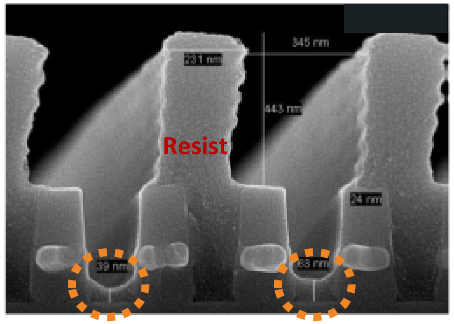
Resist Footing over Topography

Footing / Residue issue



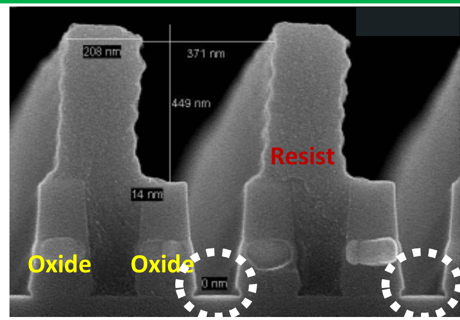


248nm Positive resist



Heavy footing

248nm Negative resist



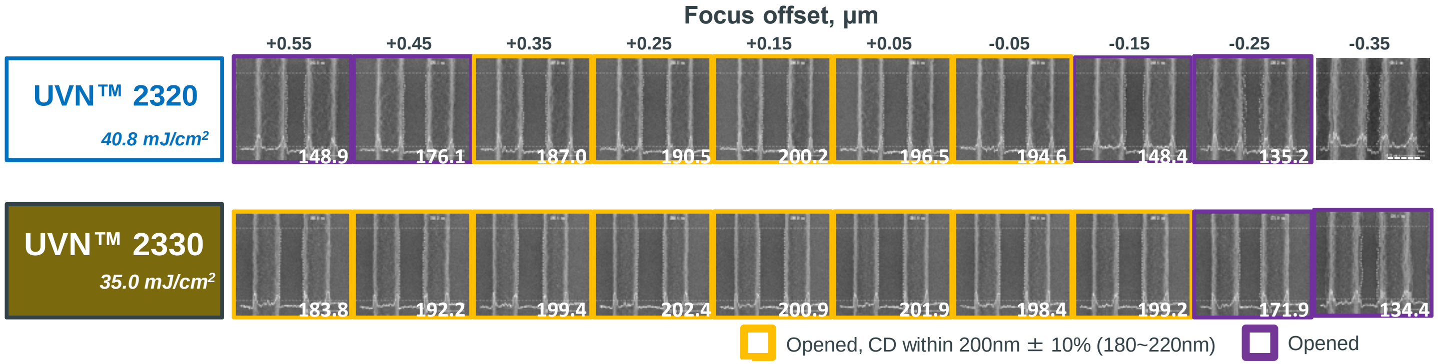
No visible footing

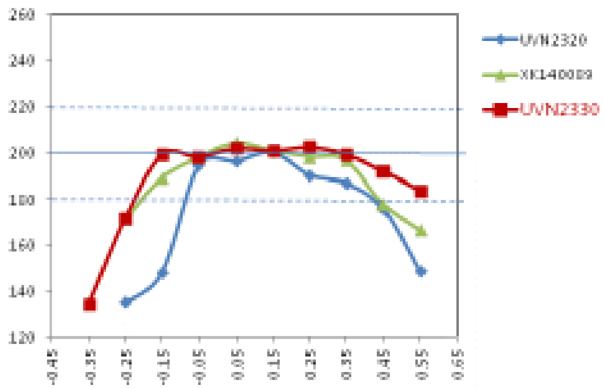
Positive-tone resist: Footing/residue usually caused by low light intensity at the bottom and shadowing effect

Negative-tone resist: No footing/residue

UVN™ 2330 Resist: Wider Process Window

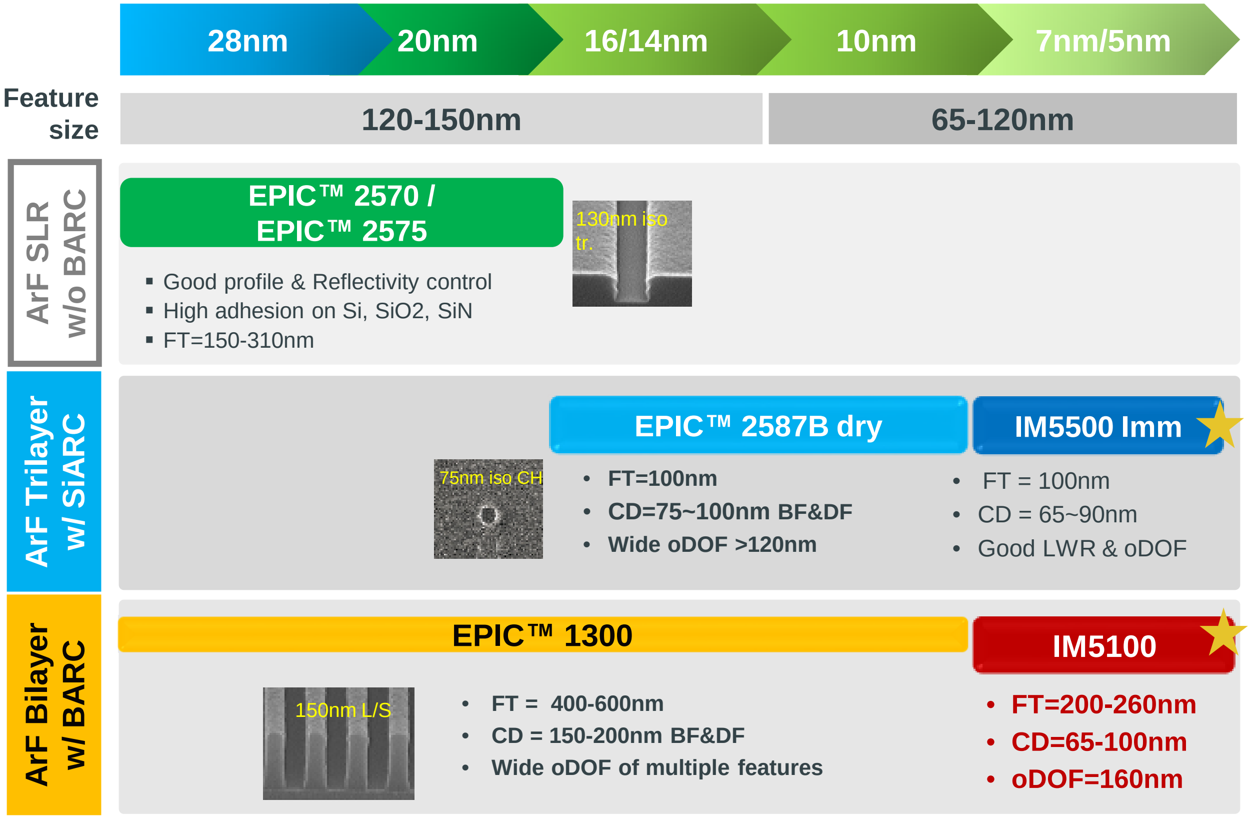
200nm 1:1 Dense Trench on bare Si



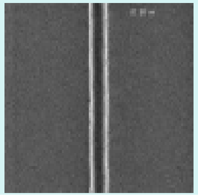
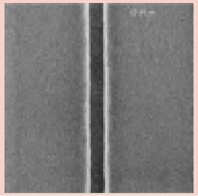


Substrate: 200mm Si
Prime: : HMDS Vapor, 120ºC, 35sec.
SB : 100°C/60sec
Thickness: 318 nm
Exposure: ASML/850, 0.68NA, 0.65PC, Binary MASK, Dark field
PEB : 120°C/60sec
Develop : MF™ CD-26 Developer, 23°C, SP60sec

DowDuPont's ArF Implant Resist Portfolio

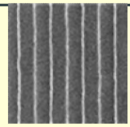
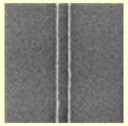
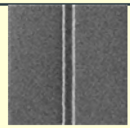
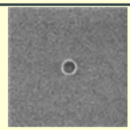
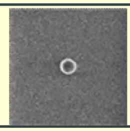


IM5100 Resist: Good LWR and DoF on BARC

Pattern	Top & Down View	Parameter	IM5100
100nm/210p Dense Trench (Mask CD : 100nm/210P)		Eop	32mJ
		DoF margin (nm)	> 200
		E-slope (nm/mJ/cm^2)	3.25
		LWR (nm)	4.0
90nm/700p Isolated Line (Mask CD : 110nm/700P)		DoF margin (nm)	180
		E-slope (nm/mJ/cm^2)	3.85
		LWR (nm)	3.1
65nm/700p Isolated Trench (Mask CD : 85nm/700P)		DoF margin (nm)	160
		E-slope (nm/mJ/cm^2)	2.88
		LWR (nm)	4.5

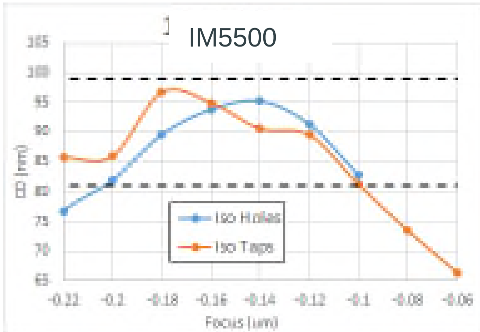
BARC	Single oBARC on Si wafer
Resist thickness	2600 Å
Exposure	NIKON S610C 0.93NA, Annular Sigma: 0.8/0.51 XY pol.
Mask	Binary
SB/PEB	110C/60s, 100C/60s

IM5500 Resist: Excellent DOF on SiARC

Resist	IM5500	
Eop	18.7mJ / 18.0% @75nm/180nmP	
DOF 75nm/180nmP	**>180nm**	
DOF 75nm iso Space	**>150nm**	
DOF 90nm iso Line	**>150nm**	
DoF 90nm Iso Hole	**120nm**	
DoF 90nm Iso Post	**120nm**	
oDoF Iso Holes/post	**115nm**	

DoF calculated with ProData at 5% EL

Stack	AR™104 oBARC, 400Å, 175°C/60s XS-110532CA SiARC, 220Å, 240°C/60s
Resist FT	1000Å
Soft-bake	85°C/60s
Exposure	ASML/1900i
Illumination	**1.35NA** , Annular, 0.80o/0.40i
Mask	85nm/180p Space sized to ~75nm 1:8 Iso-Space sized to ~75nm 1:8 Iso-Line sized to ~90nm 1000p Iso-CH sized to ~90nm 1000p Iso-Post sized to ~90nm
PEB	95°C/60s
Development	GP-12s



Summary: Our Implant Solutions for FinFET

Single layer

248nm Resist
- UV™ 1610
- UV™ 1630
- UVN™ 2330

193nm Resist
- EPIC™ 2570

Bilayer

248nm Resist
- UV™ 1660

193nm Resist
- IM5100

BARC
- AR™ 254 (GF>10nm)
- AR™ 274 (GF>5nm)
- AR™ 277 (GF>3nm)
- AR™ 284 (FE)
- AR™ 201 (GF>5nm)
- AR™ 210 (UT)
- AR™ 602 (DBARC)

Trilayer

248nm Resist
- UV™ 1660
- UV™ 217G

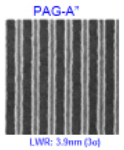
193nm Resist
- EPIC™ 2587B
- IM5500

Underlayer
- AR™ 274 (GF>5nm)
- AR™ 277 (GF>3nm)
- AR™ 284 (FE)
- AR™ 201 (GF<5nm)

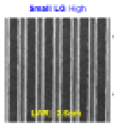
Multiple Patterning

Material Solutions

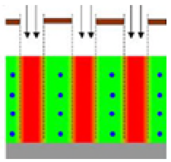
Continuously Improving LWR for Spacer Multiple Patterning



- Low diffusion PAGs
- Optimization of monomer ratio

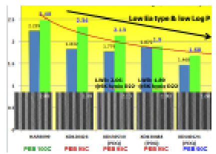


New LG with
small size & low Ea

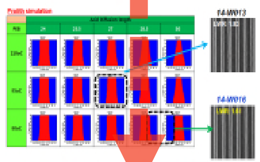


PDQ
(Photo Decomposable Quencher)

Current status



Low log P polymer



Higher PAG loading
with low PEB temp.

2.5 — LWR — 1.5 — <1.3

Various Resist Factors Affecting LWR

Exposure

- Polymer aggregation
- PAG distribution

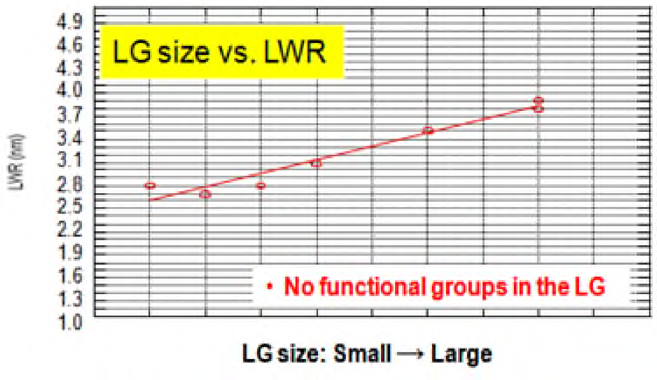
PEB

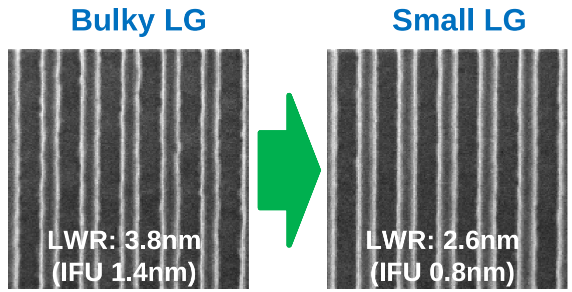
- Deprotection efficiency
- Leaving group size
- Acid diffusion
- Quenching efficiency

Development

- Dissolution rate
- Log P

Small Polymer Leaving Group Improves LWR

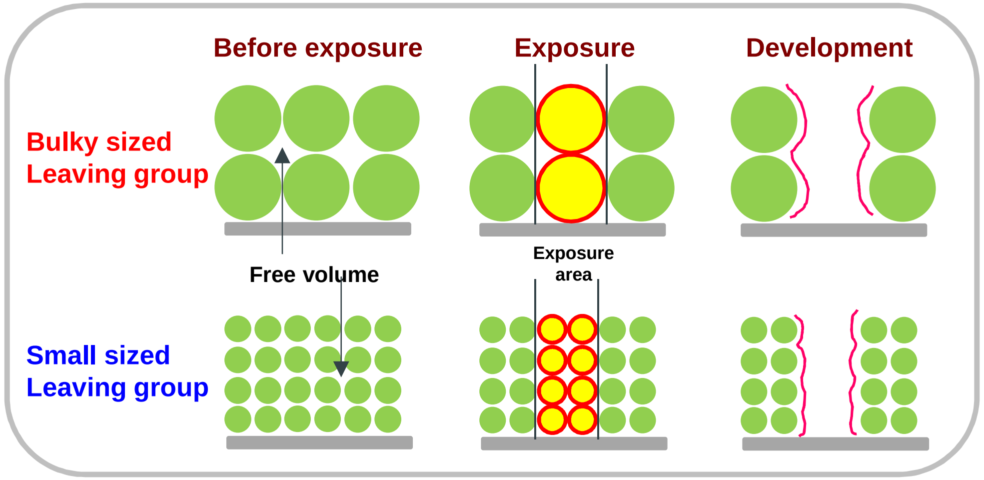




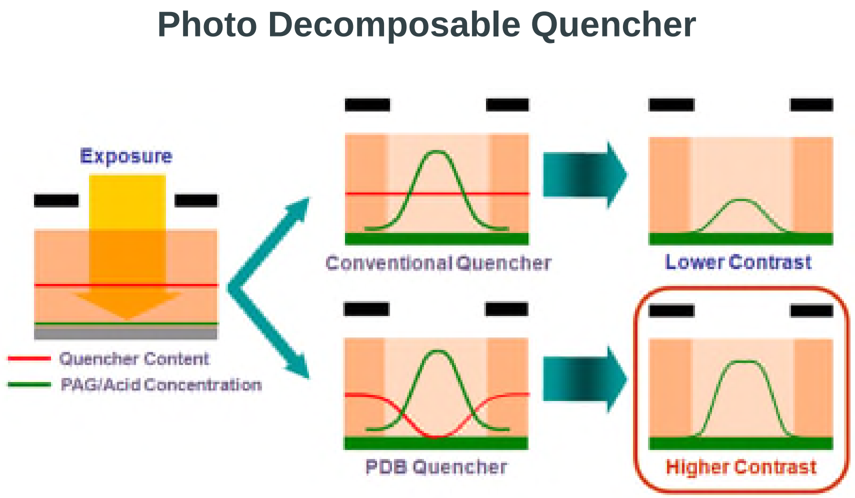
45nm/90p L/S, 1.30NA Dipole-35Y
(0.97/0.78s)

Small size leaving group:

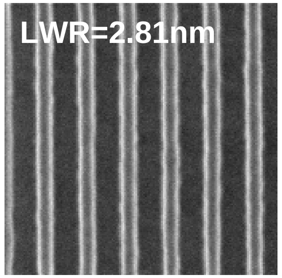
Smaller free volume after deprotection → better LWR



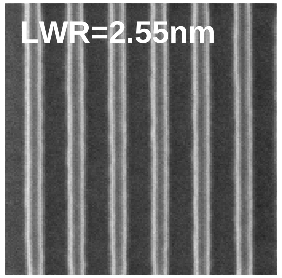
PDQ Improves LWR with Better Acid Contrast



Conventional quencher



PDQ



- Photo Decomposable Quencher enhances acid contrast
- Improves resolution, LWR an MEEF

L/S ArF Photoresist Offerings

Node | D30/L28 | D25/L20 | D20/L14 | D1x/L10 | D1y/L7 | D1z/L5

Dry

EPIC™ 1300

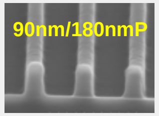
- FT = 400-600nm, CD = 150-2000nm BF&DF
- Wide oDOF of multiple features

EPIC™ 2155

- FT=200-260nm BF &DF
- Wide DOF

EPIC™ 2150

- FT=170nm BF &DF
- Wide DOF (480nm)



Immersion

w/ TC

EPIC™ 3013/4013

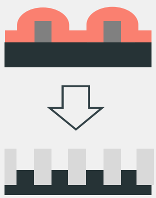
- Good LWR
- FT=90-120nm, CD=45-50

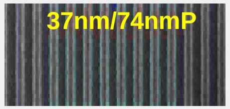
EPIC™ 2099/3099

- Good LWR (<3.2nm)
- Good DOF and PCM
- FT=90-120nm, CD=40-45

TC-free

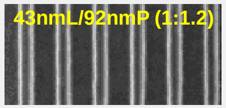
SADP





IM™5033 ★

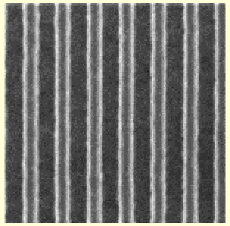
- Super dense LS (1:0.9 – 1:1) & high resolution at 2D Patterns
- LWR<2.8nm, FT=80-110nm, CD=37-65nm



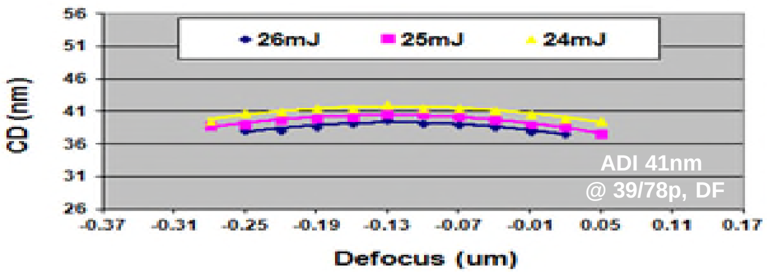
IM™5035 → IM™0208 ★

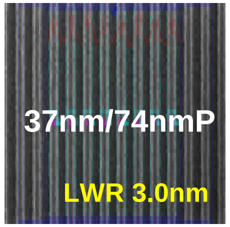
- Dense LS
- LWR<1.6nm, FT=80-100nm, CD=40-45nm

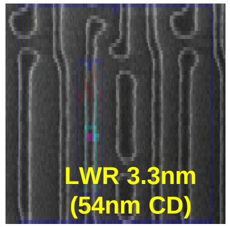
EPIC™ IM5033 Immersion Resist for SADP

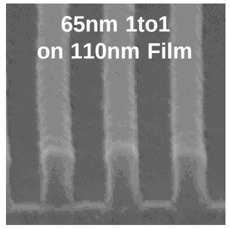
Resist	EPIC™ IM5033
Best image ADI 41nm @ 39/78p, DF	
Dense Esize [mJ]	25.1
Dense EL% @ 10%	30.8
Dense EL[nm/mJ] @ 10%	1.16
BDM [nm]	50.5
PCM [nm]	35.9
Dense FL [nm] @ Es	300
3σ LWR [nm]	**2.8**
3σ of 20pts CD	0.7

Application: Mandrel, Poly & Metal layers



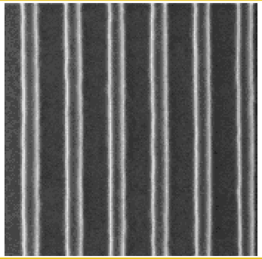
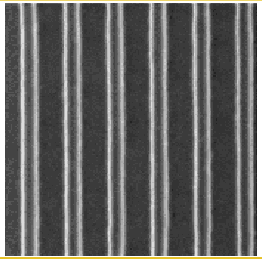






- Dow OBARC – dual layered
- Binary mask
- ASML 1900i, Dipole 35Y X-pol, 1.35NA, 0.98/0.86
- 41nm LS @ 39/78p

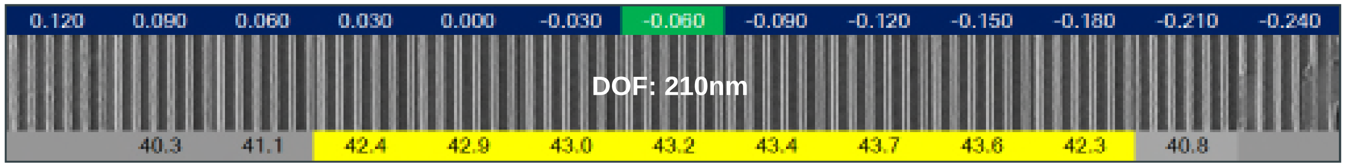
EPIC™ IM0208 Resist Further Improves LWR

Resist	EPIC™ IM™5035	EPIC™ IM0208
Top down Image 43nmL/92nmP (1:1.2)		
Eop [mJ/ cm2] @ Dow	**19.1mJ**	**18.9mJ**
EL [%] @ 10% CD	**17.3**	**18.5**
EL [nm/ mJ]	**1.21**	**1.24**
Patter collapse CD(nm)	**33.8**	**34.3**
LWR[nm]@3 sigma	**1.61**	**1.5**
DOF@ Eop	**180**	**210**

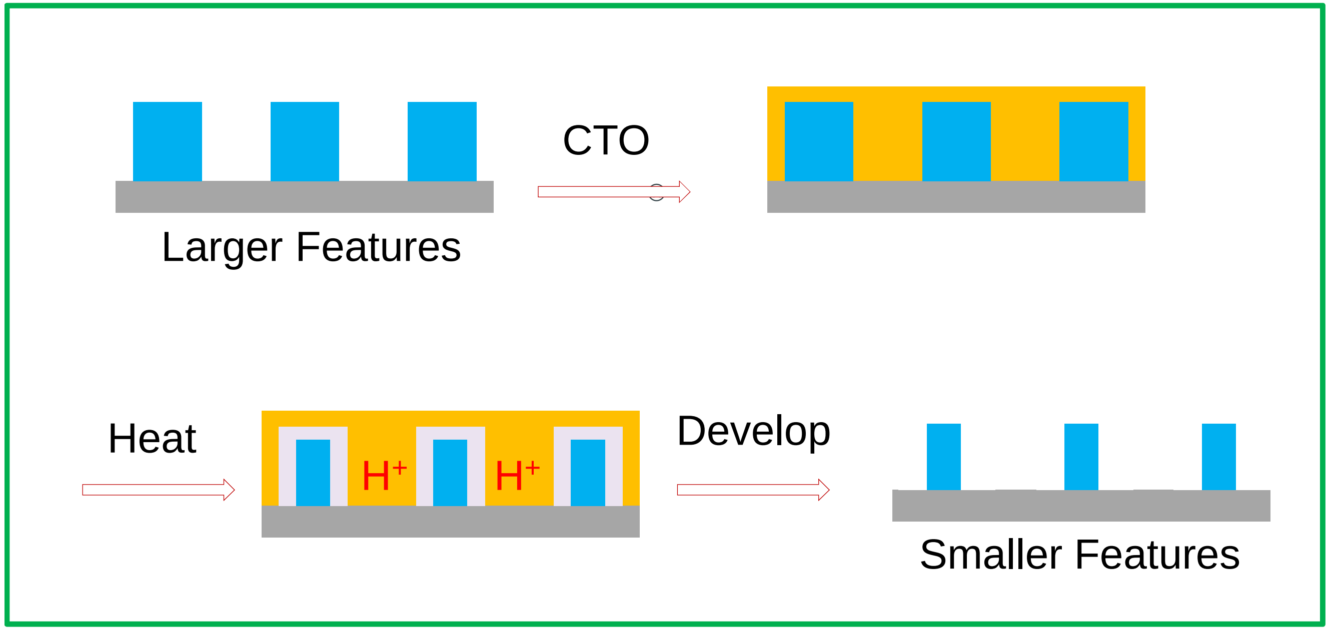
EPIC™ IM0208

- **Excellent LWR below <2nm**
- **Wide process margin for LS**

- Dow oBARC – dual layered
- PSM mask
- Nikon610C, Dipole 35Y X-pol, 1.30NA, 0.98/0.78
- 43nm line/92nm pitch_1:1.2
- Resist thickness: 800Å
- SB/PEB: 110C/90C/60s

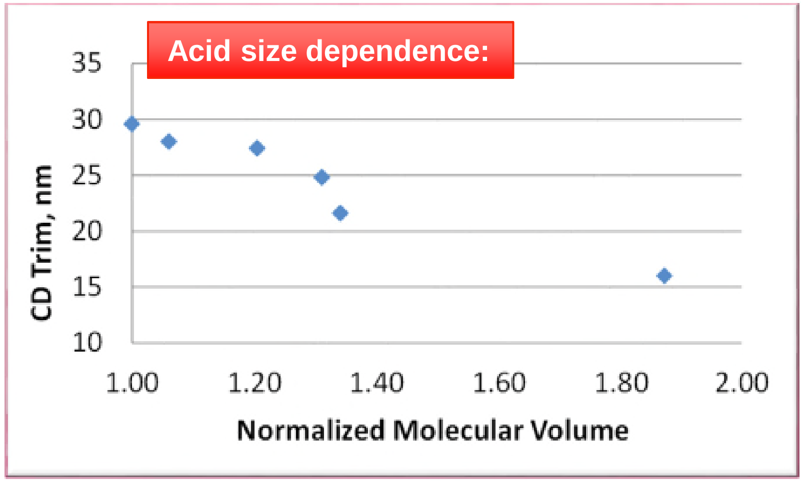


CTO™ Resist Line Trimming Materials

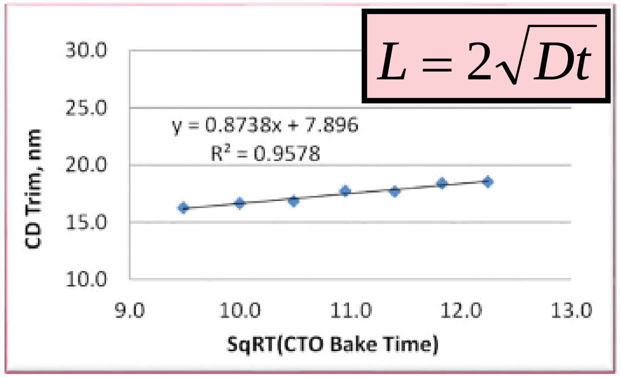


C. Liu et al., Chemical Trimming Overcoat: An Enhancing Composition and Process for 193nm Lithography, *Proc. SPIE* 2016** ***paper 9779-67

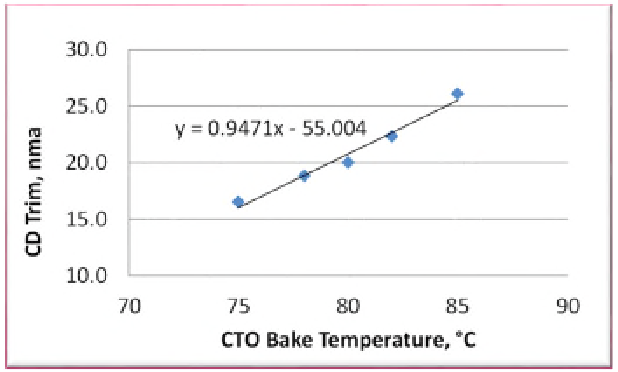
Acid Diffusion Controls the Amount of Trimming



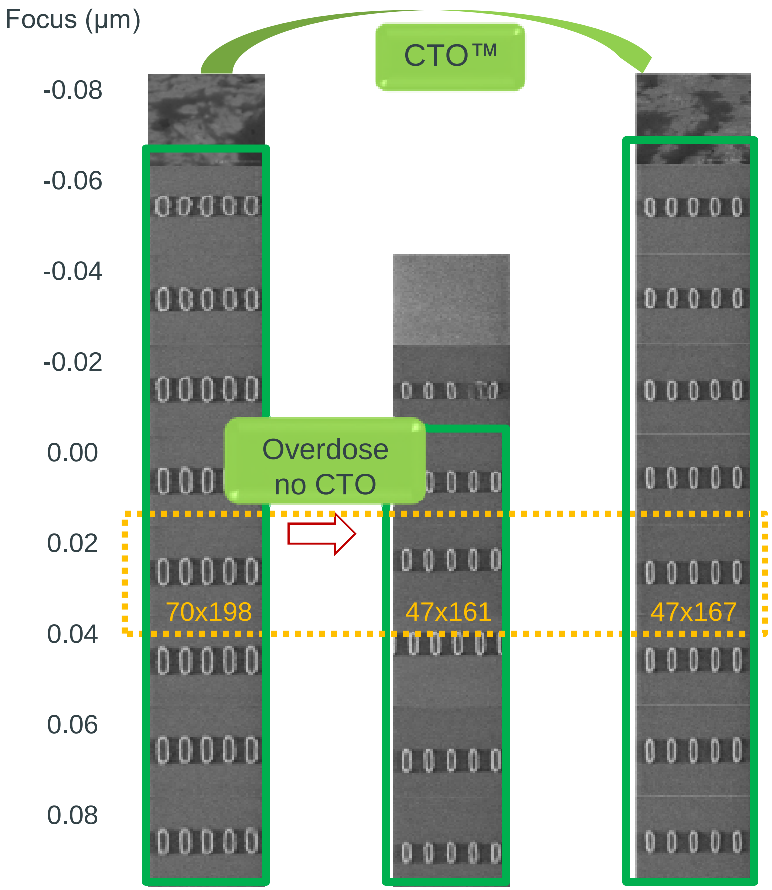
Fickian Diffusion mechanism

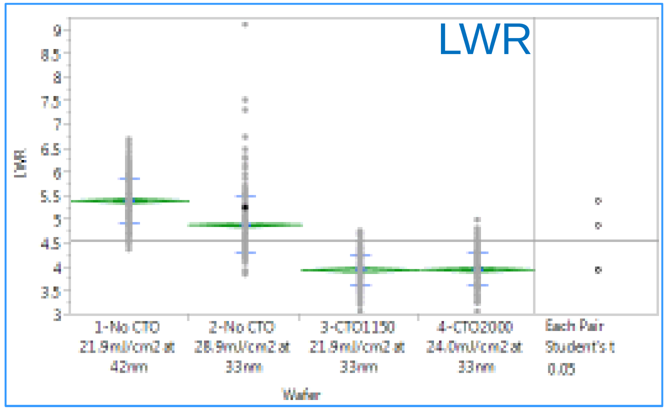


Temperature dependence



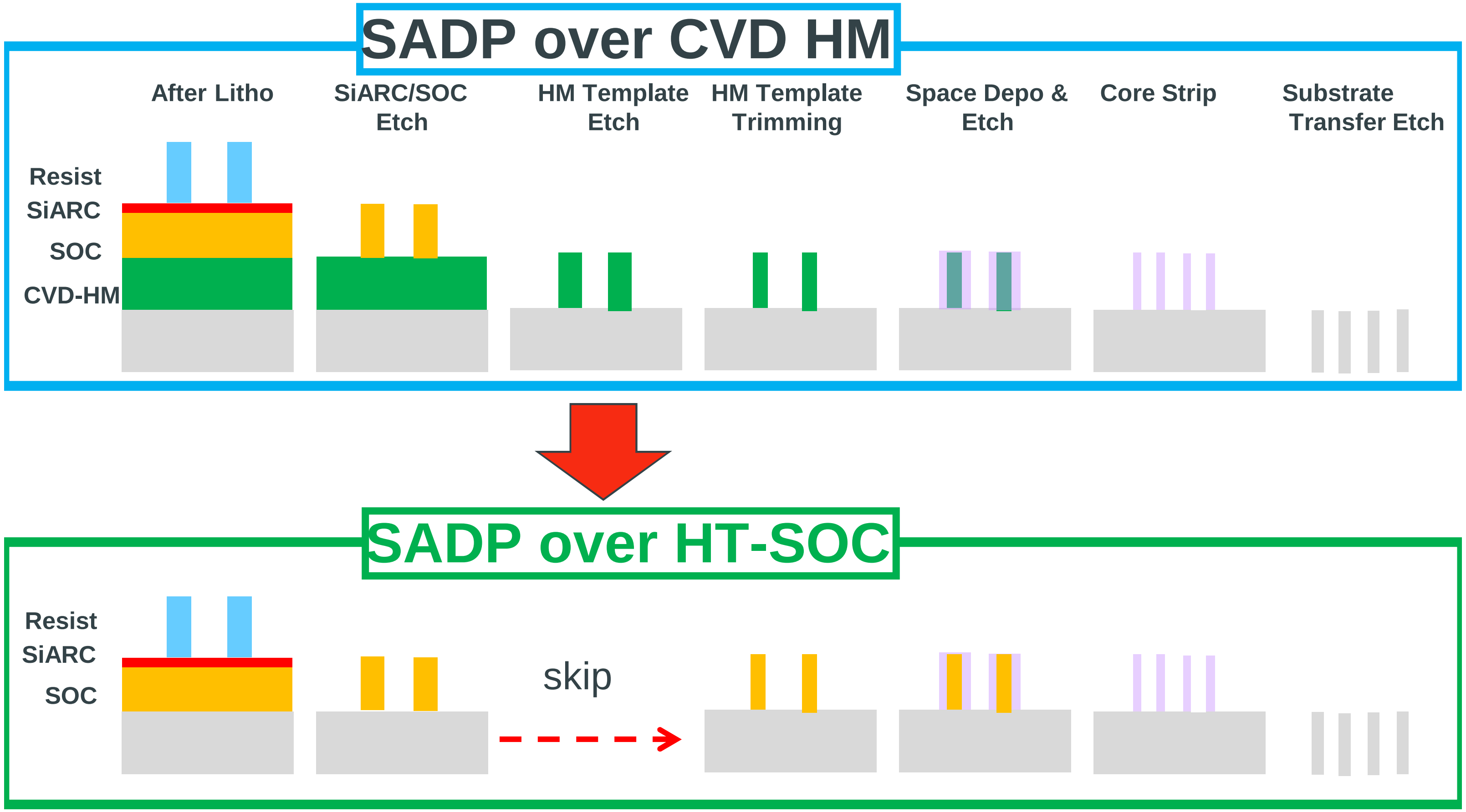
CTO™ Overcoat Offers Excellent Process Window & LWR





- CTO™ overcoat offers better process window and pattern profile than over-exposure process
- CTO™ overcoat improves LWR

Simplify SADP Process through Spacer over HT-SOC



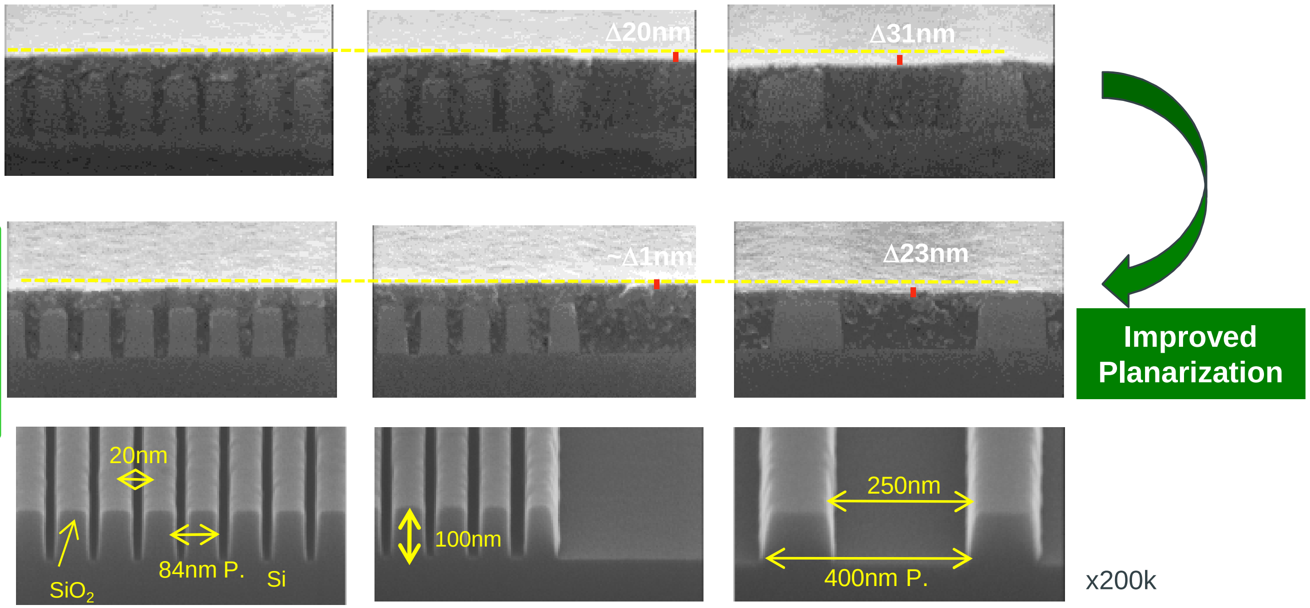
Improved Performance with New HT-SOC Platform

New HT SOC Platform → **Excellent Planarization**
Advantageous Gap Fill
Good Etch Resistance
Superior Thermal Properties

Gen 1
100nm FT
(400°C/60s/Air)

New Platform
100nm FT
(170°C/60s/Air +
450°C/10m/N_2)

Template Ref.



3D NAND

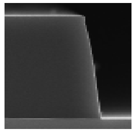
Material Solutions

DuPont Electronics & Imaging

Thick DUV Resist for 3D NAND

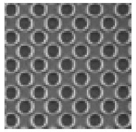
- Every challenging is from high aspect ratio
- Most challenging layers:
  - Staircase
  - Channel hole
  - Staircase contact

Staircase



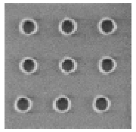
- Keep 4-6 litho steps for all generations by increasing thickness
- Need thick thickness: 12um for 128L
- Requires CDU, vertical profile, good thick film properties

Channel hole



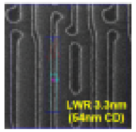
- Dense contact at 1500~2000A thickness
- PTD or NTD ArF resist
- Requires good CD uniformity

Staircase contact



- Semi-dense and isolated CH at 1300~1600A
- PTD or NTD ArF resist
- Requires overlap DoF

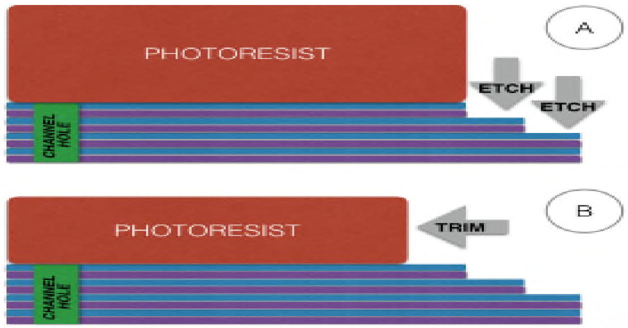
Metal line



- Dense L/S and 2D pattern at 900-1100A
- PTD or NTD ArF resist
- Requires LWR and overlap DoF for 2D-patterns

Requirements for Thick KrF Resist

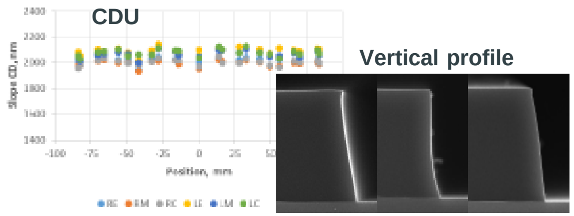
Thickness target : 12~15um for 128L and beyond



Required Performances

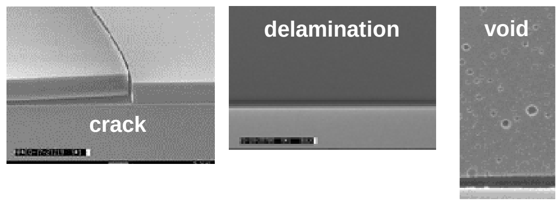
Patterning properties

- Good CD or slope CD uniformity
- Vertical profile: no tailing
- Fast photospeed

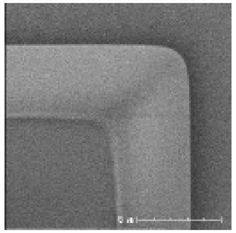
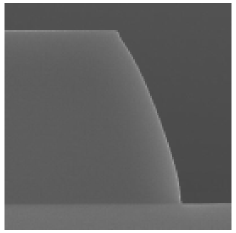
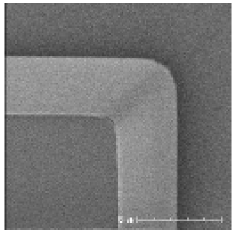
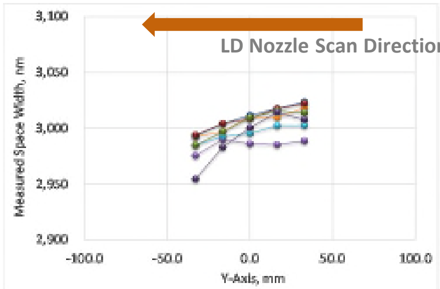
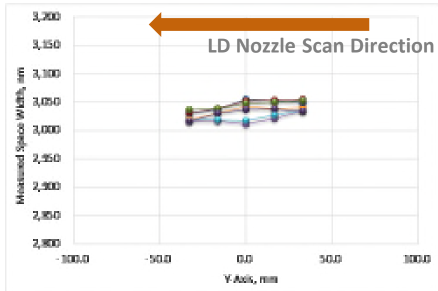


Thick Film properties

- No Crack or void
- No delamination
- Low viscosity
- Good coating uniformity



UV™ 1440 Resist: Improved CDU and Profile

Sample	17-K016BB (=17-K024AA)	UV™ 1440
Film thickness	12um	12um
SB/PEB	130C/110C	130C/110C
Esize @3.0µm L/S	98.6mJ	**48.0mJ**
Top view at bulk pattern corner & Vertical profile	 	 
In Wafer CDU, 3σ @3.0µm L/S	49.4nm	**38.8nm**
CD plot		
Viscosity (FT=12µm@1000rpm)	---	300cP

Exposure : ASML/850, 0.60NA-0.75s, Conv. , Binary mask
Development : MF™ CD-26, 23°C, 60sec, LD Nozzle

Our ArF iBARC Portfolio

Device node: 32nm → 28 → 20 → 14 → 10 → 7

Mid n value for thin film

AR™ 107 (1.85/0.29)

Thickness : 30 nm
Excellent stack coverage

AR™ 188 (1.77/0.33)

- High k(0.33) value
- Wide Process margin on metal layer

High n & low k 1st Gen

AR™ 124 (1.96/0.26)

- Thin film : 25 nm
- Good PR compatibility

AR™ 148 (1.96/0.27)

- High conformality
- Good coating over alignment

AR™ 137 (1.96/0.28)

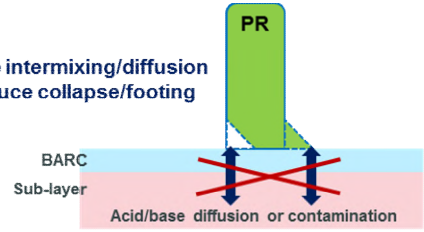
- Super fast etch rate
- Wide process margin

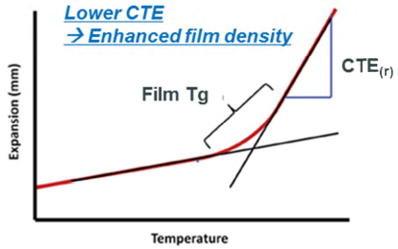
High n & low k 2nd Gen : High quality & NTD compatibility

- Low defectivity — AR™ 190 (1.96/0.28)
- NTD flexibility — AR™ 192 (1.96/0.27)

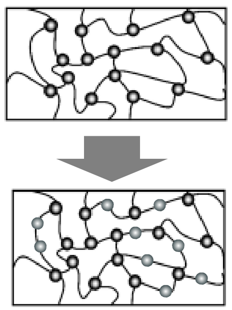
High X-linking Density by Polymer Chain Length Control

- High film density to reduce intermixing or diffusion with resist or substrate
- Film Tg & CTE as measurable index

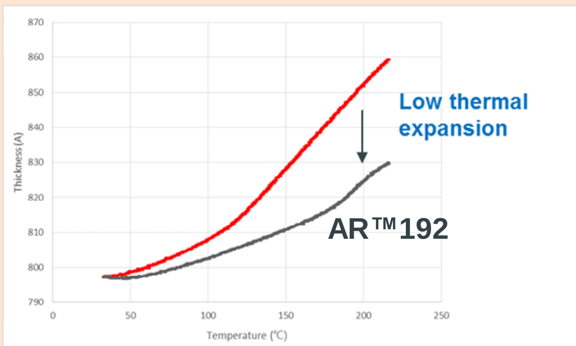




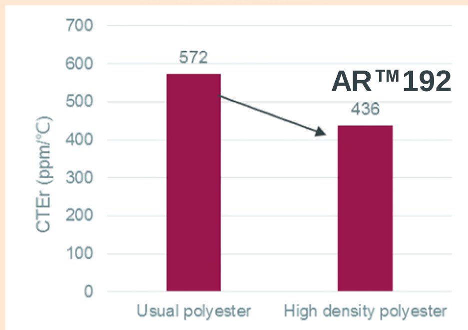
Low CTE by short chain length



Thermal expansion curve



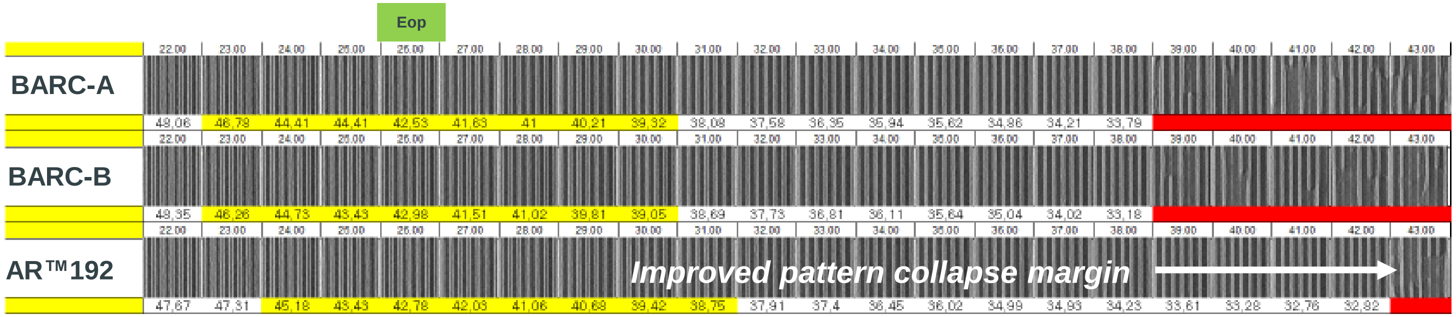
CTE decreased



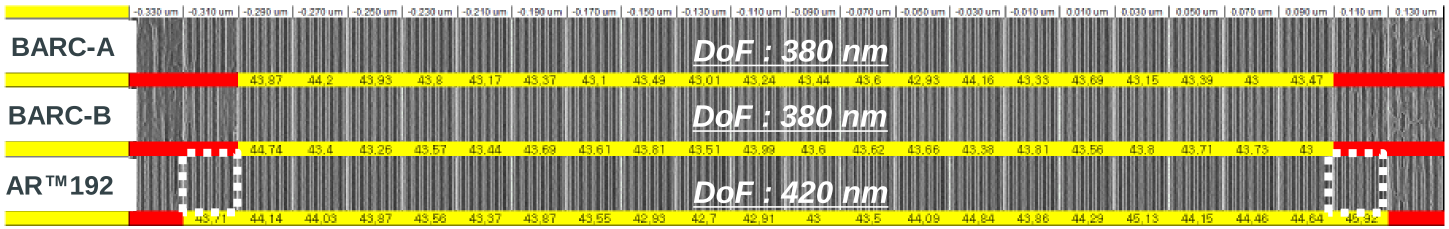
Wider Process Margin by High X-linking Density

Illumination: 1.30NA, Dipole 35X (0.98/0.78s), XY-pol.
PR : 15-W003, SB:110C/60sec, PEB:85C/60sec
BARC : 205C/60sec, Sub. : AR™46, 205C/60sec

EL margin 43/82p@43nm iL/S

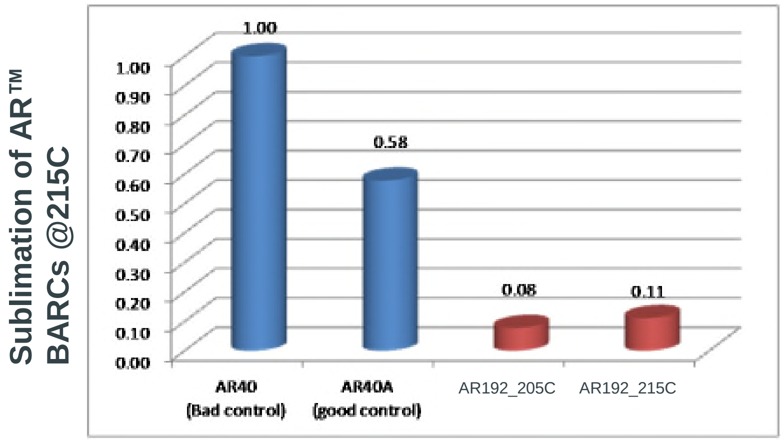


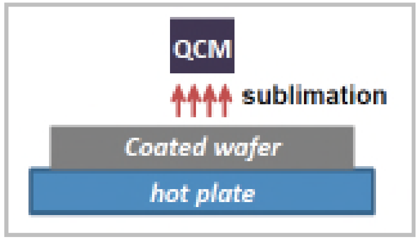
DoF margin

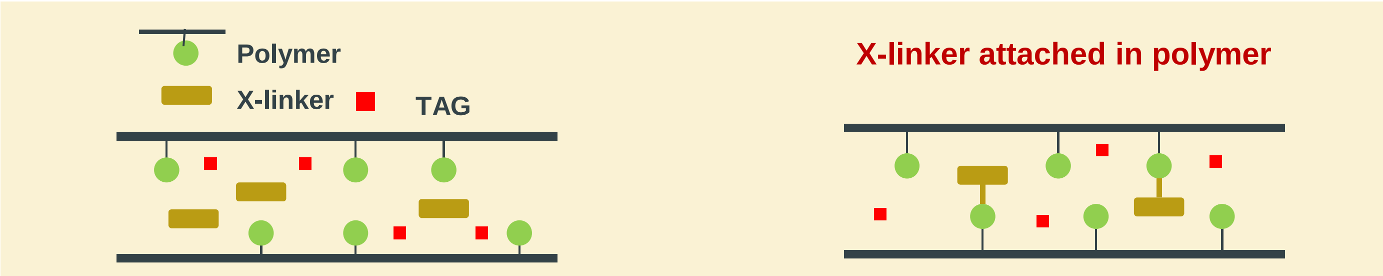


High X-linking degree improves pattern collapse and DoF margin

Low Sublimation by Attaching X-linker to Polymer







Small molecules such as X-linker is source for sublimation

Very low sublimation by attaching X-linker to polymer

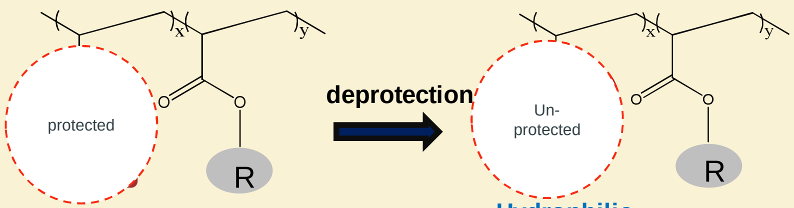
Hydrophilic Surface to Match NTD Process

Control of BARC surface energy

- Surface energy matching with exposed resist chemistry → Better adhesion
- Hydrophilic surface of BARC → Less interaction with hydrophobic developer

ArF Resist Chemistry change after exposure & PEB

Unexposed **Exposed**

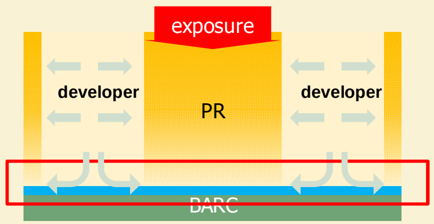


Hydrophobic
Water CA ~75 °

Hydrophilic
Water CA 60 – 65°

- **Solvent soluble**
- **High water contact angle**

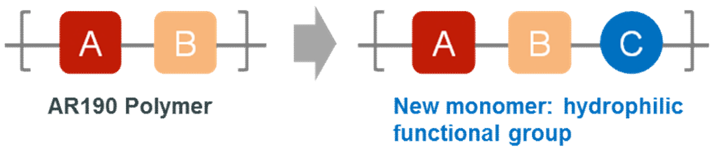
- **Solvent insoluble**
- **Low water contact angle**



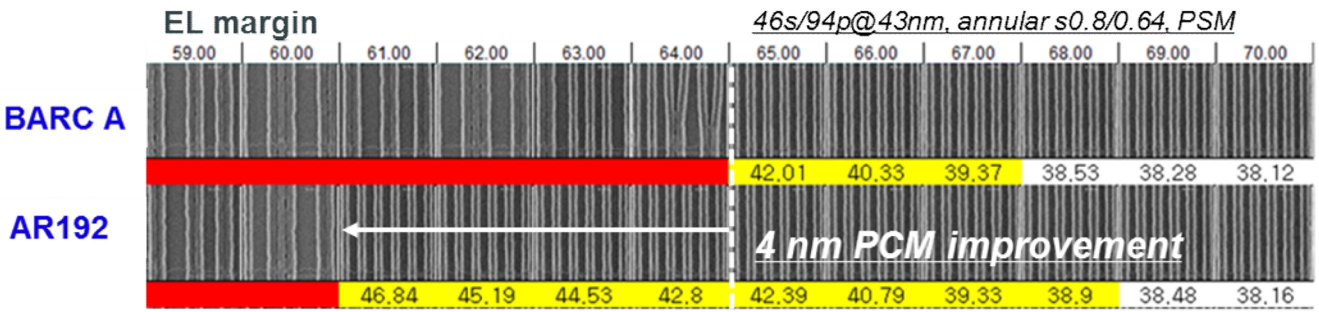
Hydrophilic surface: Less interaction with nBA

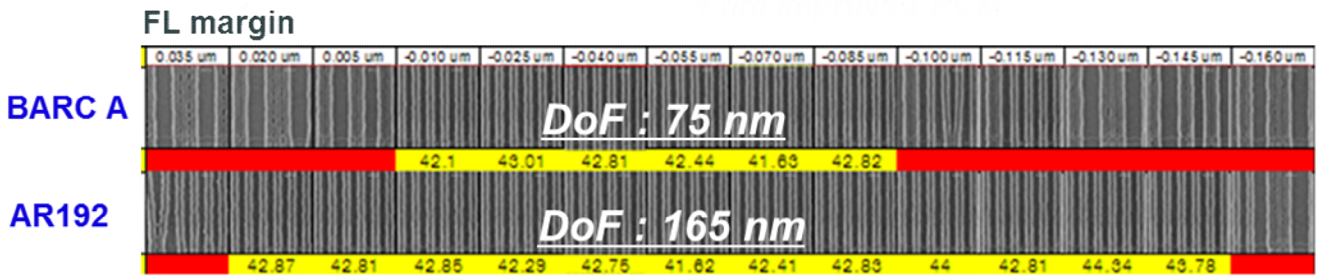
Hydrophilic BARC: better adhesion with exposed resist

Improved NTD Collapse Margin with Low Contact Angle



Sample	C.A.(˚)
BARC A	68
AR™ 192 BARC	62





Wider EL and DoF with improved collapse margin

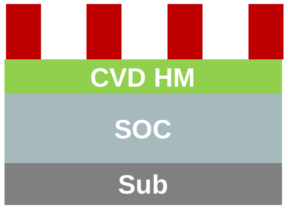
EUV Lithography

Material Solutions

DuPont Electronics & Imaging

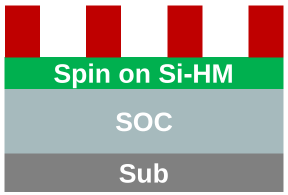
EUV Lithography Challenges

Quad layer

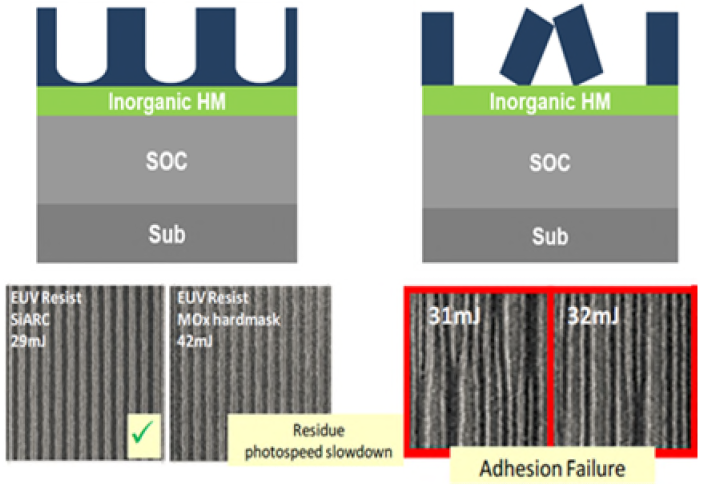


- Better etch selectivity
- Better post-etch LWR & CDU

Tri-layer



- Insufficient etch selectivity as Si-HM getting htinner



J. Vac. Sci. Technol. B 34, 06KG03 (2016).

- **Pattern collapse**
  Resist lines collapse due to poor adhesion to CVD HM and high aspect ratio.
- **Nano-bridging**
  Resist scum generates post etch bridges

✓ **DowDuPont is a leader in EUV IL materials**

DowDuPont™

Merger and Split

D u P o n t E l e c t r o n i c s & I m a g i n g

Bringing Together Two Complementary Portfolios
With Intention to Create Three Industry-Leading Companies

>300 year combined history of science & innovation creates formidable industry leaders equipped to grow

1

2

3

Specialty Products

Broad portfolio of market-leading offerings, proprietary and differentiated technologies and a robust pipeline

Electronics & Imaging

World's largest supplier with the broadest set of materials and technologies to solve complex problems for the semiconductor, circuit board, photovoltaic, display and printing industries.

Product Examples

Kapton®, Cyrel®, Tedlar®, IKONIC™, VISIONPAD™, AR™, EPIC™, SOLDERON™

Safety & Construction

Global leader in branded products including fibers & foams, aramid papers, non-wovens, solid surfaces, membranes and protective garments serving the worker safety, construction, oil & gas, energy, & transportation markets.

Product Examples

Tyvek®, Kevlar®, Nomex®, Corian®, Styrofoam®, Great Stuff®

Nutrition & Biosciences

Industry leader in bio-based ingredients and a biosciences pioneer serving the food, nutrition, pharma, home and personal care, biofuels and animal nutrition markets with healthier and more sustainable offerings.

Product Examples

Danisco®, Howaru®, Methocel™, Avicel®, Sorona®, Bio-PDO™, MECS®, BELCO®, STRATCO®, SILVADUR™, KATHON™

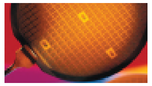
Transportation & Advanced Polymers

Industry leader providing high-performance engineering resins, adhesives, lubricants and parts to engineers and designers in the transportation, electronics and medical markets.

Product Examples

Zytel®, Hytrel®, Kalrez®, Molykote®, Betaseal®, Vespel®

Electronics & Imaging Business Overview

		DOW	DUPONT
	**Semiconductor Technologies**	✔ CMP pads and slurries ✔ Photolithography materials ✔ Advanced packaging materials ✔ Silicon-based CVD & ALD precursors ✔ Silicones for semiconductor packaging	✔ Removers and cleaners
	**Circuit & Industrial Technologies**	✔ Metallization materials ✔ Imaging materials ✔ Surface finishes	✔ Polyimide films and laminates ✔ Dry film photoresists
	**Photovoltaic and Advanced Materials**	✔ PV encapsulants ✔ Sealants for panel assembly ✔ Trichlorosilane for polysilicon wafers	✔ PV metallization pastes ✔ Thick film pastes ✔ Polyvinyl fluoromaterials
	**Advanced Printing**		✔ Flexographic plates and materials ✔ Digital inks
	**Display Technologies**	✔ OLED materials ✔ Cadmium-free quantum dot materials ✔ Display process chemicals ✔ Silicones for LED packaging ✔ Silicones for display assembly	✔ OLED materials ✔ Display enhancements

Closing Comments

- Lithography materials are required for advanced patterning to enable or improve:
  - Scaling
  - Pattern fidelity
  - Process window
  - CD control
  - Gap fill/planarization
  - Etch resistance
  - Defectivity

- DuPont provides a total material solution to address any lithography challenge.

Thank You

SEC Disclosure Rules

- Some of our comments include statements about our expectations for the future. Those expectations involve risks and uncertainties. DowDuPont cannot guarantee the accuracy of any forecasts or estimates, and we do not plan to update any forward-looking statements if our expectations change. If you would like more information on the risks involved in forward-looking statements, please see our annual report and our SEC filings.

- In addition, some of our comments reference non-GAAP financial measures. Where available, a reconciliation to the most directly comparable GAAP financial measures and other associated disclosures are provided on the internet at http://www.dow-dupont.com/investors/dowdupont-filings-and-reports/default.aspx.