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HANTOP: An Effort on Photoresist Localization

胡华勇 Daniel Hu

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OUTLINE

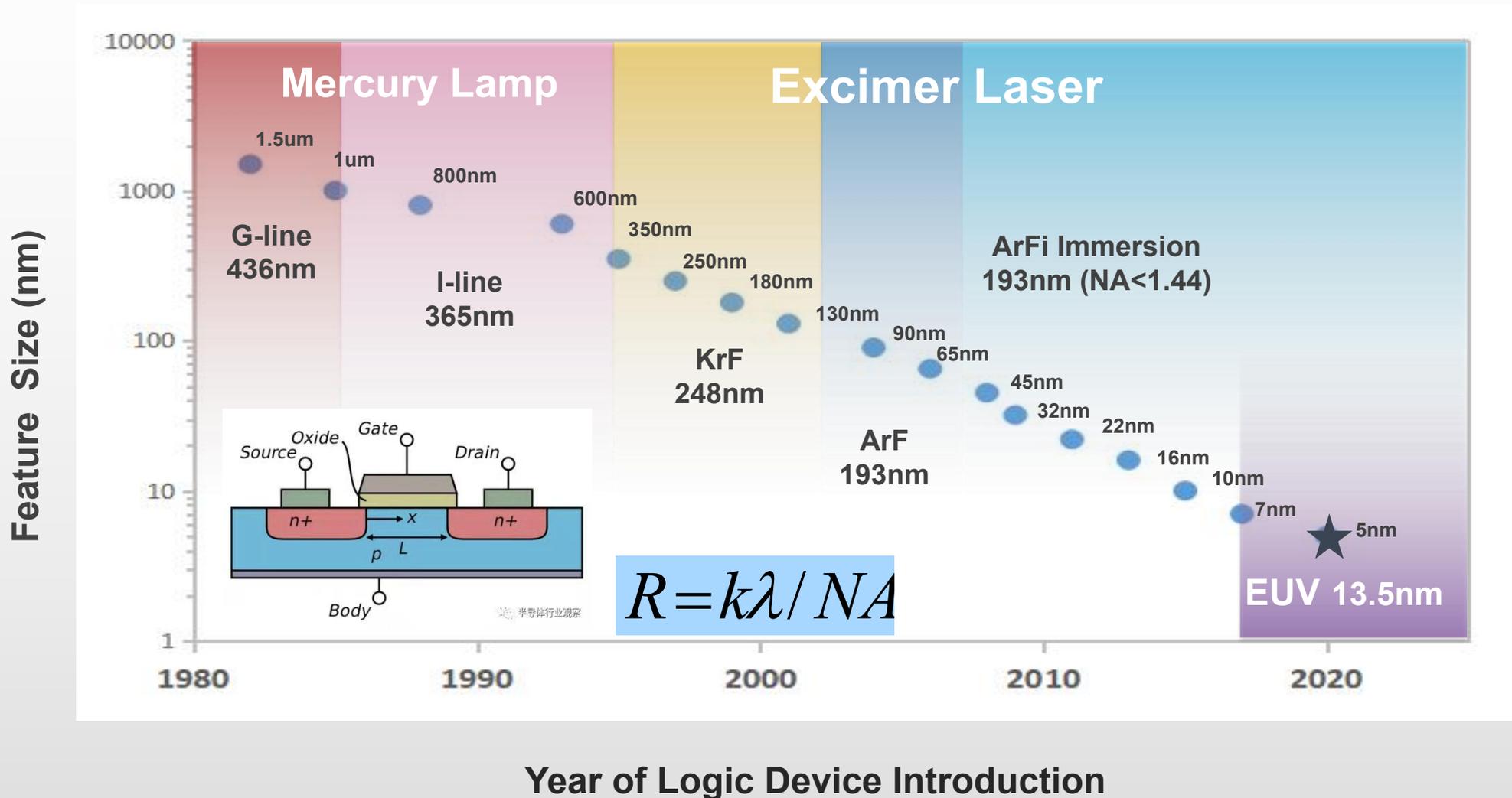


- **Lithography Evolution**
- **Photoresist Evolution and Challenges**
- **HANTOP Photoresist Introduction**
- **SUMMARY**



Lithography Evolution with Logic Device Development

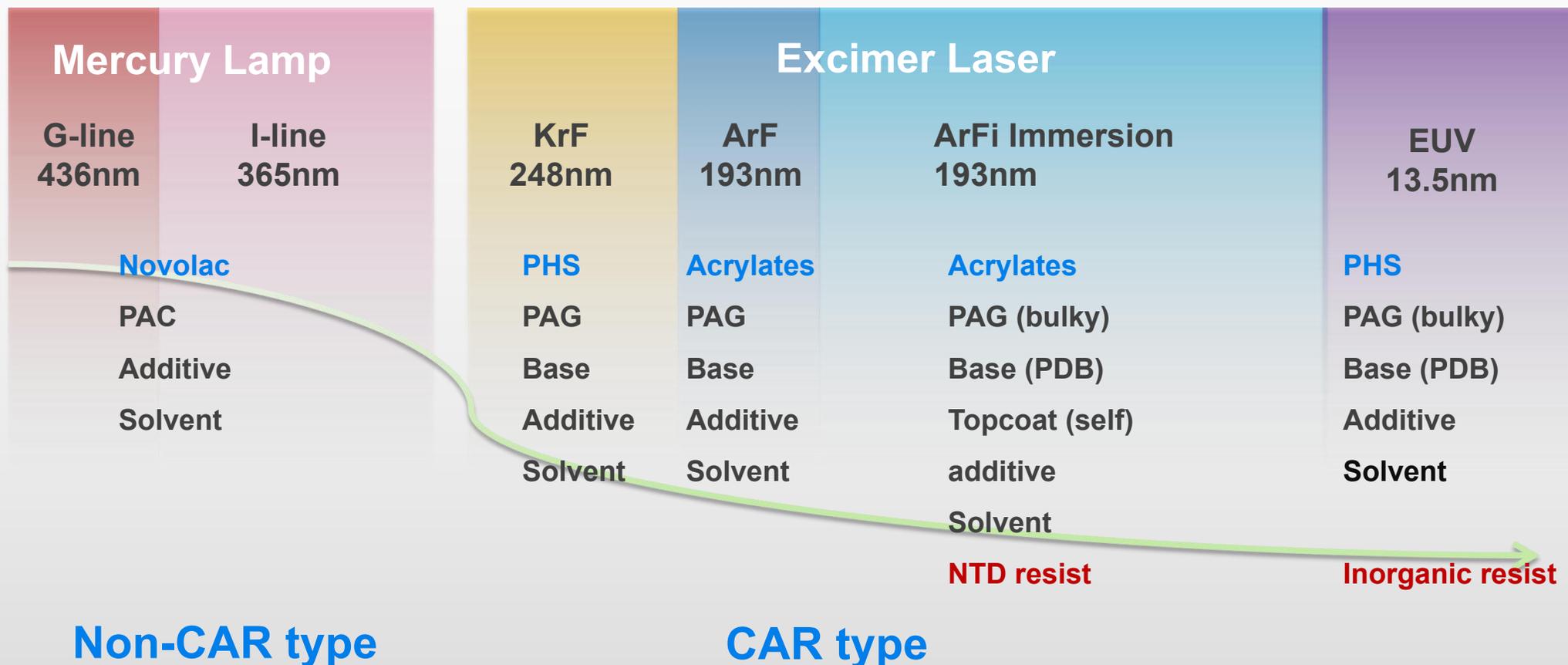
- Lithography defines the transistor speed (L: CD) and density (R: Pitch)...





Photoresist Evolution with Exposure Wavelength

- **Power** : Low laser power introduce CAR type to ensure WPH.
- **Transparent**: Polymer type evolution due to absorption increase with light wavelength decrease.
- **Resolution**: Shorten acid diffusion length (ADL) with Polymer/PAG/Base modulation to achieve high resolution.



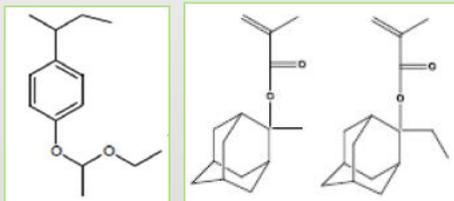


Photoresist Challenges

- Complex system including Organic Chemistry, Polymerization, Photochemistry, Lithography Engineering.

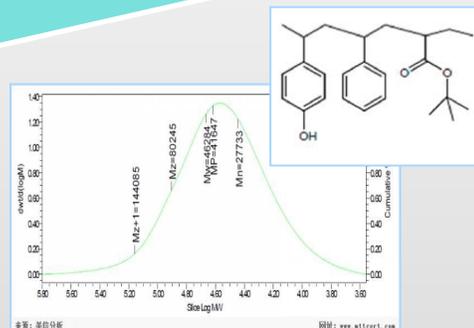
Monomers

- PHS, Acrylates
- Acid-liable/Polar/ETCH Resistance monomers
- high level purification



Polymers

- Most Tri-\Tetr copolymers
- Monomer type and composition
- **Mw/PDI (Statistic-controlled)**

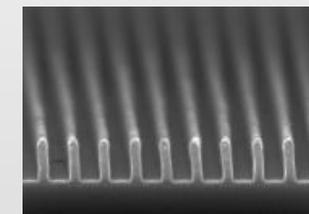
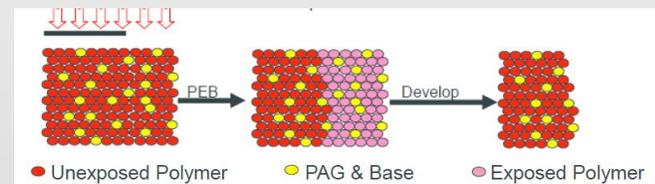


Resist Formulation

- Film formation
- PAG or PAC Modulation
- Multi-material Mix process
- Purification

Lithography

- * Patterning: Pitch, CD, OPC, Profile, PW, CDU, Defect etc..
- * Capable for the following process, like ETCH, WET, IMP etc..





HANTOP: Local Photoresist Company

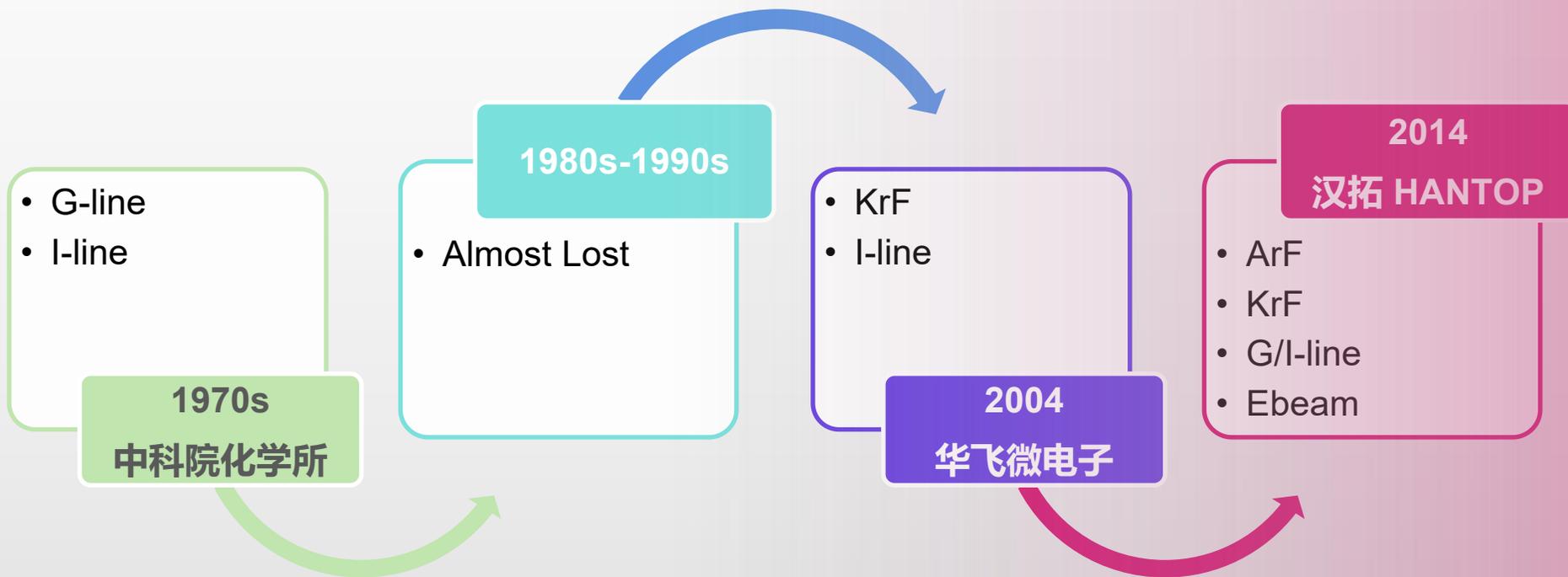
- China photoresist is not ZERO in the past, BUT almost lost for more than 20 years.
- HANTOP setup in 2014, with technique background from HuaFei at 2004.

光致抗蚀剂
光刻胶

中国科学院化学研究所
《光致抗蚀剂组》编著

表 1 国内外主要的光致抗蚀剂种类

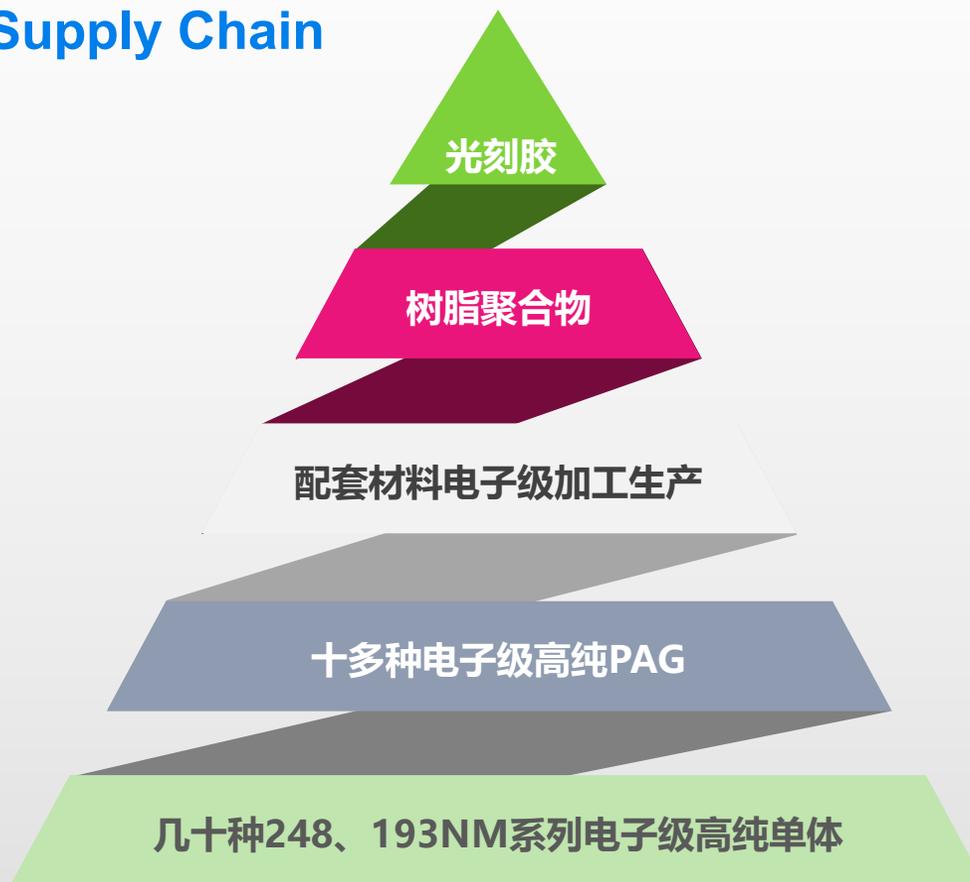
商 品 名	类 型	主要化学结构	产 地
聚乙烯醇内桂酸酯	负性	同商品名	我国
053 抗蚀剂	负性	聚乙烯醇内桂酸酯型	
金属抗蚀剂	负性	改性天然橡胶——双叠氮化合物	
聚酯型抗蚀剂	负性	肉桂又丙二酸酯型	
701 正性抗蚀剂	正性	邻叠氮型化合物	
204 正性抗蚀剂	正性	邻叠氮型化合物	
KPR(KPR-2, KPR-3)	负性	聚乙烯醇内桂酸酯	美国柯达公司
KMER	负性	改性聚异戊二烯——双叠氮化合物	
KMNR	负性	改性聚异戊二烯——双叠氮化合物	
KTRR	负性	改性聚异戊二烯——双叠氮化合物	
KOR	负性	—	
KPL	负性	—	
KAR-3	正性	邻叠氮型化合物	
AZ-111	正性	邻叠氮型化合物	美国希伯来公司
AZ-1350	正性	邻叠氮型化合物	
TPR	负性	聚乙烯醇内桂酸酯型	日本应化公司
OSR	负性	聚乙烯醇内桂酸酯型	
OMR-81	负性	—	
PSR	—	—	日本富士药品公司
HUR	—	—	
PPPR	—	—	





HANTOP Photoresist : "IDM" Mode

- Self-Developed Technique
- Self-Controlled Supply Chain
- Lab to Factory



Photoresist

10+ projects cooperation with customers, including ArF, KrF, Iline, Ebeam, Bumping resist

Polymers

PMMA, PHS, Acrylates polymers with electrical level, including lab and factory scale

Solvent & Additives

Factory purification system

PAGs

Iline, KrF, ArF PAGs

Monomers

Mature self-making factory products



HANTOP Photoresist Introduction

- Customerization with self-developed technology instead of BENCHMARK.
- Focusing on CAR type and Negative Resist;
- Advance Ebeam resist solution to bridge the gaps.

GHI Line	I Line	KrF	ArF(i)	Ebeam
436-365nm	365nm	248nm	193nm	< 1nm
封装Bumping HTF4110 60~120um	I线化学放大胶 HTI560系列 1-8um			
封装Bumping HTF4025 18~40um	Lift off 负胶 HTIN160系列 0.8~7um	HTK800系列 8~15um	I线 BACKUP HTA205 1.7~2.5um	化学放大RE209系列
环氧负胶HTIN68X系列 8~60um	I线高分辨 HTI751 0.7~1um	HTK510系列 2~5um	KrF BACKUP HTA150 4500A~7500A	PMMA RE300系列
		Lift off负胶 HTKN601 0.6~1.2um	N90 Mx(HP120nm) HTA130 2500A~4000A	高分辨 RE650
		HTK109-0.9 7500A~1.2um	N55 Mx(HP90nm) HTA121 1700A~2800A	化学放大型 NRE800
		HTK109-0.4 4000A~6000A	N55 Vx(HP90nm) HTA122 2000~3500A	HSQ RE500



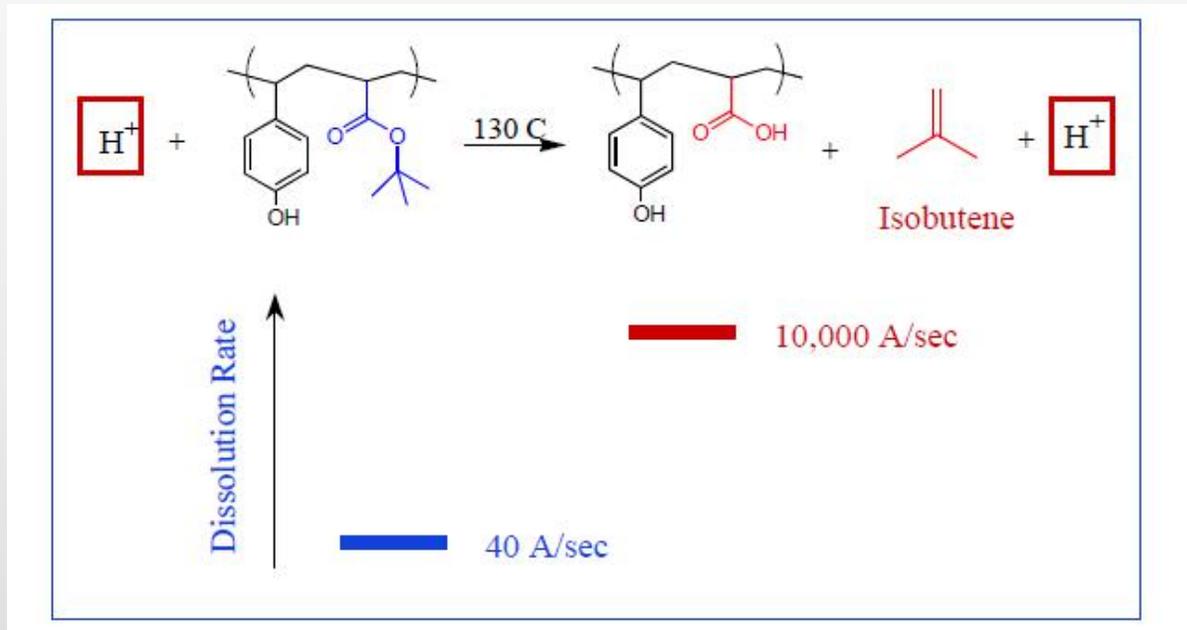
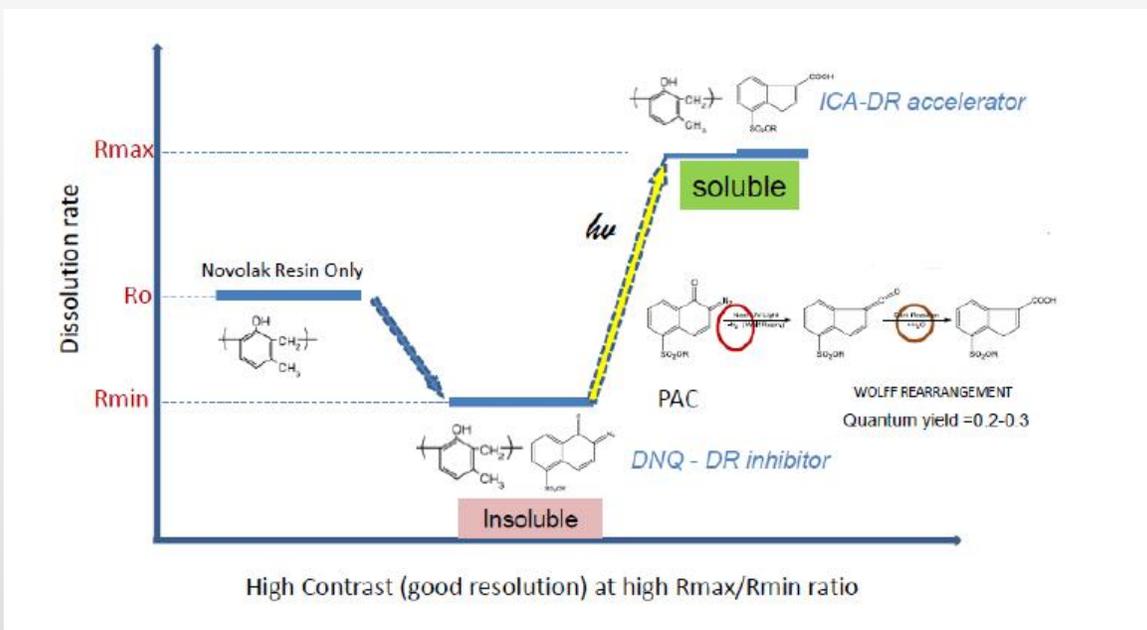
HANTOP I-line Fast CAR series: HTI560*

● What we may suffer with I-line Novolac resist?

- High dose especially for thick resist slow down scanner WPH and increase lens heating;
- Taper Profile due to less transparent;
- Resolution limitation due to less contrast.
- High Outgassing;

● What we can gain with I-line CAR resist?

- Low dose (Fast);
- Total CoO Reduction;
- Straight Resist Profile;
- High Resolution;
- Less Outgassing

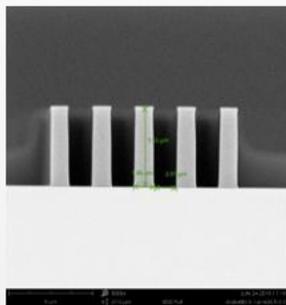




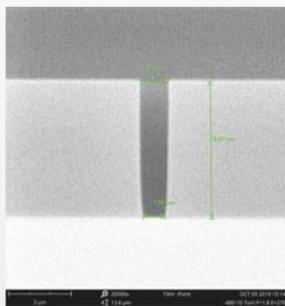
HANTOP I-line CAR series: HTI560*

- Fast I-line CAR resist with Eop 100-200mj;
- High Resolution (AR>4) with good PW;
- Straight Profile; Good D-I bias; High thermal resistance;

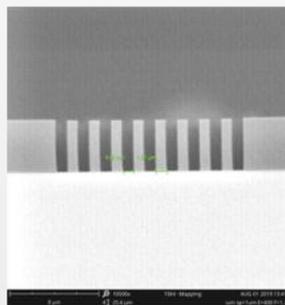
Thickness coverage: 8um-2.5um



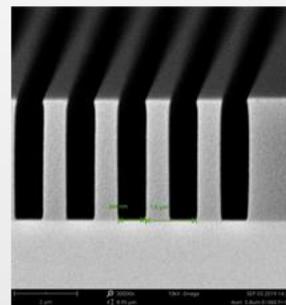
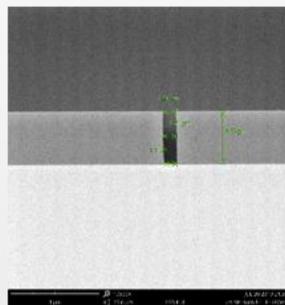
2um LS
THK 8um AR=4



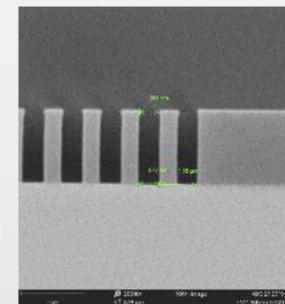
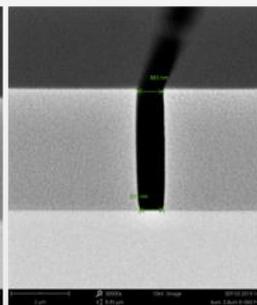
1um ISO space
THK 7um AR=7



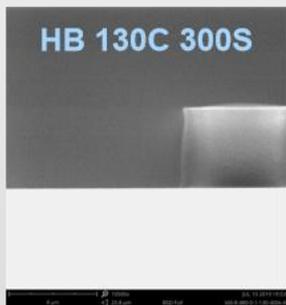
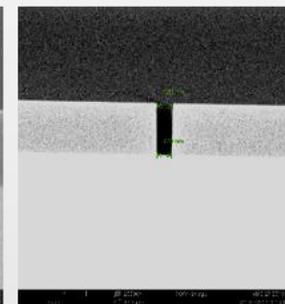
1um LS/ ISO space
THK 5um AR=5



0.8um LS/ ISO space
THK 4um AR=5



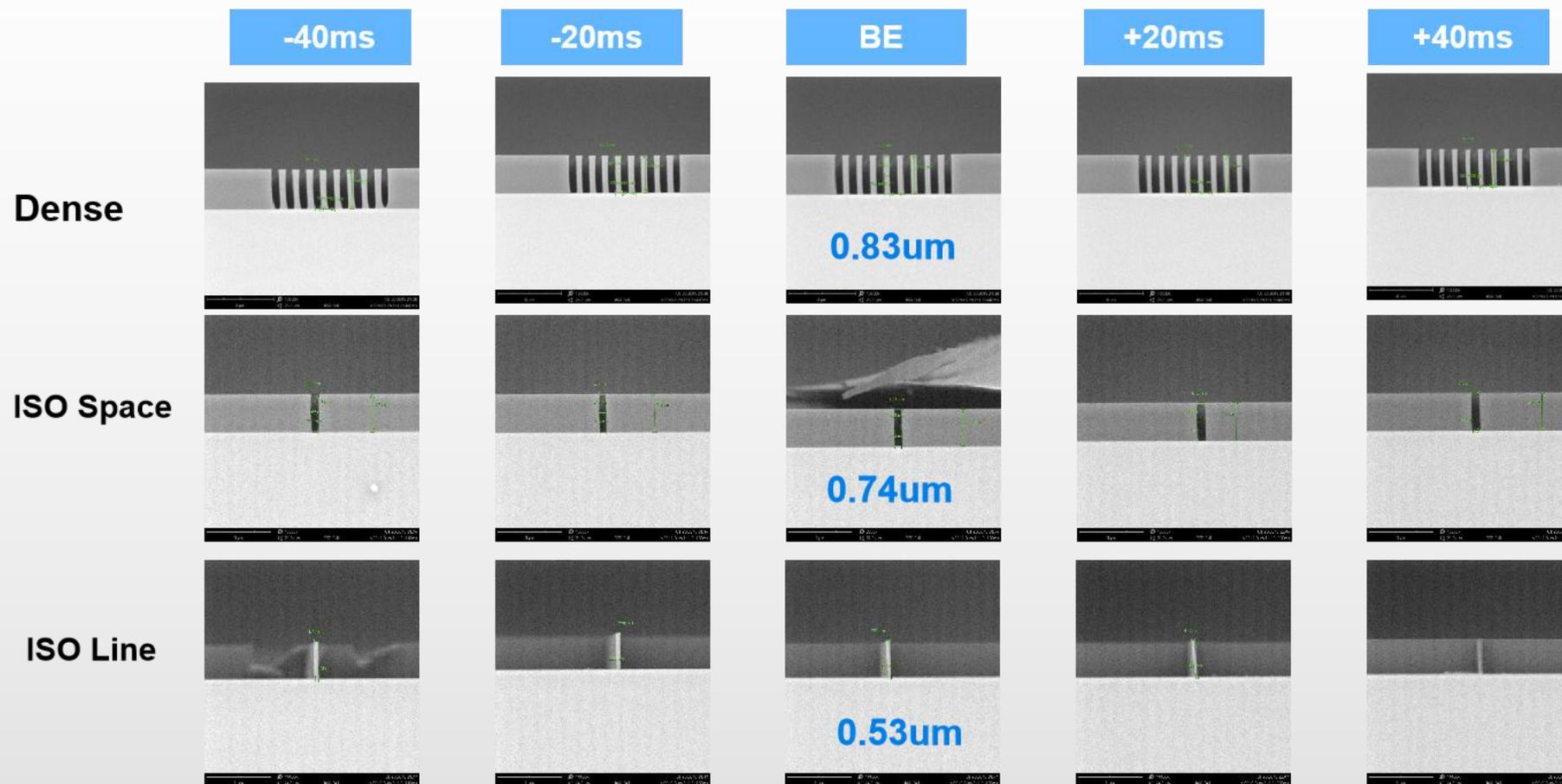
0.6um LS/ ISO space
THK 2.5um AR=4





HANTOP I-line CAR series:

- HTI560-5: 0.8um Patterning @ THK=5UM (AR=6)



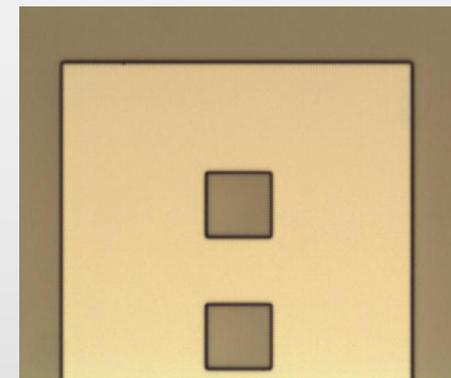
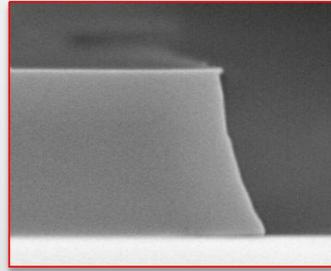
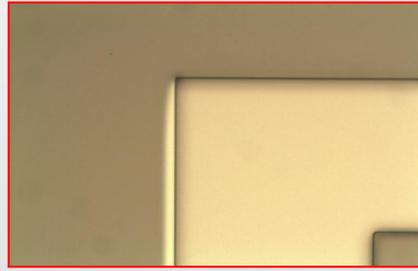
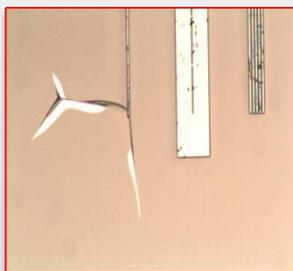
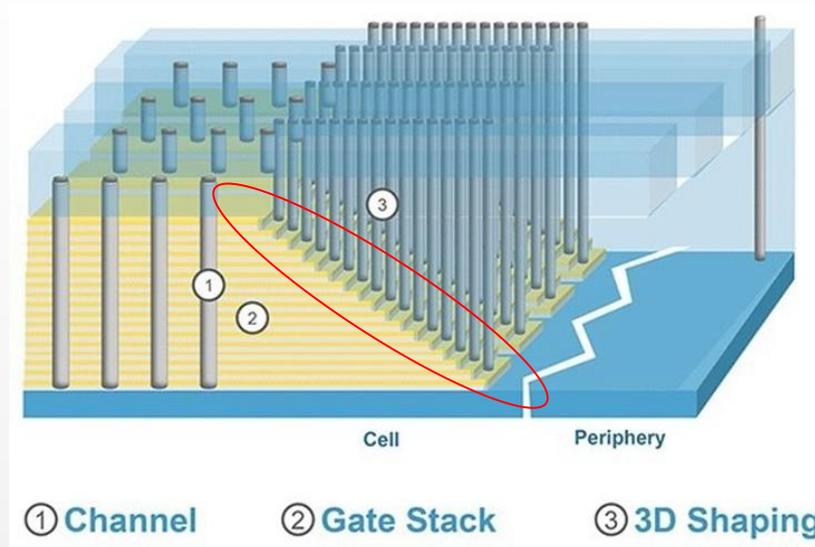
Process condition:

Si+5umPR, PAB130C90s, PEB110C90s, NA 0.63, Nikon I12, Binary mask, Dev 60s, Single puddle



HANTOP KrF Thick Resist series (3D NAND Application)

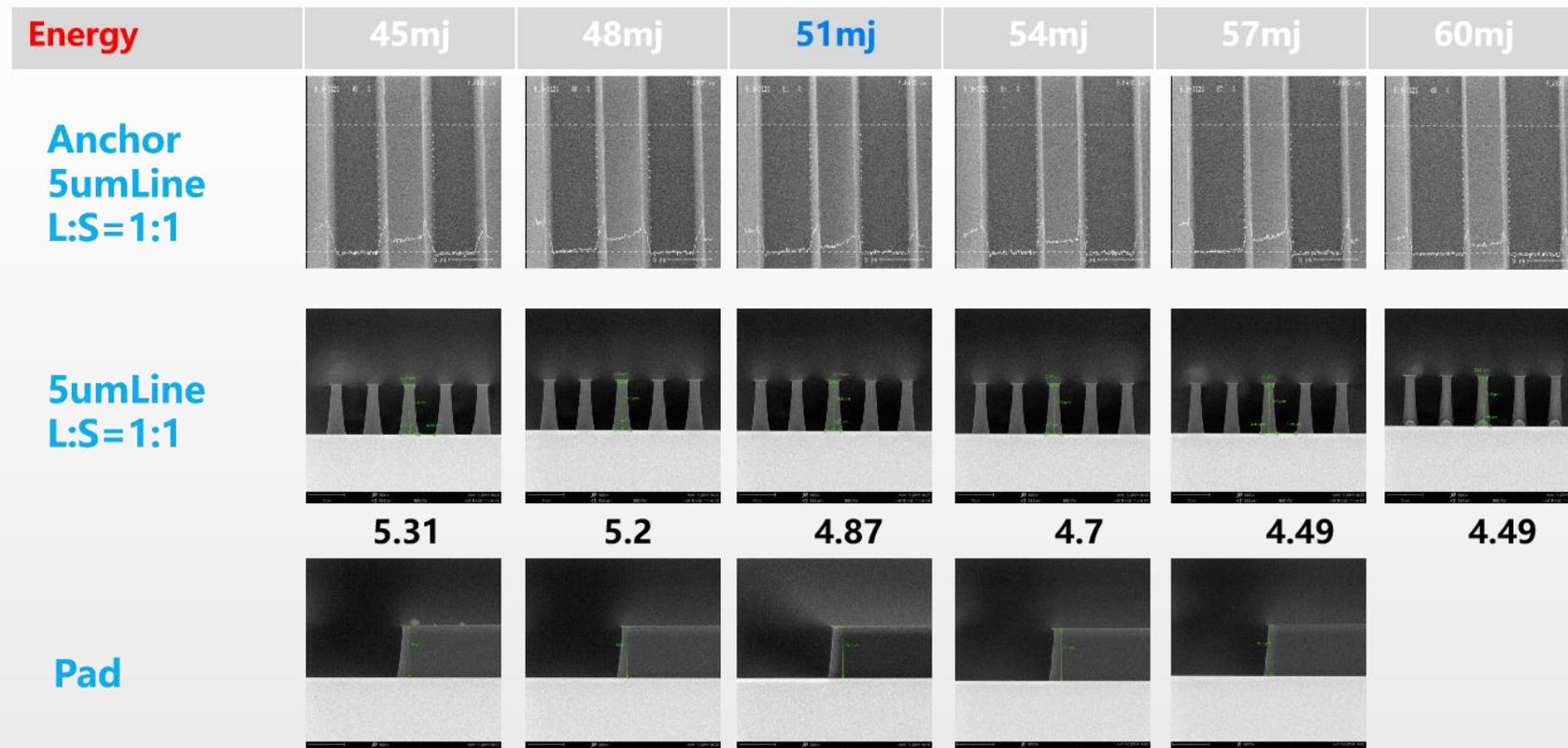
- **Challenge increase with resist thickness.**
 - Film formation: Crack, Viscosity, Thickness Uniformity (THU), Pin Hole
 - Patterning: Adhesion (Peeling or Foot Crack), Sensitivity, Residue, Profile (Taper)
 - Integration: ET resistance





HANTOP KrF Thick Resist series: **HTK81x_15um**

- Thickness: 5 to 15um
- Reasonable Sensitivity: 40-60mj
- Controlled Profile: SWA 80-85 varied w/ focus
- Good film Adhesion, Optical and Mechanical property;



Process condition:

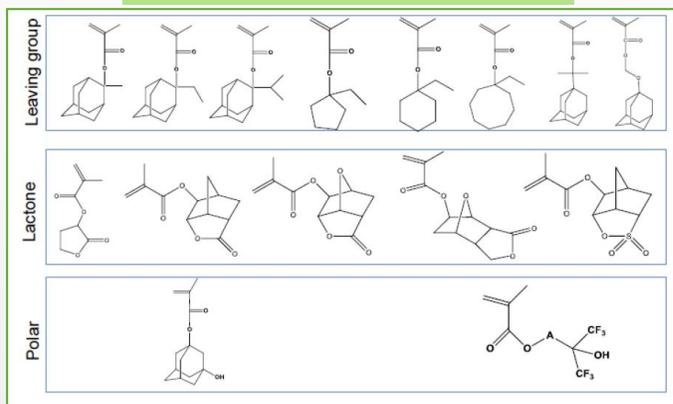
Substrate+PR, PAB140C150s, PEB125C90s, NA 0.55/C 0.6, Nikon S204, TMAH2.38%, Double Puddle 60S



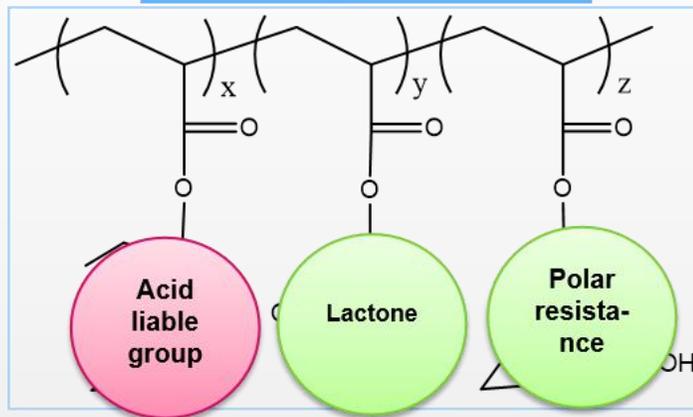
HANTOP ArF Resist

- More complex and variable approaches to achieve smaller patterning size.
- Higher quality requirement for polymer composition/Mw/PDI, particle, metal ion and sensitivity control.

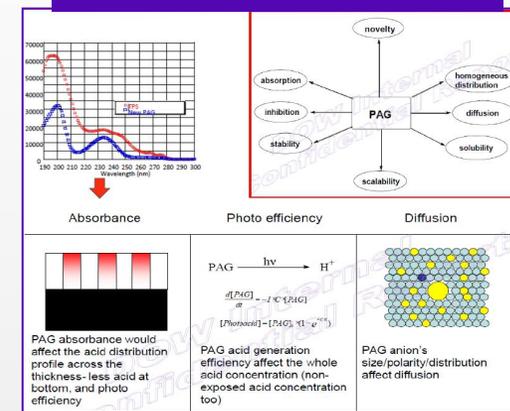
Monomers



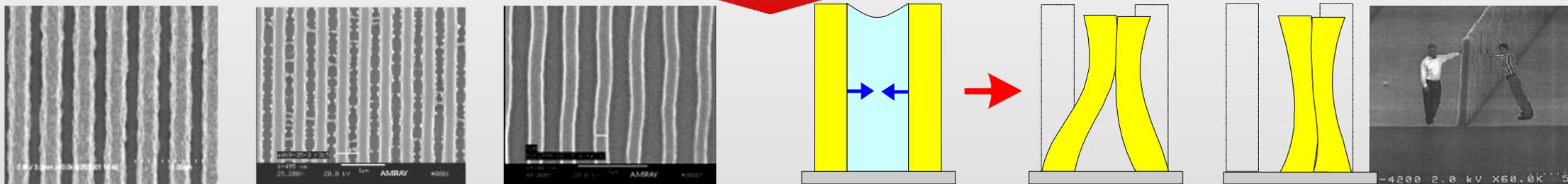
Polymers



Resist Formulation



Lithography Patterning



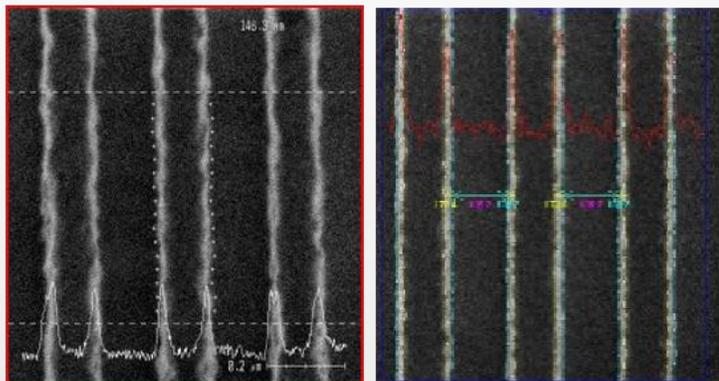


HANTOP ArF Resist

Co-optimization of Photoresist and Lithography Process

N90nm

HP140nm LS @3000A



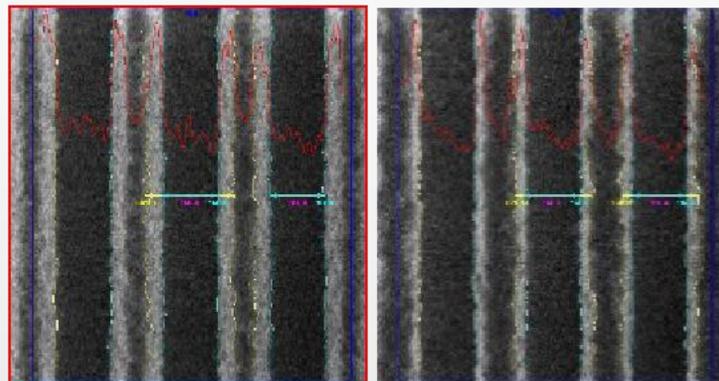
EL: 12%



EL: 29.9%
E=24mj
DOF: >0.24um
(ADI=140nm)

N65nm

HP90nm LS @2100A



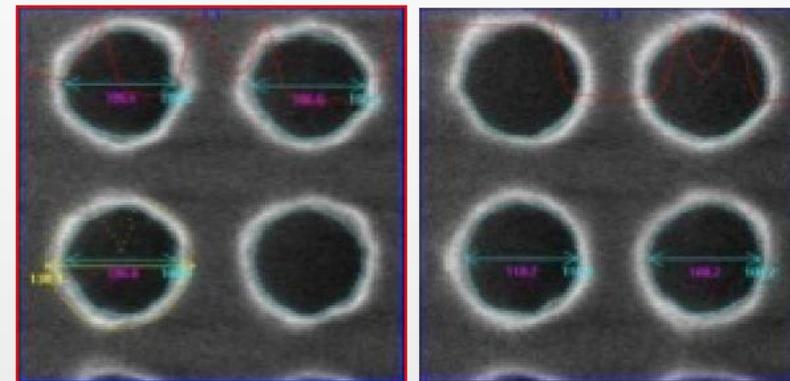
EL: 13.5%



EL: 20.8%
E=33mj
DOF: >0.2um
(ADI=90nm)

N55nm Contact

HP90nm Hole @3000A



EL: 16%

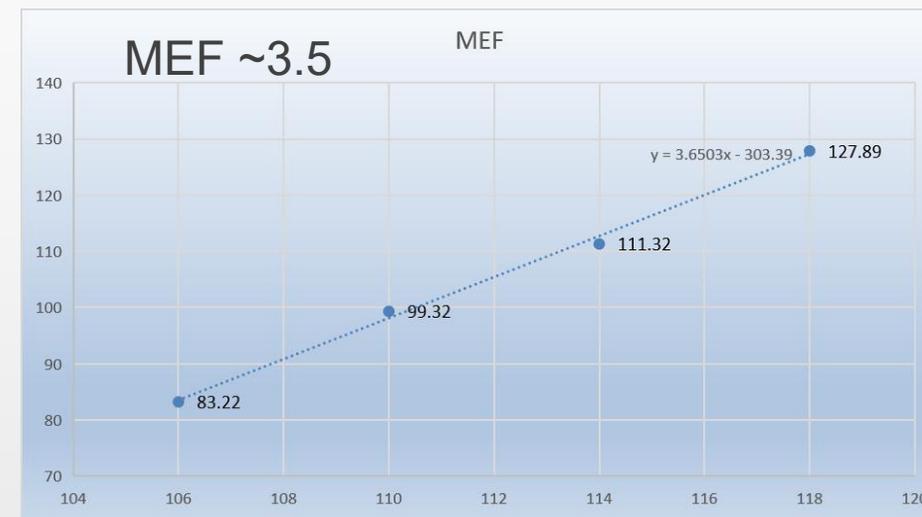
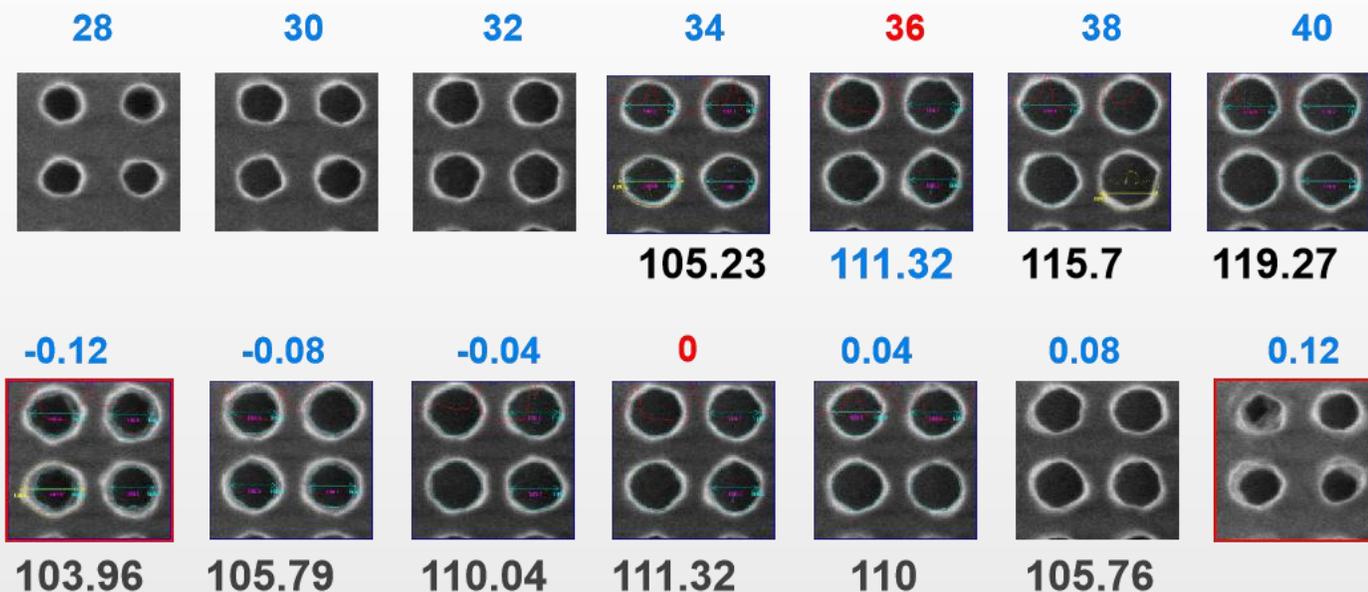


EL: 25%
E=36mj
DOF: >0.16um
(ADI=110nm)



HANTOP ArF Resist: HTK12x HP90nm hole @3000A

- Resolution to HP90nm hole patterning with good PW and circularity
- Acceptable MEF ~3.5



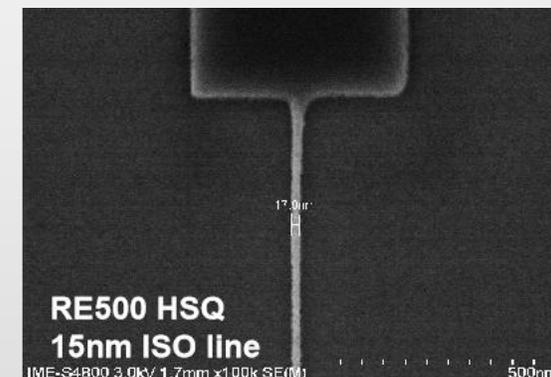
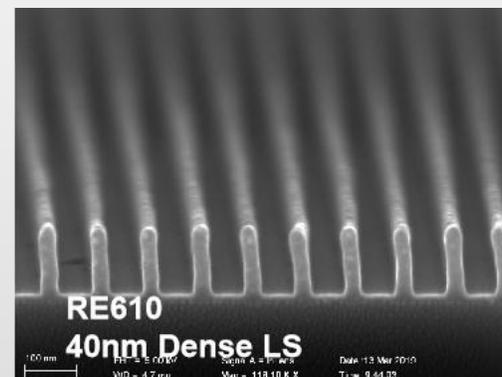
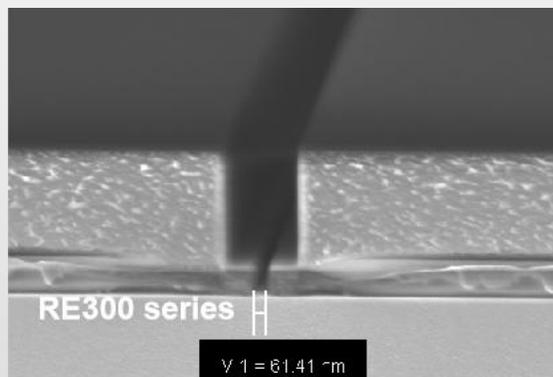
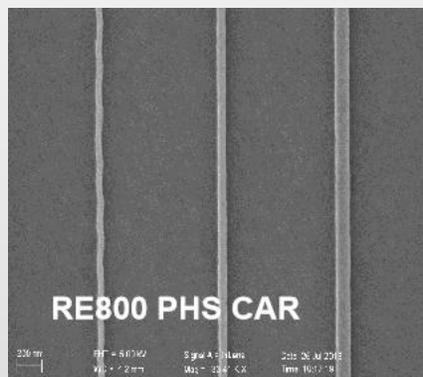
EL 25% DOF >160nm



HANTOP Ebeam Resist

- Diff. types capable for diff. applications: PMMA series, PHS CAR, P(MCA/MST), HSQ etc..
- Production starting from Y2015, supporting more than 15+ customers for their high-tech researchs.

Ebeam Resist	Polymer	Type	DEV	Charatistic
RE209	PHS CAR	Posi.	2.38% TMAH	CAR, high resistance
RE300.XX.X	PMMA(70K~950K)	Posi.	MIBK:IPA=1:3	high resolution, bi-layers
RE610	P(MCA/MST)	Posi.	amyl acetate	high resolution, resistance
RE500	HSQ	Nega.	2.38%TMAH	high resolution, resistance
NRE800	PHS CAR	Nega.	2.38%TMAH	CAR, high resistance



SUMMARY



- **Photoresist is one of the most complex material in semiconductor manufacture, supporting and developing with IC technology;**
- **HANTOP, as a local photoresist supplier, provides variable customized products with its advantage of self-controlled supply chain and self-developed techniques;**



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Thank You !
谢谢!