MERCK AZ IPS-6000 SERIES

TECHNICAL DATASHEET

MERCK PM-I THICK FILM RESIST, MAC 2016

1.0 Introduction

The **AZ IPS-6000** Series advanced electronic product is a i-line and broadband sensitive photoresist that have been developed for use as patterning in semiconductors advanced packaging application (3DIC/TSV, Cu Pillar, FO, WLCSP, MEMS).

The product was developed with Merck's greatest enthusiasm and research & development effort to make it a state-of-art product in the industry that suit a wide range of applications:

- ✓ Electro-chemical deposition/ plating of Cu RDL in WLCSP process
- ✓ Electro-chemical deposition/ plating of Cu, Ni, Sn, SnAg, Au for 3DIC, FO, Flipchip processing.
- ✓ Sacrificial layer for Si etching process in TSV
- ✓ Sacrificial layer for SiO2 or SiN etching process in CMOS sensor processing

The development of AZ IPS-6000 series has also included extensive test and verification to determine it delivers the following performance:

- ✓ Higher aspect ratio and high resolution
- ✓ Better coating uniformity
- ✓ Straight pattern profile and footing free
- ✓ Enhanced thermal & chemical resistance (plating)
- ✓ Better bubble performance during coating

2.0 Featured Performance

2.1 Extreme high aspect ratio

Note that AZ IPS-6000 is a positive acting chemically amplified photoresist, it enables patterning of extremely high aspect ratio structures, with relatively low exposure dose for the thickness of the film. Typical exposure doses for AZ IPS-6000 series are given in Table 1.

These recommended doses were determined on standard Cu sputtered wafer. Exposure dose on silicon surface will be much lower.

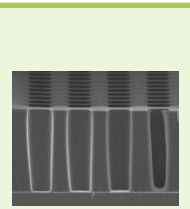
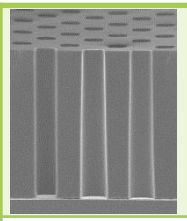
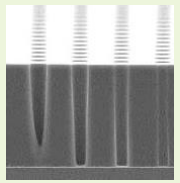
A 5:1 aspect ratio is typically achieved on a lower end exposure tool such as Mask aligner. The performance is even better with utilizing a low NA stepper tool for radiation.

A highest 12:1 aspect ratio pattern has been printed with a CANON FPA-5510iV i-line stepper. Meanwhile 8:1 aspect ratio pattern is typically achievable on an Ultratech AP300 broadband stepper.
Resolution and aspect ratio of pattern printed at various film thickness are shown in Table 2.

Table 1. Typical Exposure dose at various film thickness (broadband exposure on Cu substrate)

Film thickness	Exposure dose (mJ/cm2)
50um	500-700
60um	600-800
70um	800-1000
80um	1200-1400

Table 2. Aspect ratio achieved with various exposure tool.

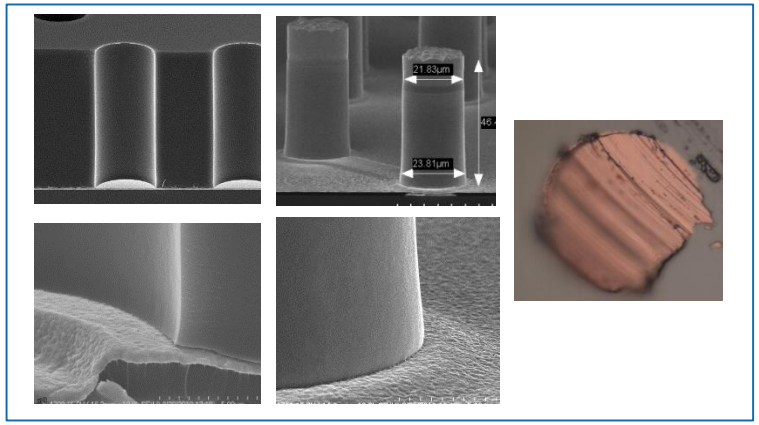
	AZ IPS-6000			**Negative PR**
SEM				
Exposure tool	ALIGNER	ULTRATECH	CANON	ULTRATECH
Film thickness	50um	80um	60um	~75um
CD	10um	10um	5um	25um
Aspect ratio	5:1	8:1	12:1	3:1

2.2 Straight pattern profile, less footing

The combination of PAG, base polymer, resin etc has made pattern profile of AZ IPS-6000 series uniquely straight and almost footing-less.
Many had come across issue of collapsed micro-bump highly linked to footing pattern, as footing length reduce landing area and sturdiness of bump-pad bonding.
With less footing and straight pattern profile, it is beneficial to achieve stronger bump-pad bonding and higher shear strength.

Fig 1.

Microbump plating (Ø21um) and shear mode with >75% metal remain.

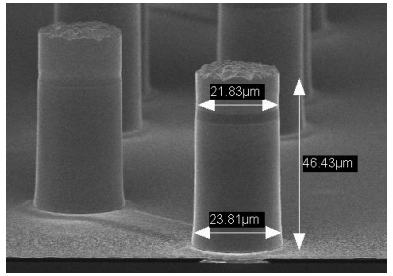
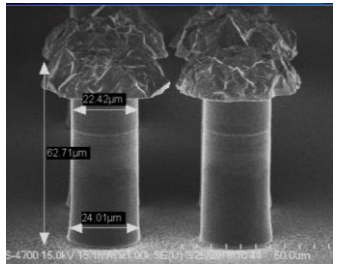
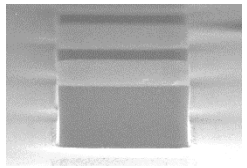
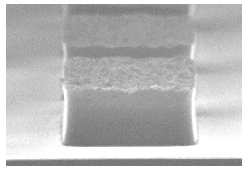
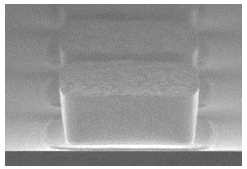
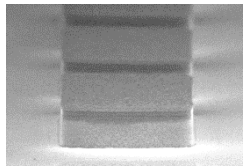
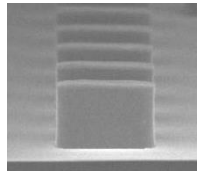
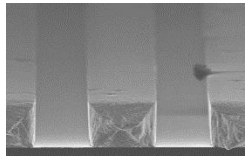
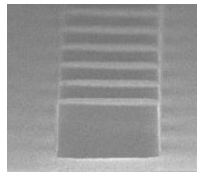
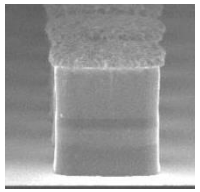


2.3 Chemical resistivity, close zero dark erosion

As aforementioned, AZ IPS-6000 series has been tested extensively with different series of commercialized electrolytes. Table 3 shown a list of electrolytes which demonstrate high compatibility and SEM images of plated bump.

Table 3. List of comparable plating chemistry and SEM inspection of plated bump.

Cu	SC20, SC40, SC50,MSA100, Cu8540, Cu1000, Cu350
Ni	Ni100, Ni200, Nicekl Surfamate (Surtec)
SnAg	TS140, TS202, TS304, BPTS4000
Others	Au- Au660;

Micropillar bump (Cu/Ni/SnAg)		Mushroom bump (Cu/Ni/SnAg)	
			
 Cu350/20um	 Ni100/20um	 Au660/ 20um	 Cu350/Ni100/Au 660- 10/3/1um
 Cu1000/ 26um	 SC50- Cu RDL	 Cu1000/Ni100- 15/5um	 Cu1000/Ni100/T S304- 15/5/35u

Chemical resistance of a photoresist is also measured by its "dark erosion" or film loss in aqueous developer.
Table 4 shown close-zero film loss of AZ IPS-6000 resist upon dipping in standard TMAH (2.38%) developer for 240sec.

Table 4. Film loss of unbleached resist upon 240sec dipping in standard TMAH (2.38%) developer.

	Wfr 1	Wfr 2	Wfr 3	Wfr 4	Wfr 5	Avg
Bfr Dev.	**55.97**	**55.21**	**54.51**	**54.43**	**54.43**	**54.91**
Post Dev	**56.03**	**55.11**	**53.83**	**54.09**	**54.55**	**54.72**
Film loss	-0.06	0.10	0.68	0.34	-0.12	0.19

Result: Unbleached resist area did not suffer dark erosion or film loss due to standard development by TMAH.

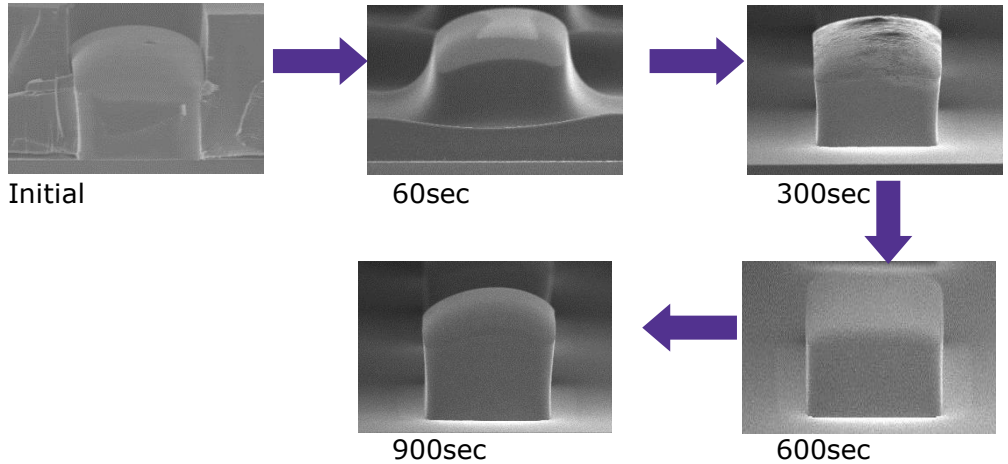
2.4 Easy stripping

As a known draw back to the negative tone resists, the highly cross-linked resist masks require much stronger stripper and longer solvent strip times.

AZ IPS-6000 photoresist fit in as a solution to difficulties in solvent strip process. It is highly dissolved in acetone, AZ R100 Remover, PGMEA based solvent and other stripper solvent which commercially available for positive tone resist.

Fig. 2 shown clean resist removal in AZ R100 Remover.

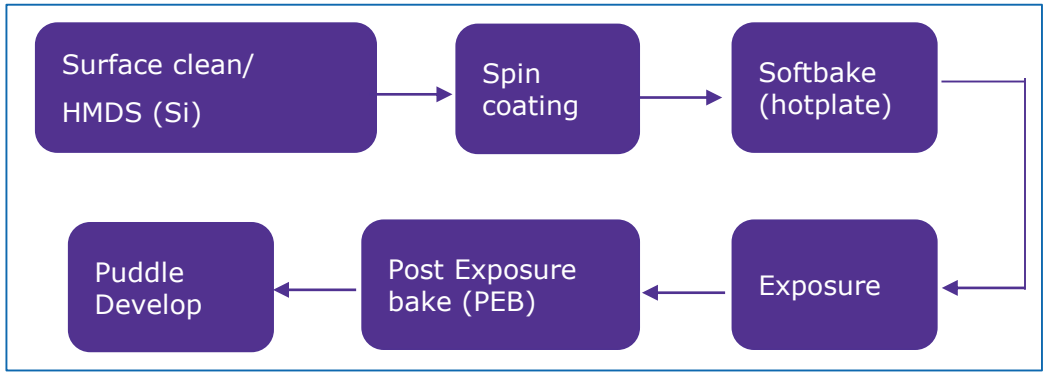
Fig. 2 Resist removal in AZ R100 remover



3.0 Easy Processing

Various processing options (equipment) are available, nevertheless, process steps for AZ IPS-6000 resist is rather simple and user friendly for a standard bumping facility setup.
A flowchart of a typical process steps is outlined in Fig 3.

Fig. 3 Flowchart of typical process steps



Detail process condition

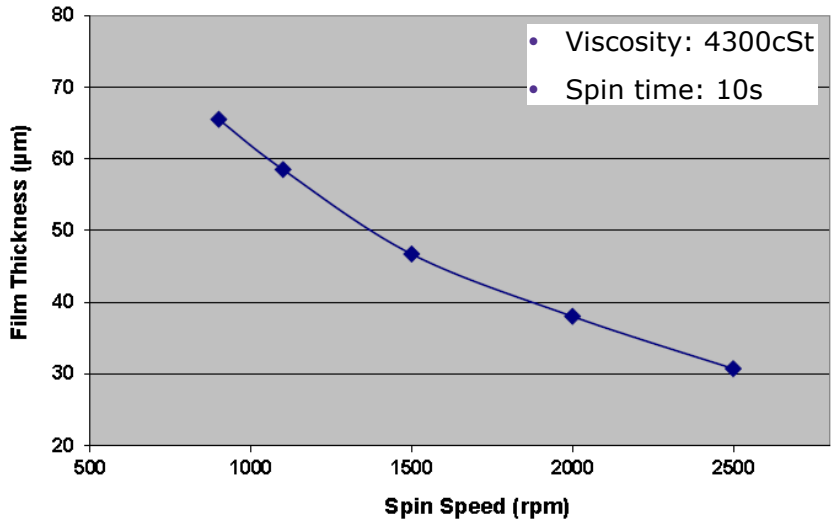
The process may be optimized for time, temperature and dose based on respective tool setup/combination.

Film thickness	FT50um	FT70um
Coating/Disp.	Dynamic	Dynamic
Disp volume	~12ml	~14ml
Softbake	HP1: 80C/180sec HP2: 125C/300sec	HP1: 80C/180sec HP2: 135C/360sec
Exposure	• ~500-700mJ/cm2; • Broadband, i-line	• ~800-1000mJ/cm2; • Broadband, i-line
Post Exp. Bake (PEB)	100C/ 100sec Hotplate	100C/ 100sec Hotplate
Develop	• 2.38% TMAH • 3 puddles x50sec	• 2.38% TMAH • 5 puddles x45sec

APPENDIX

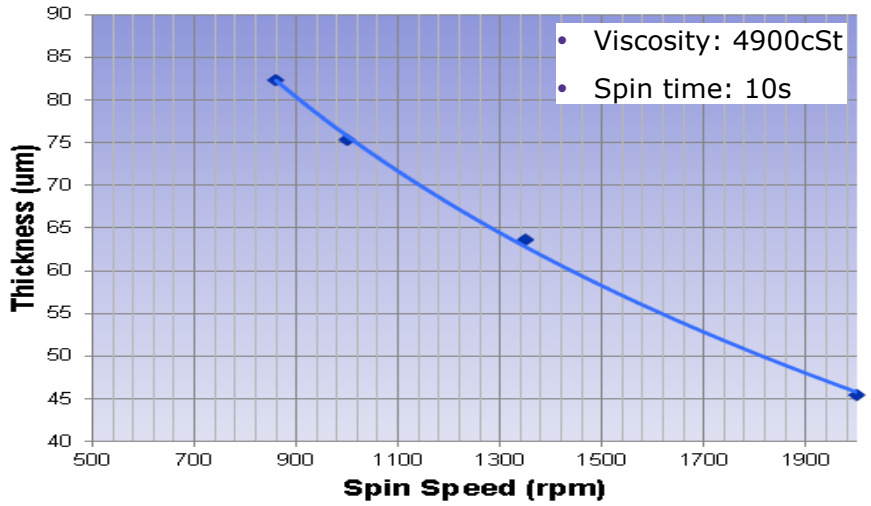
MERCK PM-I THICK FILM RESIST, JAN 2016

AZ IPS-6050 – Spin curve (4300cSt)



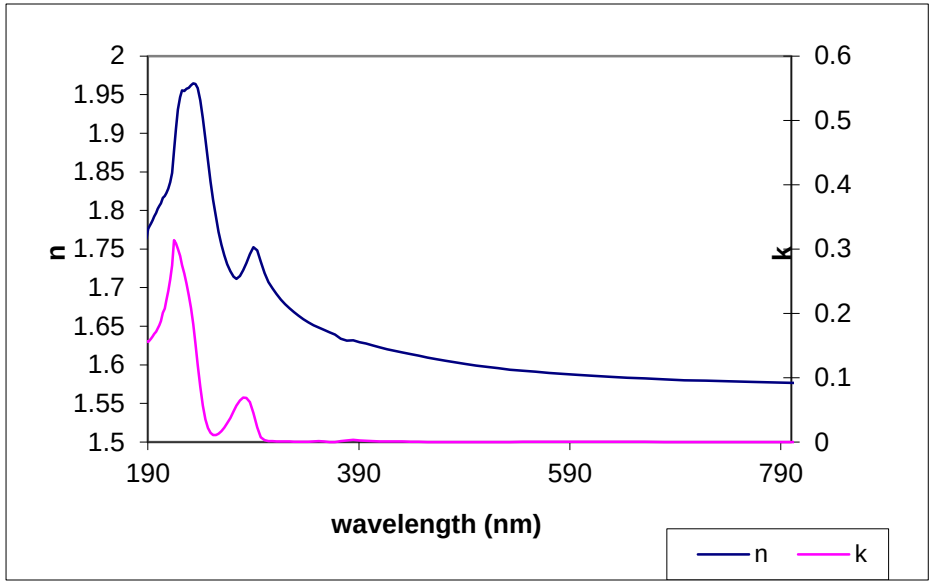
RPM	900	1100	1500	2000	2500
FT (µm)	65.5	58.5	46.7	38.0	30.7

AZ IPS-6090 – Spin curve (4900cSt)



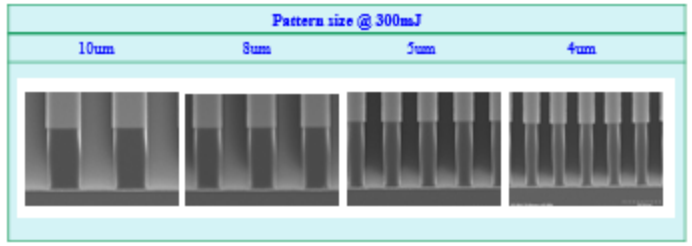
RPM	860	1000	1350	2000
FT (µm)	82.3	75.3	63.6	45.4

AZ IPS-6000 series- n & k value

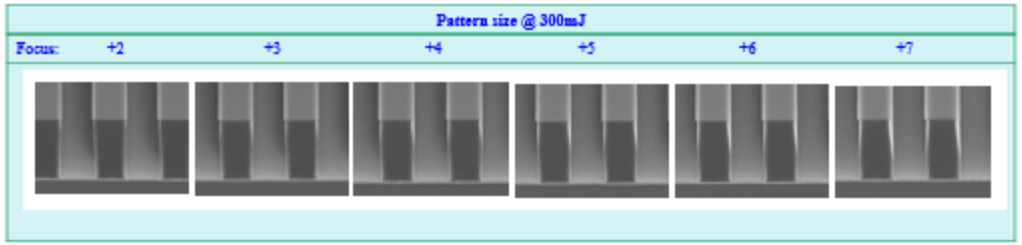


AZ IPS-6020_Lithography (ASML Stepper) @FT20um

Linearity on Copper, 300mJ, Focus: 5.0 @ FT=20.0 µm

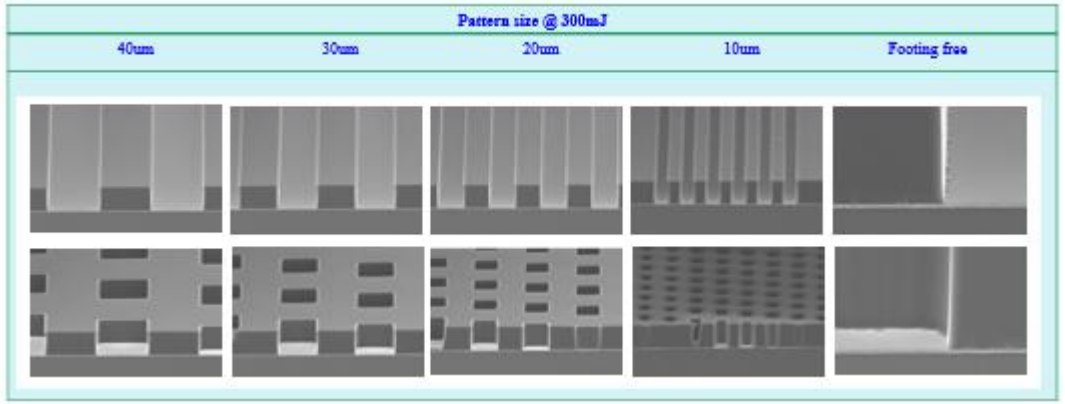


DOF on Copper, 300mJ, CD: L/S10um @ FT=20.0 µm



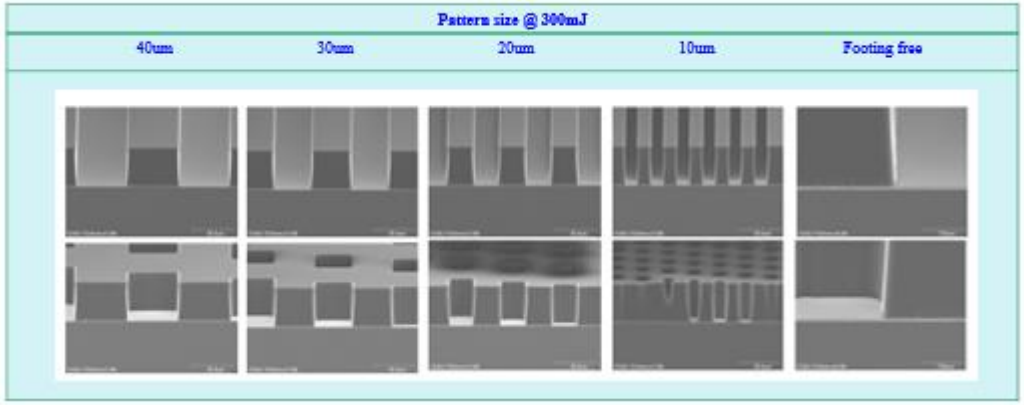
AZ IPS-6020_Lithography (Mask Aligner) @FT20um

Linearity on Copper @ FT=20.0 µm



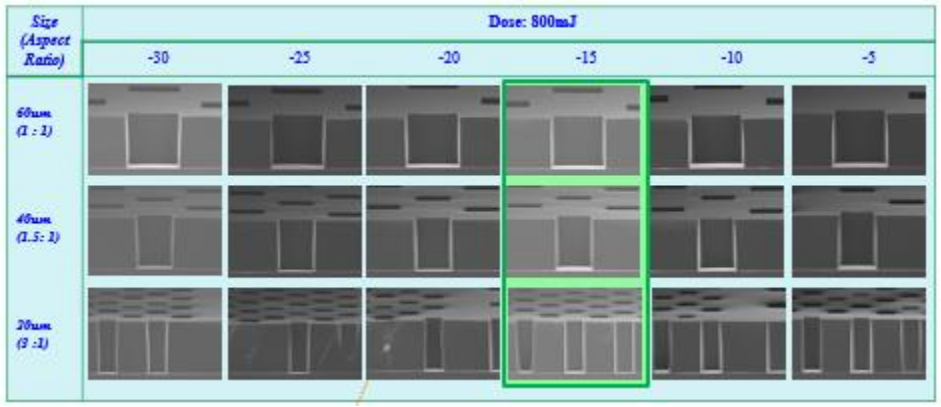
AZ IPS-6020_Lithography (Mask Aligner) @FT20um

Linearity on Copper @ FT=30.0 µm

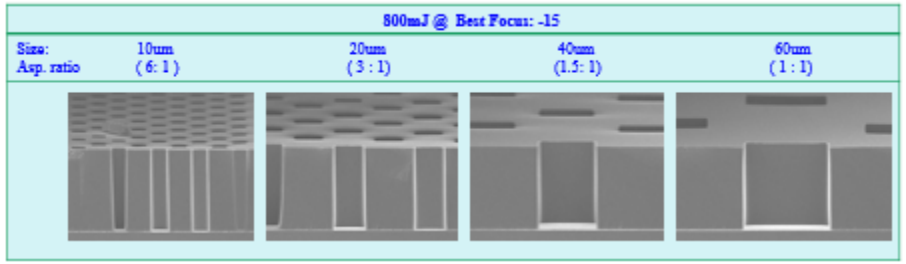


AZ IPS-6050_Lithography (Ultratech Stepper) @FT60um

Focus Latitude on Copper @ FT=60.0 µm; Dose: 800mJ

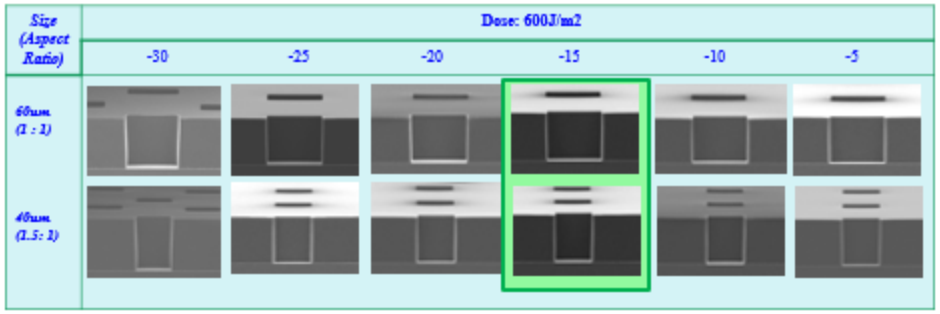


Resolution @ FT=60.0 µm; Dose: 800mJ; Focus: -15

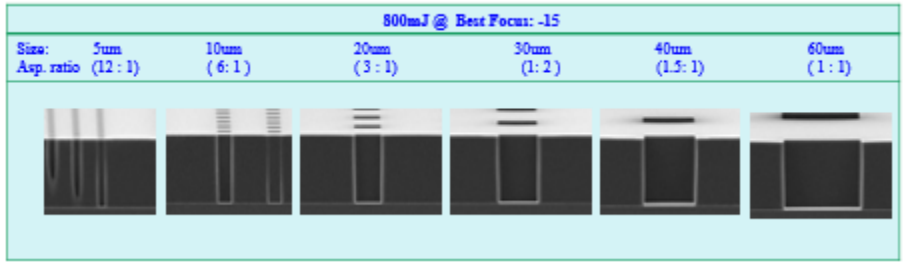


AZ IPS-6050_Lithography (Canon Stepper) @FT60um

Focus Latitude on Copper @ FT=60.0 µm; Dose: 600mJ/cm2

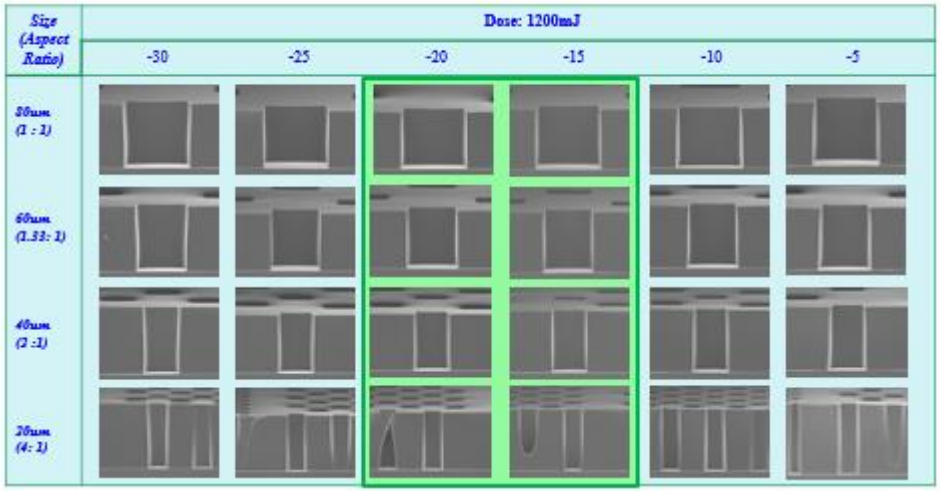


Resolution @ FT=60.0 µm; Dose: 800mJ/cm2; Focus: -15



AZ IPS-6090_Lithography (Ultratech Stepper)@ FT80um

Focus Latitude on Copper @ FT=80.0 µm; Dose: 1200mJ



Resolution @ FT=80.0 µm; Dose: 1400mJ; Focus: -15