

產品概述:

AR-P 630 - 670 series 是一系列不同溶劑,不同分子量的PMMA正型阻劑組合.適合各種電子束微影應用,如光罩製作,積體電路等高精密圖案製程(multi-layer and planarization),對玻璃,矽晶元,金屬等,有良好的接著性.

PMMA阻劑,產品分子量50k比950k敏感性(sensitivity)高約20%.

顯影後的阻劑結構在120°C能有良好的安定性.(thermal-stability).

系列產品,最低固型份含量,可降低膜厚到30nm. 適合奈米等級微影.此系列產品過慮規格為0.2um.

		AR-P 631 - 639	AR-P 641 - 649	AR-P 661 - 669	AR-P 671 - 679
Molecular weight 分子量		50 k	200 k	600 k	950 k
Film thickness@4000rpm (FT vary with solid contend)	nm	20 - 310	20 - 780	20 - 1,040	30 - 1,870
Solid content 固形份	%	1 - 12	1 - 12	1 - 11	1 - 11
Resolution best value	nm	6			
Contrast 對比度		7			
Flash point 閃火點	°C	vary with solvent			
Storage 6 months	°C	10 - 22			

AR-P 6 x x .04	產品編碼說明
固形份 %	04=4 %
溶劑種類	1 : Chlorobenzene (氯苯) 2 : Anisole (苯甲醚) 9 : ethyl lactate (乳酸乙酯)
分子量	3 : 50 k 4 : 200 k 6 : 600 k 7 : 950 k
產品編碼	
阻劑類型	P: 正型 N: 負型
公司編碼	

產品包裝:

250 ml / 瓶

1 L / 瓶

其它包裝可依客戶需求增加.

出貨:

☒ 4 – 8 週 : 德國運出

☐ 1 週 : 國內庫存
(目前暫無國內庫存)

價格詢問

其它諮詢

產品GHS標識

AR-P 631/641/661/671

AR-P 632/642/662/672

AR-P 639/649/669/679

Characterization

- e-beam, deep UV (248 nm)
阻劑可於電子束, 深紫外線下曝光
- very good adhesion to glass, silicon and metals
阻劑與玻璃, 矽及金屬的粘著度良好
- 50K 20 % more sensitive than 950K
分子量50k的產品, 其敏感度比950k的優約20%
- for planarization and multi-layer processes
適合於平坦化及多層電路製程
- highest resolution, high contrast
產品具高解析度及高對比
- poly(methyl methacrylate) with diff. molecular weights
高分子為不同分子量的PMMA (聚甲基丙烯酸甲酯).
- 各產品編號使用的溶劑如下:
 - AR-P 631-671 solvent chlorobenzene, (氯苯) flash point 28 °C
 - AR-P 632-672 safer solvent anisole, (苯甲醚) flash point 44 °C
 - AR-P 639-679 safer solvent ethyl lactate, (乳酸乙酯) flash point 36 °C

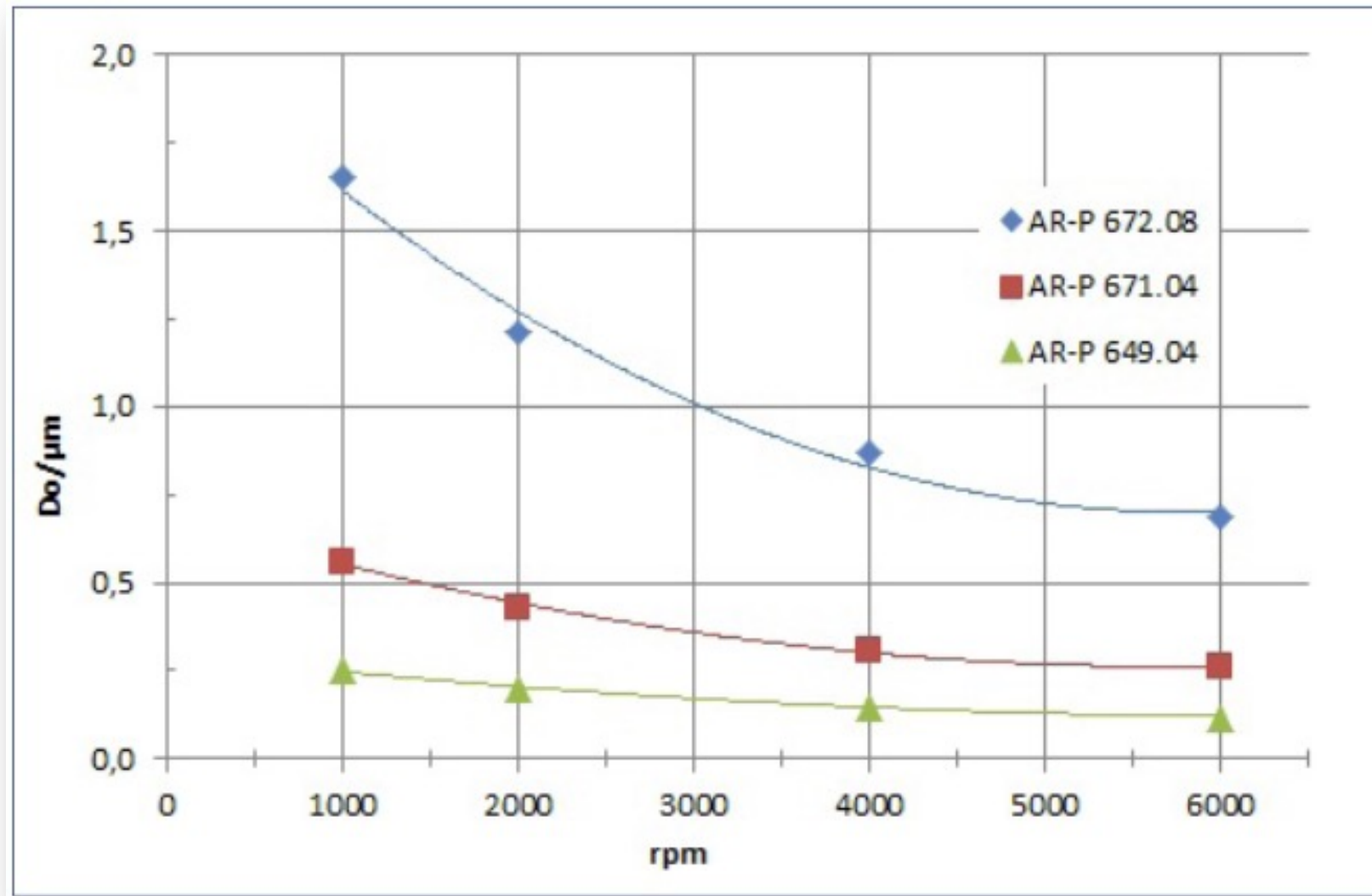
Property I

Parameter		AR-P 631 - 639	AR-P 641 - 649	AR-P 661 - 669	AR-P 671 - 679
PMMA molecular weight		50 k	200 k	600 k	950 k
Solids content	%	1 -12	1 - 12	1 - 11	1 - 11
Film thickness@4000 rpm (Vary with solid content)	nm	20 - 310	20 - 780	20 – 1,040	30 – 1,870
Resolution best value	nm	6			
Contrast		7			
Storage 6 months	°C	10 - 22			

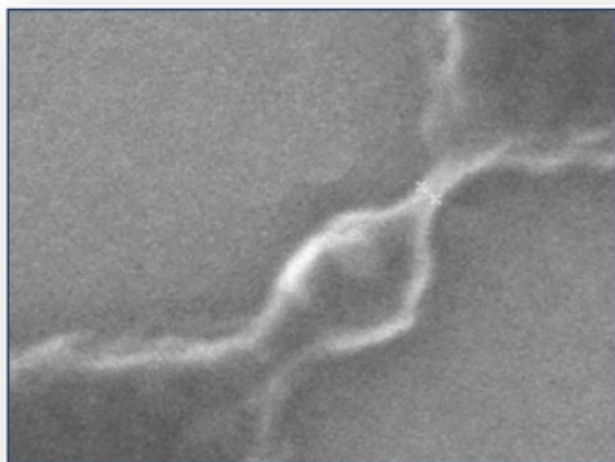
Property II

Glass trans. temperature	°C	105			
Dielectric constant		2.6			
Cauchy coefficients	N ₀	1.478			
	N ₁	47.3			
	N ₂	0			
Plasma etching rate 5 Pa, 240-250 V Bias	nm/min	Ar-sputtering		21	
		O ₂		344	
		CF ₄		59	
		80 CF ₄ +16 O ₂		164	

PMMA EBL resist spin curve

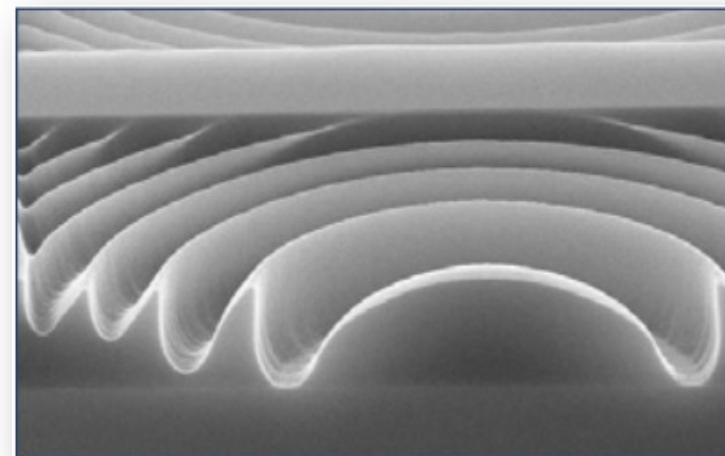


Structure resolution



AR-P 679.02
Structural resolution:
6.2 nm gap, 65 nm high

Resist structures



AR-P 671.09
diffractive optics,
thickness of 4.4 μm

Process parameter

Substrate	Si 4" wafer
Soft-bake	150 °C x 3 min, hot plate
Exposure	Raith Pioneer, 30 kV
Development	AR 600-56 x 60 sec, 21 °C
Stopper	AR 600-60 x 30 sec, 21 °C

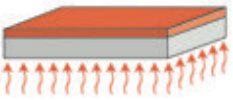
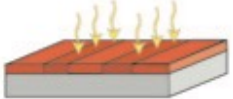
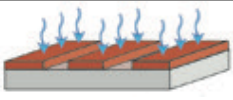
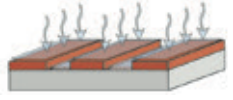
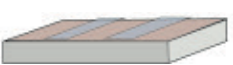
Process chemicals

Adhesion promoter	AR 300-80new
Developer	AR 600-55, AR 600-56
Thinner	AR 600-01, -02, -09
Stopper	AR 600-60
Remover	AR 600-71, AR 300-76

Process conditions

This diagram shows exemplary process steps for resists of AR-P 630 – 670 series. All specifications are guideline values which must be adapted to own specific conditions. For further information on processing, 🖱️ “Detailed instructions for optimum processing of e-beam resists”. For recommendations on wastewater treatment and general safety instructions, 🖱️ “General product information on Allresist e-beam resists”.

圖示AR-P 630-670 series PMMA阻劑產品製程參數的範例。所有參數為參考值,使用者應依設備環境實際狀況加以調整

Coating		AR-P 632.06	AR-P 671.05
		110 nm@4000rpm x 60 sec	690 nm@2000rpm x 60 sec
Soft bake ($\pm 1^{\circ}\text{C}$)		150 °C x 3 min hot plate or 150°C x 60 min convection oven	
e-Beam exposure dose (E_0):		ZBA 21, 20 kV	Raith Pioneer, 30 kV
		95 $\mu\text{C}/\text{cm}^2$	770 $\mu\text{C}/\text{cm}^2$
Development (21-23 $\pm 1^{\circ}\text{C}$) puddle		AR 600-55, 1 min	AR 600-56, 3 min
Stopping		AR 600-60, 30 sec	
Post-bake (optional)		130°C x 1 min hot plate, or 130°C x 25 min convection oven for slightly enhanced plasma etching resistance	
Customer specific technology		Generation of semiconductor properties	
Removal		AR 300-71, or O ₂ plasma ashing	

2-layer Coating and Lift-off Application

Processing instructions for coating

Large undercut structures (lift-off) are obtained if PMMA resists with different molecular weight are chosen for a two-component system. As upper layer, an ethyl lactate PMMA is recommended since ethyl lactate does not, in contrast to other solvents, attack the second layer. For the lower layer, a chlorobenzene, anisole or ethyl lactate PMMA is suitable. Both tempering steps are performed at 150 °C.

Recommendation:

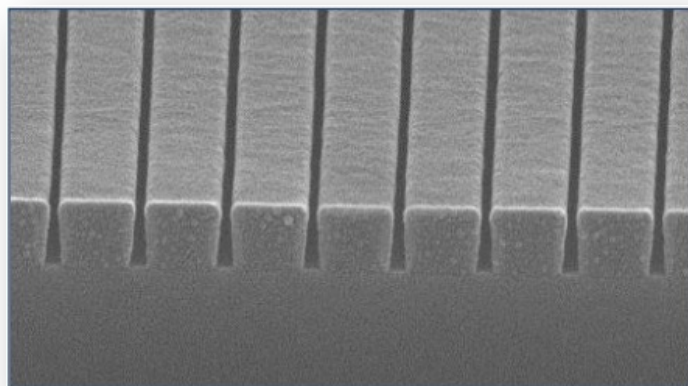
large undercut (low resolution): bottom layer 50K, upper layer 200K, 600K or 950K. High resolution (smaller undercut): bottom layer 600K, upper layer 950K.

懸浮剝離法所需的下切型阻劑結構可以不同分子量的PMMA阻劑作為2層結構的組合。上層的PMMA建議選用以乳酸乙酯(ethyl lactate)為溶劑,因相較於其它溶劑,乳酸乙酯不會攻擊第底層阻劑。底層PMMA的溶劑可以是氯苯(chlorobenzene),苯甲醚(anisole),或乳酸乙酯(ethyl lactate)。兩層阻劑可同時於150°C軟烤。

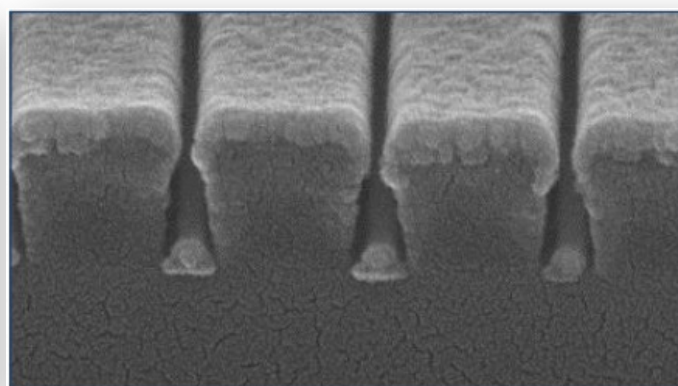
一般建議的組合:

下切結構較大(低解析度): 分子量, 底層PMMA 50k, 上層PMMA 200k.

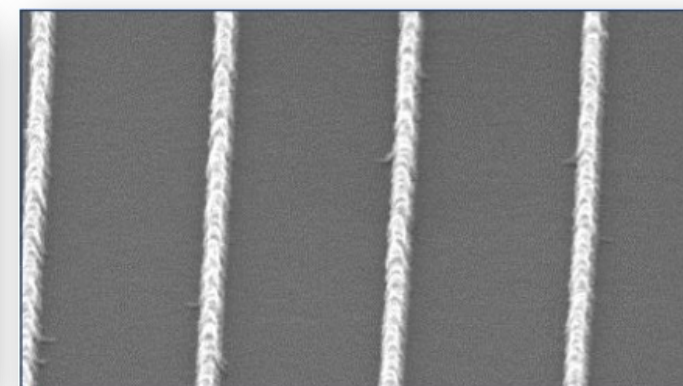
下切結構較小(高解析度): 分子量, 底層PMMA 600k, 上層PMMA 950k.



After development (AR 600-56)



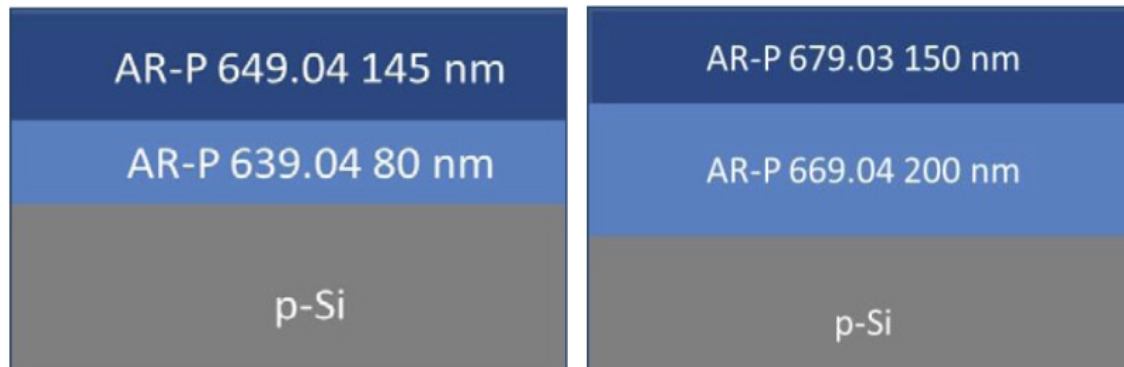
Structures coated with metal films



Lifted 30 nm metal lines

2-layer Coating and Lift-off Application

Investigations of 2-layer PMMA lift-off structures

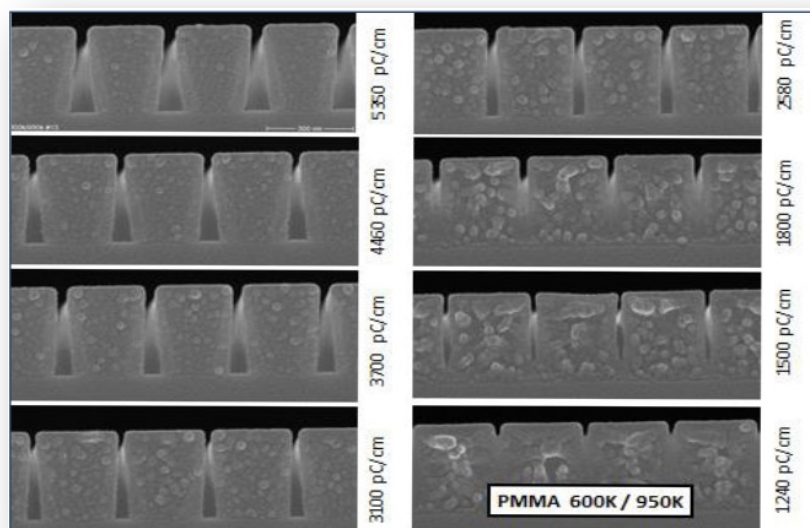


Layer structure of the two-layer system 50K/200K

Layer structure of the two-layer system 600K/950K

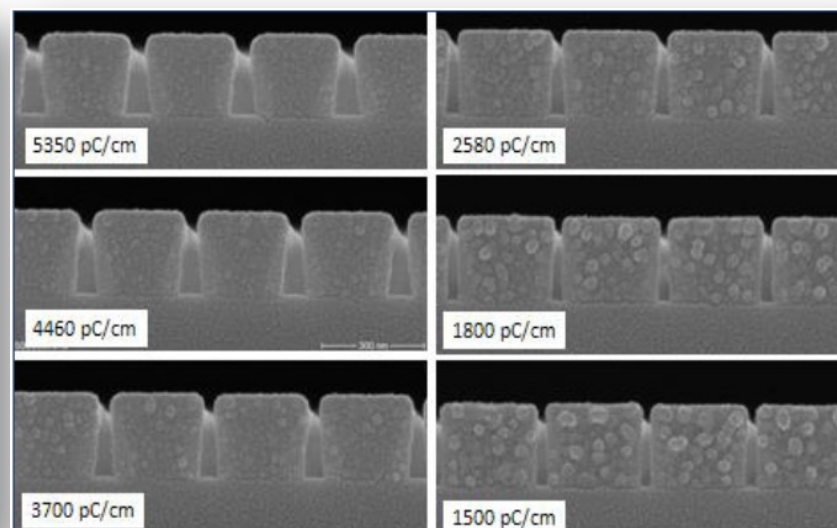
For these tests, the 2-layer systems were coated as shown to the left and tempered at 180 °C, 60 s, followed by irradiation with different doses (30 kV) and development (AR 600-60, IPA).
雙層組合結構的測試,例如左圖的組合,塗佈後以180°C軟烤,再以30kV加速電壓在不圖劑量下曝光後顯影(AR 600-60, IPA)

Dose sequence of the 600K/950K system



Not yet completely developed at 1800 pC/cm

Dose sequence of the 50K/200K system



Constantly increasing undercut

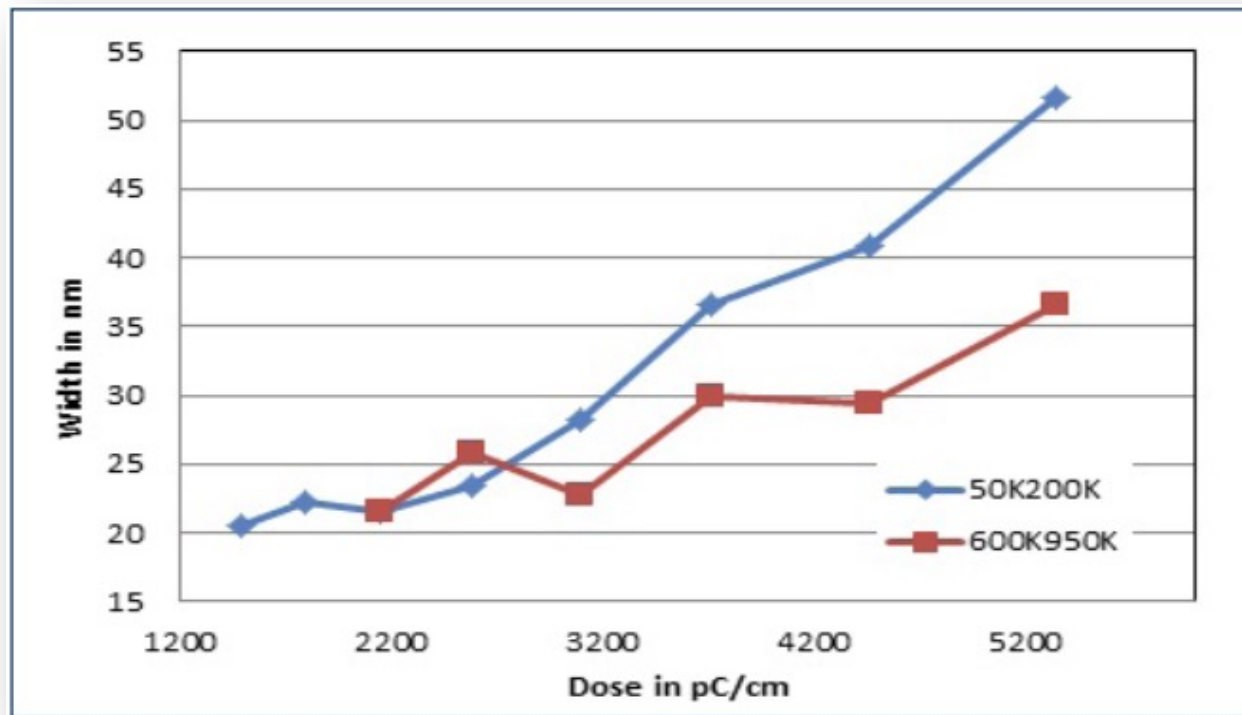
Definition: The sensitivity is expressed in pC/cm for lines, while the unit for areas is $\mu\text{C}/\text{cm}^2$

The system 50K/200K is more sensitive, the double layer is completely developed at 1500 pC/cm². The variant 600K/950K in contrast requires the higher dose of 2200 pC/cm². With increasing dose, also a larger undercut is generated if the 50K/200K system is used, which is thus predestined for complicated lift-off procedures. Variant 600K/950K may be utilized for higher total film thicknesses (> 500 nm) and is a reliable lift-off system for simple applications. For these investigations, always AR 600-60 (IPA) was used as developer which explains both the comparably high doses and the good process stability.
分子量 50k/200k的組合,其敏感度較高,雙層完全顯開約需 1500 pC/cm的曝光能量. 分子量 600k/950k則需 2200pC/cm的較高劑量. 複雜的懸浮剝離製程,一般先以 50k/200k的組合,增加曝光劑量可獲得較大的下切結構. 600k/950k的組合,則應用於膜厚需求較高的製程(>500nm). 這些研究皆以AR 600-60(IPA)為顯影劑,因此需要較高的曝光劑量,但製程相當穩定.

2-layer Coating and Lift-off Application

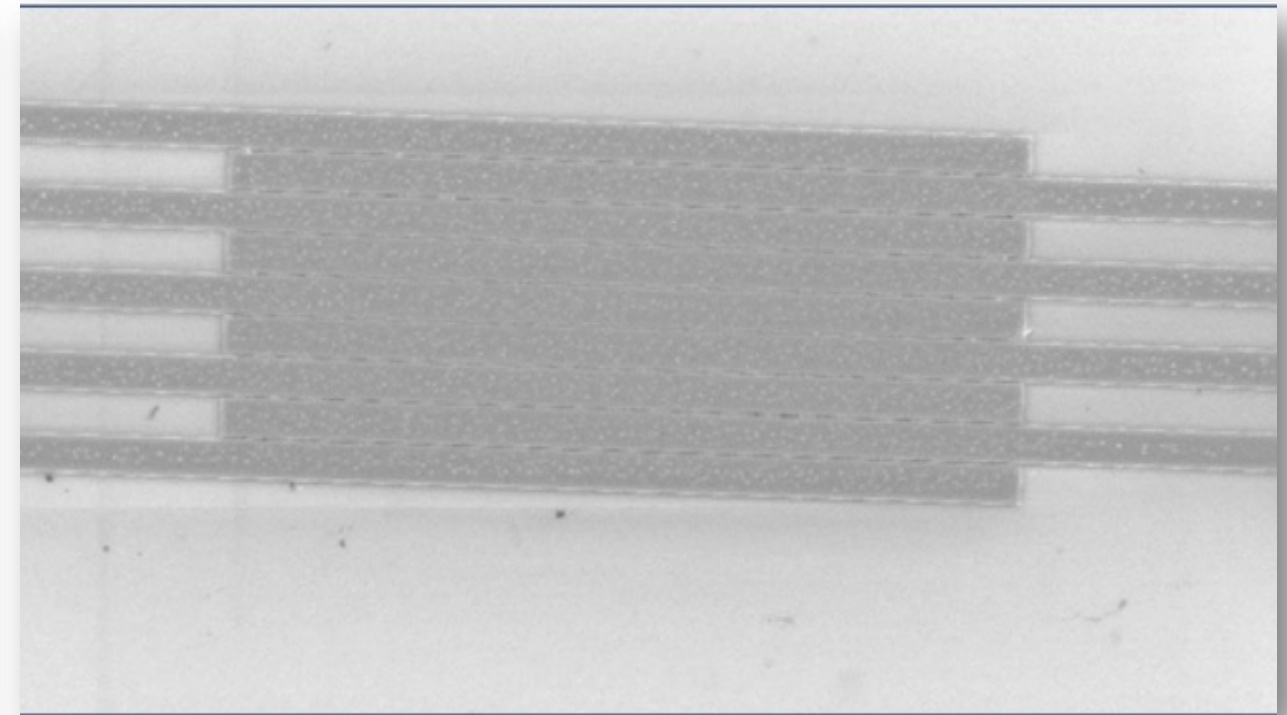
Investigations of 2-layer PMMA lift-off structures

Formation of undercut vs. exposure dose



Trench width top: 20 nm, measured values in the diagram: width of trenches at the bottom

Application example

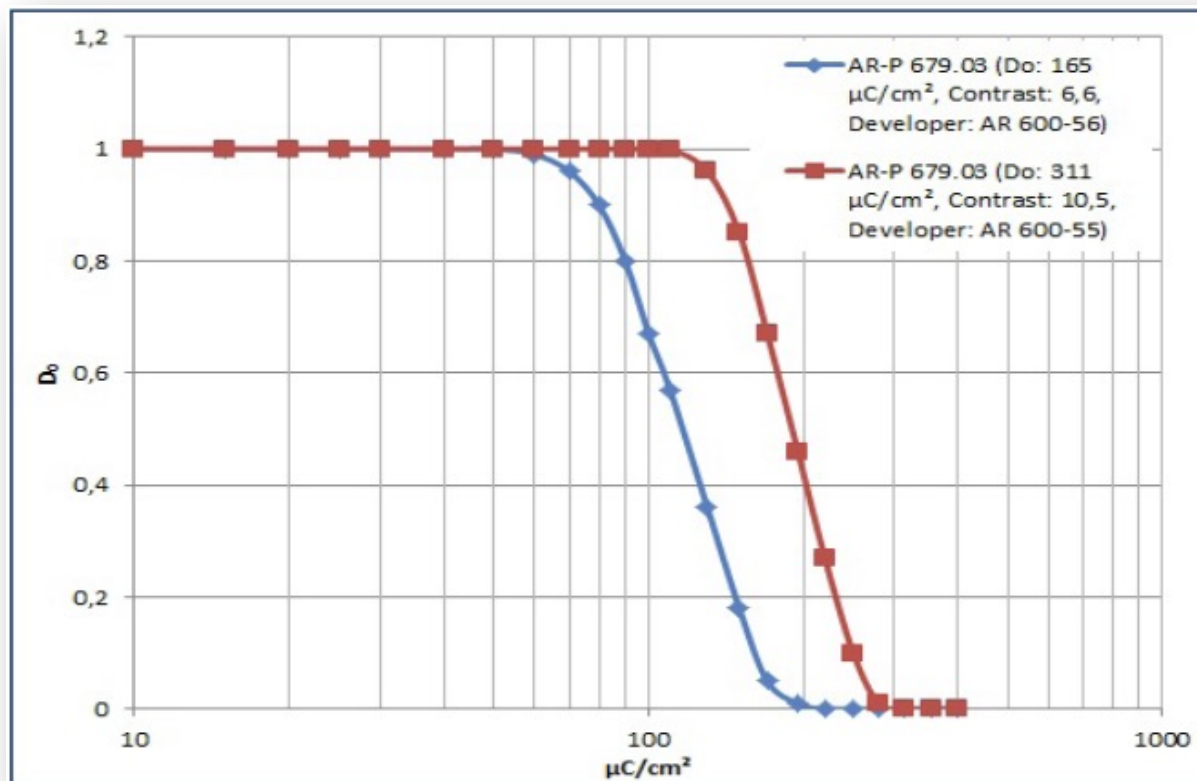


“Finger structures“ produced with the special system PMMA 90k/200K, trench width 30 nm

2-layer Coating and Lift-off Application

Investigations of 2-layer PMMA lift-off structures

Sensitivity of a PMMA resist



Comparison of developer AR 600-55 and AR 600-56

The left diagram shows a comparison of the sensitivity of AR-P 679.03 in two different developers. Under otherwise identical conditions (30 kV, 165 nm film thickness), the sensitivity is almost twice as high if the standard developer AR 600-55 is used as compared to AR 600-60 (IPA). A development with IPA however results in a considerably higher contrast (10.5 : 6.6). This developer is thus predestined for higher resolutions. Experience furthermore shows that the process window is significantly larger as compared to faster developers.

Dose deviations of e.g., 10 % are tolerated without any quality loss.

左圖以AR-P 679.03為例顯示在2種不同顯影劑下的敏感度的比較。在相同參數條件下 (30kV, 165nm film thickness), 使用顯影劑AR 600-55比AR 600-50 (IPA), 敏感度高出2倍。

然而使用IPA顯影有高對比特性(10.5 : 6.6)。因此IPA用於較高解析度的製程。實驗也顯示其製程穩定度高於快速顯影的製程。

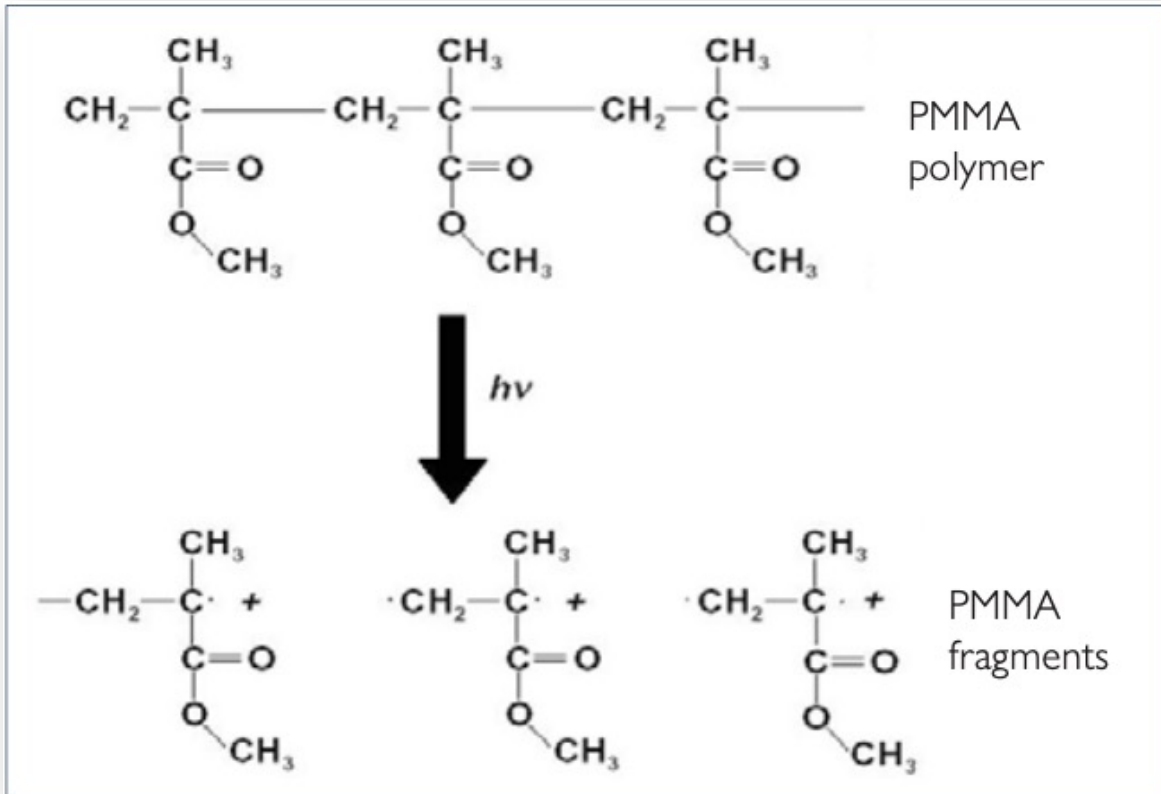
10%的曝光劑量偏差不會影響製程品質

Reaction Mechanism

Upon electron irradiation of PMMA resists, the main chain is cleaved and the molecular mass drops from initially 950 000 g/mol (950K) to 5.000 – 10.000 g/mol. This main chain scission is primarily due to radical processes (see figure below). At an optimal dose, radicals recombine and form molecules with a molecular mass of about 5 000 g/mol. If, however, the dose is drastically increased, a large number of radicals are produced and undergo crosslinking so that molecules with higher molecular masses are obtained. The PMMA is turned into a negative resist. This effect is depicted in the diagram on the right which shows the gradation curve of a standard process (AR-P 671.05, 490 nm film thickness, 30 kV, developer AR 600-56). High exposure doses convert the resist into a negative resist.

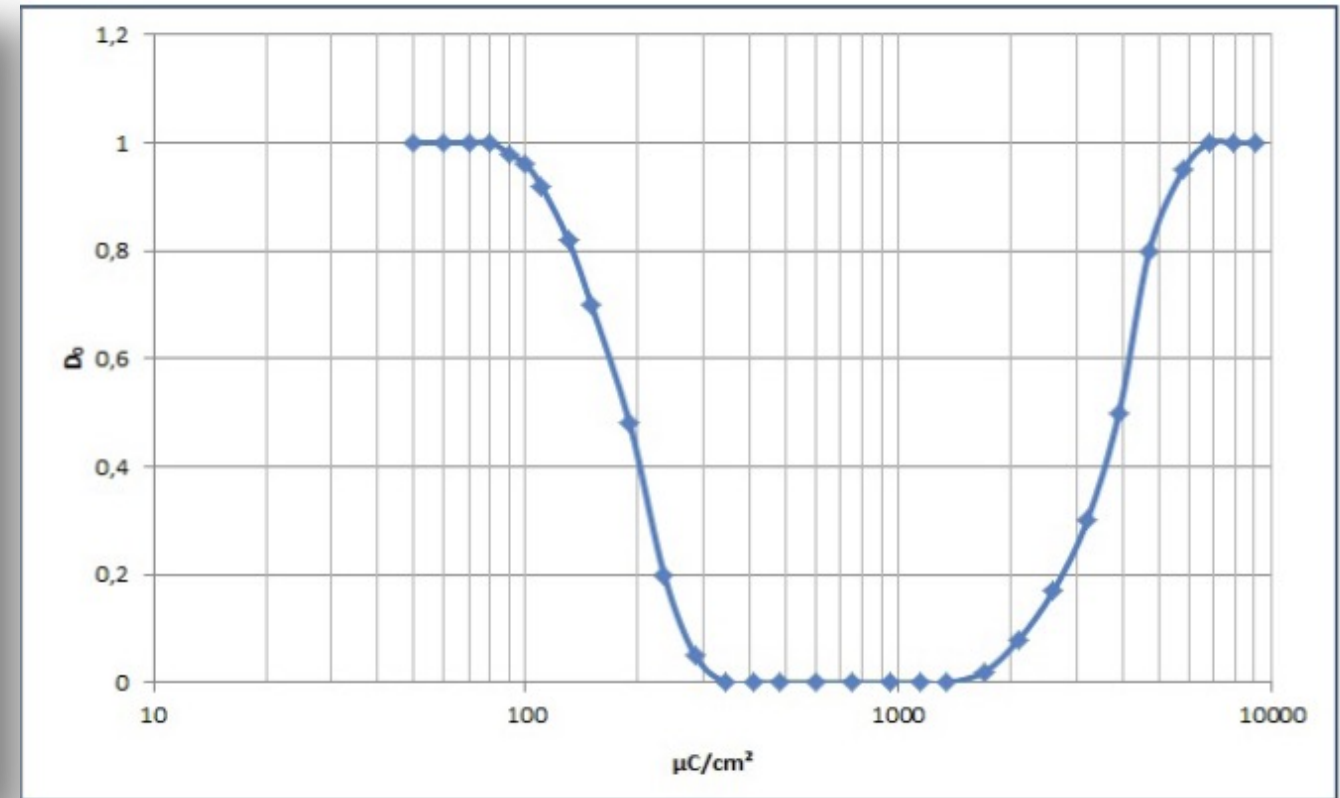
PMMA聚合物在電子束照射下主鏈斷裂,分子量從原來950,000 g/mol(950k)降為5,000 – 10,000 g/mol. 這種主鏈斷健主要來自於根基反應.(如左下圖). 在適合的曝光劑量下,自由基重組形成分子量約5,000g/mol的聚合物. 然而,大量提高曝光劑量,產生的大量自由基會形成架橋反應,分子量提高,反而變成負型阻劑. 右下圖顯示在標準製程(AR-P 671.05, 490nm film thickness, 30kV, developer AR 600-56), 高曝光劑量使阻劑轉為負型.

Depolymerization upon exposure



The main chain of the PMMA is cleaved into many radical fragments

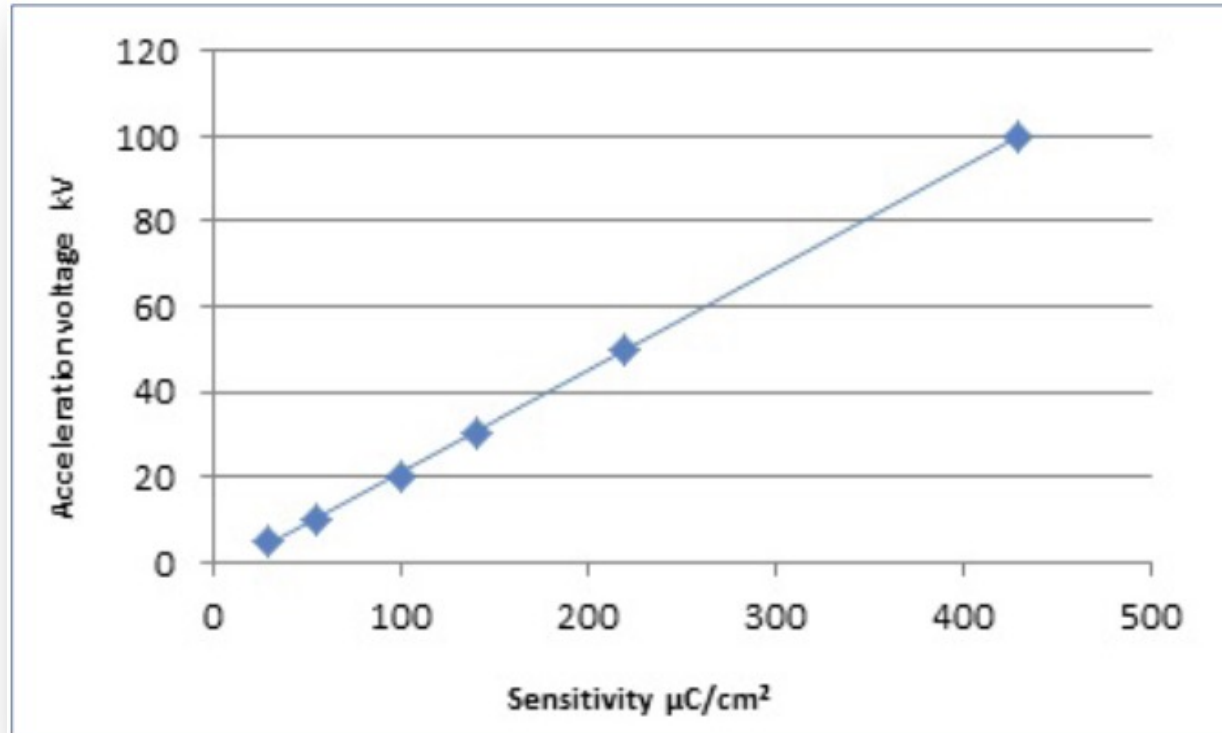
Gradation curve PMMA



Gradation curve up to maximum dose

Reaction Mechanism

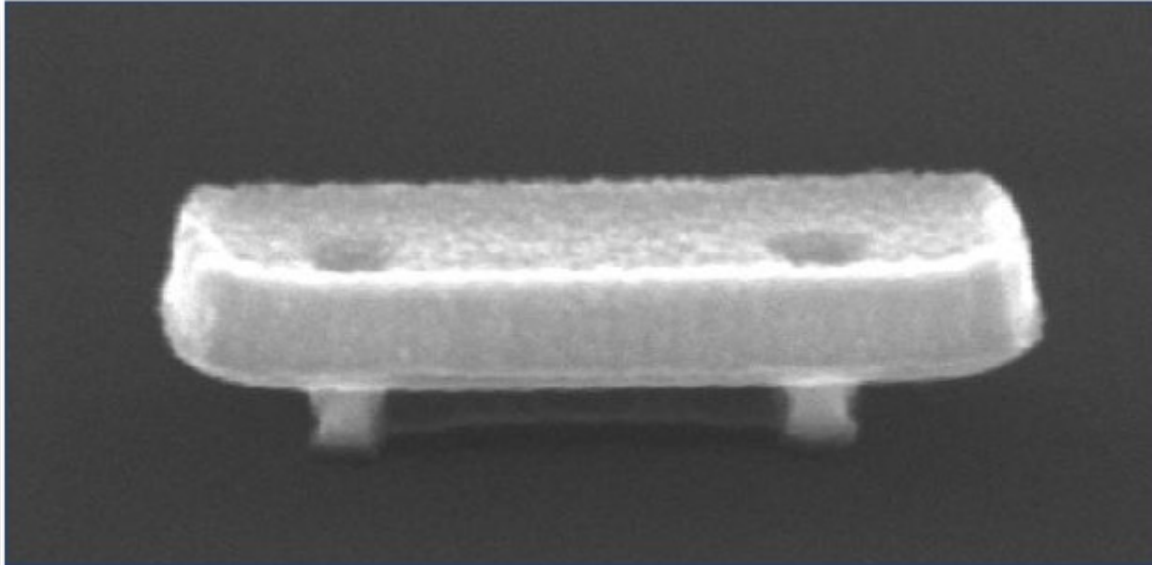
Dose versus acceleration voltage



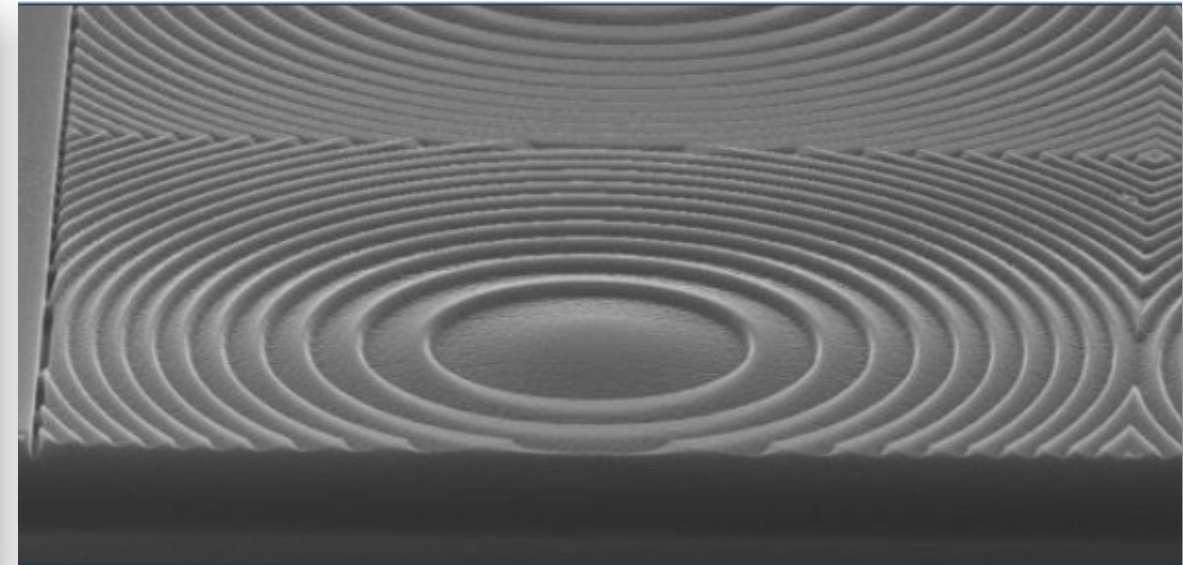
The sensitivity of a PMMA resist (AR-P 671.05) strongly depends on the acceleration voltage. At 100 kV a major part of the energy passes the resist without any interaction and the resist is consequently less sensitive. At 5 kV however, all electrons are absorbed.

PMMA阻劑,的敏感度與加速電壓有直接關係,左圖以AR 671.05為例,在100kV曝光參數下,能量直接穿透阻劑而無反應,敏感明顯下降. 在5kV下,所有電子都可被吸收.

Applications for PMMA resists



Fabrication of a PMMA bridge with AR-P 679.04 by exploiting Fresnel lenses with AR-P 671.09 the limited penetration depth at low acceleration voltage



Fresnel lenses with AR-P 671.09

Specifications of 50K, 200K, 600K and 950 K in chlorobenzene, anisole and ethyl lactate

溶劑類型:

Type of solvent

氯苯

Chlorobenzene

苯甲醚

Anisole

乳酸乙酯

ethyl lactate

Products in regular production are highlight in orange-bold

橙色粗體字為固定排程生產的產品

PMMA M.W	Code AR-P	Solid Content %	Viscosity 25°C mPa.s	Film Thickness @1000 rpm (nm)	Film Thickness @2000 rpm (nm)	Film Thickness @4000 rpm (nm)	Film Thickness @6000 rpm (nm)	Density 20 °C (g/cm ³)
50 k	631.01	1.0	0.9		20	20	10	1.104
	631.04	4.0	1.3		130	90	80	1.107
	631.06	6.0	1.9		230	170	140	1.110
	631.09	9.0	3.1	570	410	300	250	1.112
	632.01	1.0	1.2		20	20	10	0.992
	632.04	4.0	1.8	110	80	60	50	0.995
	632.06	6.0	2.3	210	160	110	90	0.997
	632.08	8.0		300		170	140	
	632.09	9.0	3.5	380	270	200	170	0.999
	632.12	12.0	5.1	600	420	310	250	1.001
	639.01	1.0	1.4	20	20	20	10	0.964
	639.04	4.0	2.2	160	120	80	70	0.970

PMMA M.W	Code AR-P	Solid Content %	Viscosity 25°C mPa.s	Film Thickness @1000 rpm (nm)	Film Thickness @2000 rpm (nm)	Film Thickness @4000 rpm (nm)	Film Thickness @6000 rpm (nm)	Density 20 °C (g/cm ³)
200 k	641.01	1.0	1.4		40	20	10	1.104
	641.04	4.0	4.4	330	230	160	130	1.108
	641.06	6.0	7.9		380	280	260	1.110
	641.07	7.0	11.0	710	520	370	310	1.110
	641.09	9.0	17.4	1130	830	590	480	1.112
	642.01	1.0	1.9	30	20	20	10	0.992
	642.03	3.0	4.8	130	90	70	50	0.994
	642.04	4.0	6.8	210	150	110	80	0.996
	642.06	6.0	12.8	410	290	210	170	0.997
	642.07	7.0	16.5	530	370	270	220	0.998
	642.09	9.0	30.3	850	590	410	350	0.999
	642.12	12.0	62.3	1510	1080	780	630	1.002
	649.01	1.0	1.9		30	20	10	0.964
	649.04	4.0	5.8	250	200	150	120	0.970

PMMA M.W	Code AR-P	Solid Content %	Viscosity 25°C mPa.s	Film Thickness @1000 rpm (nm)	Film Thickness @2000 rpm (nm)	Film Thickness @4000 rpm (nm)	Film Thickness @6000 rpm (nm)	Density 20 °C (g/cm ³)
600 k	661.01	1.0	2.2		40	30	20	1.104
	661.04	4.0	13.7	430	320	230	190	1.108
	661.06	6.0	28.2		670	480	390	1.110
	661.08	8.0	76.0		1290	930	740	1.120
	661.09	9.0	105	2580	1750	1250	1000	1.113
	662.01	1.0	2.6	30	20	20	10	0.991
	662.04	4.0	12.2	280	220	140	90	0.995
	662.06	6.0	31.2	590	410	290	250	0.998
	662.09	9.0	82.5	1270	910	620	540	1.003
	662.11	11.0	158.8	2140	1470	1040	880	1.005
	669.01	1.0	2.5		30	20	20	0.965
	669.04	4.0	15.6	460	310	220	180	0.970
	669.06	6.0	68	990	740	520	420	0.975
	669.07	7.0	128	1660	1070	740	600	0.978

PMMA M.W	Code AR-P	Solid Content %	Viscosity 25°C mPa.s	Film Thickness @1000 rpm (nm)	Film Thickness @2000 rpm (nm)	Film Thickness @4000 rpm (nm)	Film Thickness @6000 rpm (nm)	Density 20 °C (g/cm ³)
950 k	671.01	1.0	3.2	50	40	30	20	1.105
	671.02	2.0	7.3	190	130	90	70	1.106
	671.04	4.0	23.2	560	430	310	260	1.108
	671.05	5.0	57.0	950	690	490	390	1.109
	671.06	6.0	86.0		970	680	540	1.110
	671.07	7.0	135		1370	970	780	1.111
	671.09	9.0	285	3700	2400	1700	1340	1.113
	672.01	1.0	3.8	50	40	30	20	0.998
	672.02	2.0	8.8	120	90	70	60	0.991
	672.03	3.0	15.5	220	170	130	100	0.994
	672.045	4.5	46.2	410	320	230	190	0.998
	672.05	5.0	63.1	650	450	320	260	1.000
	672.06	6.0	76.2	830	630	450	360	1.001
	672.08	8.0	211	1650	1210	870	690	1.005
	672.11	11.0	503	3940	2820	1870	1420	1.007
	679.01	1.0	3.4	50	40	30	20	0.965
	679.02	2.0	7.8	120	100	70	60	0.967
	679.03	3.0	16.4	310	230	160	120	0.968
	679.04	4.0	43.4	630	400	270	220	0.970