2L-Lift-off System with AR-BR 5400 (positive or negative)

AR-BR 5400 bottom resist for two-layer lift-off systems

Positive or negative system for optically transparent and thermally resistant structures

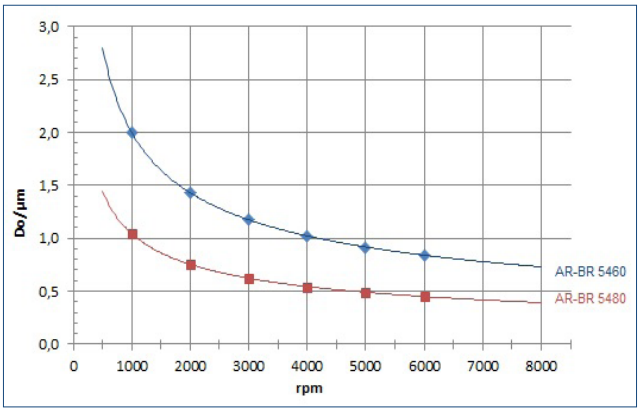
Characterisation

- bottom resist not light sensitivity
- broadband UV, i-line, g-line for top resist
- for lift-off structures
- for optically transparent structures from 270 nm to IR with thermally stable structures up to 250 °C
- aqueous-alkaline development
- temperature-stable up to 140 °C (with AR-P 3500)
- 5400 copolymer methyl methacrylate/methacrylic acid
- 3- safer solvent PM (5400), PGMEA (3500, 4340)

Properties I

Parameter / AR-BR	5460	5480
Solids content (%)	12	9
Viscosity 25 °C (mPas)	73	33
Film thickness/4000 rpm (µm)	1.0	0.5
Resolution top resist 2 L (µm)	3.0	1.5
Contrast	lift-off	lift-off
Flash point (°C)	30	30
Storage 6 month (°C)	10 - 22	

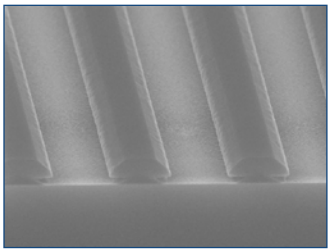
Spin curve



Properties II

Glass transition temperature	125	
Dielectric constant	2.9	
Cauchy coefficients	N_0	1.526
	N_1	0
	N_2	117
Plasma etching rates (nm/min) (5 Pa, 240-250 V Bias)	Ar-sputtering	14
	O_2	283
	CF_4	51
	80 CF_4 + 16 O_2	133

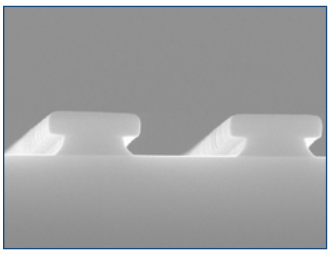
Structure resolution of positive system



AR-BR 5460 - AR-P 3510

5 µm-bars of positive two-layer system after development

Structure resolution of negative system



AR-BR 5480 - SX AR-N 4340/7

Finely adjusted lift-off undercut with negative resist

Process parameters

Substrate	Si 4“ wafer
Tempering	150 °C, 5 min, hot plate
Exposure	Maskaligner MJB 3
Development	AR 300-47, 1 : 1, 2 min, 22 °C

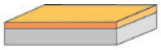
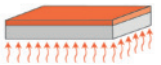
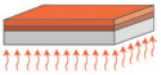
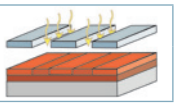
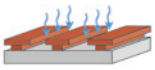
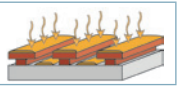
Process chemicals

Adhesion promoter	AR 300-80
Developer	AR 300-47
Thinner	AR 600-07
Remover	AR 300-76, AR 300-73

2L-Lift-off System with AR-BR 5400 - AR-P 3500

Process conditions positive process

This diagram shows exemplary process steps for the positive system AR-BR 5400 – AR-P 3540. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, ☞ "Detailed instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, ☞ "General product information on Allresist photoresists".

1. Coating 	AR-BR 5460 (bottom resist for lower layer)	AR-BR 5480 (bottom resist for lower layer)
	2000 rpm, 60 s 1.4 µm	2000 rpm, 60 s 0.7 µm
1. Tempering (± 1 °C) 	150 °C, 5 min hot plate or	
	145 °C, 30 min convection oven	
2. Coating 	AR-P 3540 (top resist for upper layer)	
	4000 rpm, 60 s 1.4 µm	
2. Tempering 	100 °C, 2 min hot plate or	
	95 °C, 30 min convection oven	
UV exposure 	Broadband UV, 365 nm, 405 nm, 436 nm	
	Exposure dose (E_0, bb UV st.): 42 mJ/cm^2, 1.4 µm (upper layer)	
Development (21-23 °C ± 0,5 °C) puddle 	AR 300-47, 1:1	AR 300-47, 1:1
	50 s	35 s
Rinse	DI-H_2O, 30 s	
Selective removal of the photoresist film (optional)	AR 600-70	AR 600-70
	10 s	10 s
Post-bake (optional)	Not required	
Customer-specific technologies 	Evaporation / sputtering of metal onto lift-off structures	
Lifting / Removal 	AR 300-76	

Important processing instructions on single process steps are outlined on the following page ☞

2 L-Lift-off Positive System AR-BR 5400 - AR-P 3500

Processing instructions for positive two-component system

Coating: The substrate is at first coated with the copolymer AR-BR 5400 and tempered. After cooling to room temperature, the photoresist is applied onto the copolymer. Dwell times are to be avoided; the liquid photoresist should not be left for more than 10 s on the standing wafer. The film thickness may be varied in a range between 1.6 - 4.0 µm. Subsequently, the two-component system is tempered.

Note: The ratio of film thicknesses of both films will affect structural geometry. For a strong lift-off effect, a thin photoresist layer and a thick copolymer layer is advantageous. For a dimensionally accurate transfer of structures into the copolymer layer however, both layers should have approximately the same thickness. The entire system always has to be optimised for the particular application.

Exposure:

AR-P 3500: Exposure and aqueous-alkaline development are carried out as usual (☞ Product information AR-P 3500). AR-BR 5400: The copolymer itself is not sensitive in the UV-range between 300-450 nm. The properties of the layer are however adjusted such that the polymer will dissolve quickly in the recommended aqueous-alkaline developer.

Development: After the upper photoresist layer is entirely developed in exposed areas, the developer begins to dissolve the copolymer.

The dissolution process now takes place in undirected manner (isotropic).
AR-BR 5400 is in this process removed both towards the bottom and towards the left or right side so that the undercut is formed. The longer the developer can exerts its effect, the more of the copolymer under the photoresist film is removed by dissolution. For a reduction of the dissolving rate, a higher temperature of up to 180 °C has to be chosen (instead of 150 °C). The desired undercut can thus be adjusted via the parameters temperature and development time (☞ see images below).

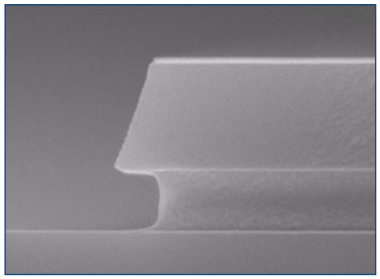
Selective removal of the photoresist layer (optional):

For transparent and temperature-stable films, the copolymer layer is used alone. In this case, the residual photoresist is selectively removed after development with remover AR 600-70. The substrate is briefly immersed in remover AR 600-70 and dried immediately with compressed air.

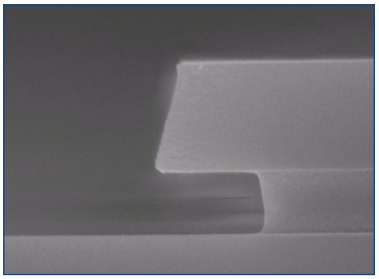
Lifting / Removal:

Removers AR 300-73 and AR 300-76 are both suitable for lifting undil.poses. If lift-off structures are not thermally stressed during evaporation or sputtering, lifting will take place within a minute.
After high thermal load (> 150 °C), the time required for lifting increased considerably. Ultra sound and heating facilitate a removal. Remover AR 300-73 may in this case be heated up to 50 °C max.

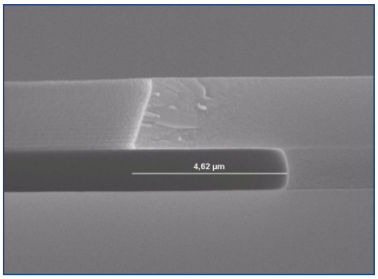
Adjustment of the undercut via development time



25 s development
0.8 µm undercut



40 s development
1.6 µm undercut

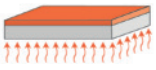
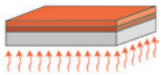
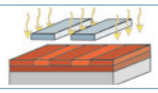
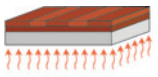
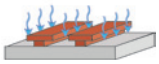
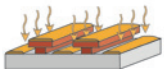


90 s development
4.6 µm undercut

2L-Lift-off Negative System AR-BR 5400 - SXAR-N 4340/7

Process conditions negative process

This diagram shows exemplary process steps for the positive system AR-BR 5400 – AR-P 4340/7. All specifications are guideline values which have to be adapted to own specific conditions. For further information on processing, ☞ "Detailed instructions for optimum processing of photoresists". For recommendations on waste water treatment and general safety instructions, ☞ "General product information on Allresist photoresists".

1. Coating 	AR-BR 5460 (bottom resist for lower layer)	AR-BR 5480 (bottom resist for lower layer)
	2000 rpm, 60 s, 1.4 µm	2000 rpm, 60 s, 0.7 µm
1. Tempering (± 1 °C) 	150 °C, 5 min hot plate or 145 °C, 30 min convection oven	
2. Coating 	SX AR-N 4340/7 (top resist for upper layer) 4000 rpm, 60 s, 1.4 µm	
2. Tempering (± 1 °C) 	90 °C, 2 min hot plate or 85 °C, 30 min convection oven	
UV exposure 	Broadband UV, 365 nm, 405 nm, 436 nm Exposure dose (E_0, bb UV st.): 20 mJ/cm^2, 1.4 µm (upper layer)	
3. Tempering (± 1 °C) Crosslinking bake 	95 °C, 2 min hot plate or 90 °C, 30 min convection oven	
Development (21-23 °C ± 0,5 °C) puddle 	AR 300-47, 1:1	AR 300-47, 1:1
	50 s	35 s
Rinse	DI-H_2O, 30 s	
Selective removal of the photoresist film (optional)	AR 600-70	AR 600-70
	10 s	10 s
Post-bake (optional)	Not required	
Customer-specific technologies 	Evaporation/sputtering of metal onto lift-off structures	
Lifting / Removal 	AR 300-73 or AR 300-76	

Important processing instructions on single process steps are outlined on the following page ☞

2L-Lift-off Negative System AR-BR 5400 - SXAR-N 4340/7

Processing instructions for negative two-component system

The negative two-layer lift-off system is characterised by a particularly high temperature resistance up to 250 °C after development.

Coating: The substrate is at first coated with the copolymer AR-BR 5400 and tempered. After cooling to room temperature, the negative resist SX AR-N 4340/7 which was specifically designed for two-layer systems is applied onto the copolymer. Dwell times are to be avoided; the liquid photoresist should not be left for more than 10 s on the standing wafer. The film thickness may be varied in a range between 1.0 – 2.5 µm. Subsequently, the two-component system is tempered.

Note: The ratio of film thicknesses of both films will affect the structural geometry. For a strong lift-off effect, a thin photoresist layer and a thick copolymer layer is advantageous. For a dimensionally accurate transfer of structures into the copolymer layer however, both layers should have approximately the same thickness. The entire system always has to be optimised for the particular application.

Exposure:
SX AR-N 4340/7: Exposure and aqueous-alkaline development are carried out according to the general process descriptions which require an additional cross-linking bake in the negative mode.

AR-BR 5400: The copolymer itself is not sensitive in the UV-range between 300-450 nm. The properties of the layer are however adjusted such that the polymer will dissolve quickly in the recommended aqueous-alkaline developer.
Development: After the upper photoresist layer is entirely developed in exposed areas, the developer begins to dissolve the copolymer. The dissolution process now takes place in undirected manner (isotropic).

AR-BR 5400 is in this process removed both towards the bottom and towards the left or right side so that the undercut is formed. The longer the developer can exerts its effect, the more of the copolymer under the photoresist film is removed by dissolution. For a reduction of the dissolving rate, a higher temperature of up to 180 °C has to be chosen (instead of 150 °C). The desired undercut can thus be adjusted via the parameters temperature and development time (☞ see images below). In addition, the steepness can be influenced by the exposure time of the negative resist.

Selective removal of the photoresist layer (optional):

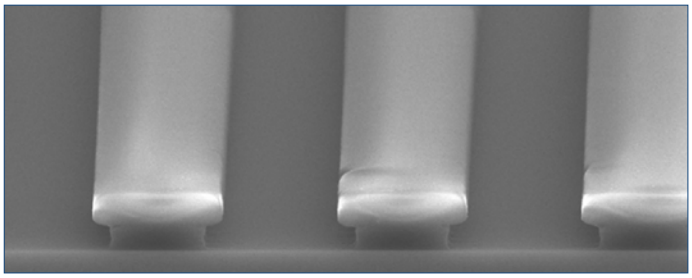
For transparent and temperature-stable films, the copolymer layer is used alone. For this undil.pose, the residual photoresist is selectively removed after development with remover AR 600-70. The substrate is briefly immersed in remover AR 600-70 and dried immediately with compressed air.

Lifting / Removal:

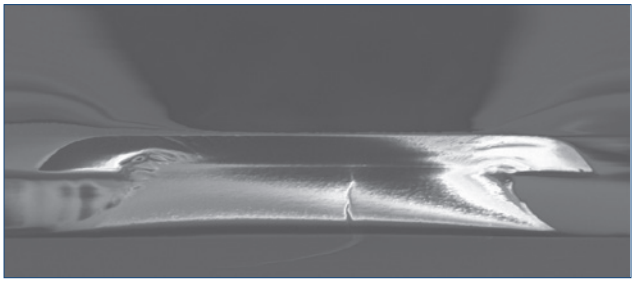
Removers AR 300-73 and AR 300-76 are both suitable for lifting. If lift-off structures are not thermally stressed during evaporation or sputtering, lifting will take place within a minute.

After high thermal load (> 250 °C), the time required for lifting increased considerably. Ultra sound and heating facilitate a removal. Remover AR 300-73 may in this case be heated up to 50 °C max.

Two layer lift-off system AR-BR 5400 – SX AR-N 4340/7



Steep edges due to optimised exposure times of the negative system



Negative lift-off structures after tempering at 200 °C