# Medusa 82 presentation materials

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- spin curve
- structure & resolution
- process baseline
- data for fine tune

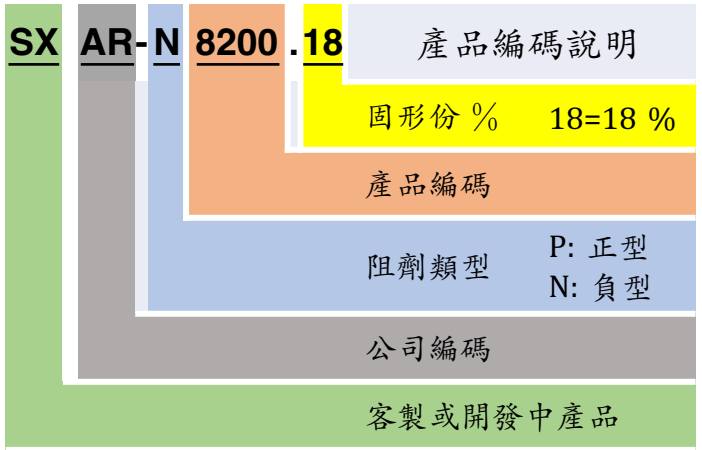
# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist

### 產品簡介:

AR-P 8200系列, 實驗代號Medusa 82, 為矽倍半氧烷類(silsesquioxane)負型電子束微影阻劑 (negative tone EBL resist). 與傳統HSQ resist相較, Medusa 82具有較佳製程穩定度, 較容易去除及較長的使用壽命等優點. 產品系列目前有:

| | | SX AR-N 8200.03 | SX AR-N 8200.06 | SX AR-N 8200.18 |
|---|---|---|---|---|
| Film thickness@4000rpm | nm | 50 | 100 | 400 |
| Resolution best value | nm | 10 | 13 | 20 |
| Contrast | | 5 | | |
| Flash point | °C | 38 | | |
| Storage 6 months | °C | 8 - 12 | | |




### 產品包裝：

100 ml /瓶

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

# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist



## Characterization

- high-resolution e-beam resist (10 nm)
  高解析度電子束微影阻劑,解析度可達10nm.
- etch-stable resist structures available in three film thicknesses
  抗蝕刻能力穩定, 三種厚度範圍產品
- comparable to HSQ, but higher process stability, easier to remove, considerably higher shelf life
  類似於HSQ,但製程較為穩定,也較容易去除且俱有較長的有效期
- sensitivity is increased by a factor of 20 if an additional tempering step is applied
  增加曝後烤步驟可提高敏感度達20倍
- silsesquioxane dissolved in 1-methoxy-2-propanol
  主要成份為矽倍半氧烷類溶於丙二醇甲醚(PGME)

# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist



### Properties I

| Parameter | | AR-P 8200.03 | AR-P 8200.06 | AR-P 8200.18 |
|---|---|---|---|---|
| Solids content 固型份 | % | 3.0 | 6.0 | 18.0 |
| Viscosity@25°C 黏度 | mPa.s | 2.3 | 2.5 | 3.2 |
| Film thickness@4000 rpm膜厚 | nm | 50 | 100 | 400 |
| Resolution 解析度 | nm | 10 | 13 | 20 |
| Contrast 對比 | | 5 | 5 | 5 |
| Flash point 閃火點 | °C | 38 | | |
| Storage 6 months<br>儲存溫度/有效期限 | °C | 8 - 12 | | |

### Property II

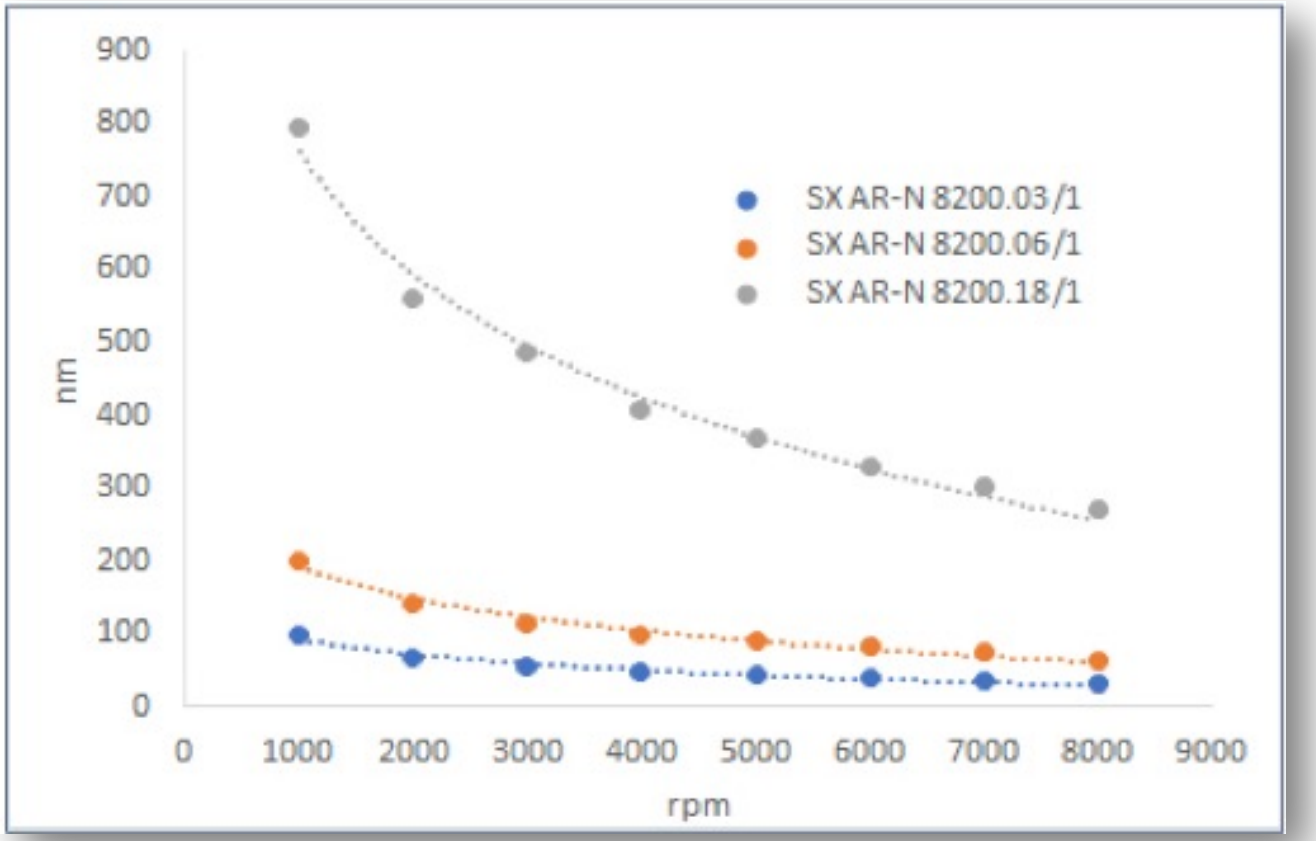
| | | | |
|---|---|---|---|
| Glass transition temperature | °C | - - | |
| Dielectric constant | | - - | |
| Cauchy coefficients | $N_0$ | 1.461 | |
| | $N_1$ | 72 | |
| | $N_2$ | 0 | |
| Plasma etching rates<br>1 Pa, 230 W Bias | nm/min | Ar sputtering | |
| | | $O_2$ | 6 |
| | | $CF_4$ | |
| | | 30 $CF_4$ + 5 $O_2$ | 220 |

# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist



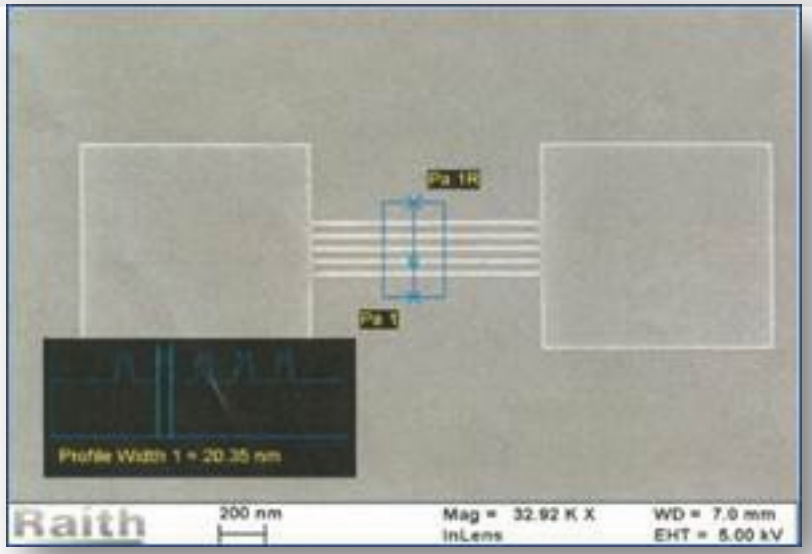
### SX AR-N 8200 series spin curve



# Medusa 82 silsesquioxane based e-Beam Resist

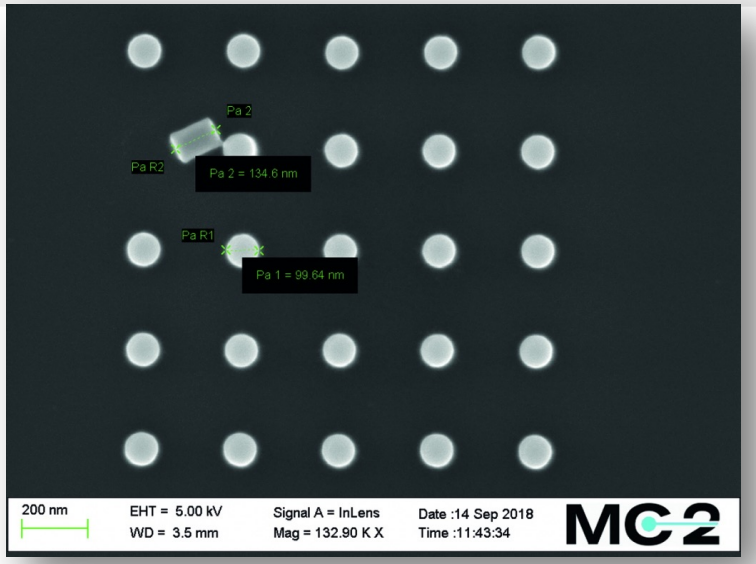
## High-resolution, etch-stable, negative tone, HSQ compatible resist

### Structure resolution




11 nm structures produced with SX AR-N 8200.03/1

### Resist structures




100 nm bars with SX AR-N 8200.06/1

### Process parameters

| | |
|---|---|
| Substrate | Si 4” wafer |
| Soft-bake | 150 ˚C x 10 min, hot plate |
| Exposure | Raith Pioneer 30 KV |
| Development | AR 300-44 x 90 sec, 23 ˚C |

### Process chemicals

| | |
|---|---|
| Developer | AR 300-44 |
| Thinner | AR 600-07 |
| Stopper | DI water |
| Remover | 2n NaOH, BOE |

# Medusa 82 silsesquioxane based e-Beam Resist

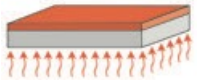
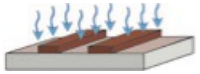
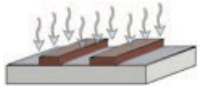
## High-resolution, etch-stable, negative tone, HSQ compatible resist



## Process conditions

This diagram shows exemplary process steps for resists of SX AR-N 8200 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 SX AR-N 8200 series 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  | SX AR-N 8200.03 | SX AR-N 8200.06 | SX AR-N 8200.18 |
| | 50 nm@4000 rpm | 100nm@4000 rpm | 400 nm@4000 rpm |
| Soft bake (± 1°C)  | 150 °C x 10 min hot plate | | |
| e-Bean exposure dose ($E_0$):  | Raith Pioneer, 30 kV | | |
| | 1,300 µC/cm² | | 2,000 µC/cm² |
| Hard-bake (optional)  | To enhance the sensitivity 170 ˚C, 10 min, hot plate | | |
| | 60 µC/cm² | | 85 µC/cm² |
| Development (21-23±0.5°C) puddle  | AR 300-44, 90 sec | | |
| Rinse | DI water, 30 sec | | |
| Customer specific technology  | | | |
| Removal  | 2n NaOH | | |

**Note on stability:** Liquid Medusa resists are stable for up to 6 months if kept refrigerated at least 8 - 12 ˚C. Coated substrates can be stored under normal conditions and processed without any loss of sensitivity or resolution even after several weeks. Current studies show that irradiated substrates can be processed even after 21 days without significant loss of sensitivity.

穩定性: Medusa 82阻劑保存在8-12°C環境下,有效期限為6個月. 阻劑已塗佈在基板上,在正常情況下仍可維持其敏感度或解析度至數週. 目前研究顯示,已曝光的基板在21天後顯影,其敏感度幾乎不變.

# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist



## Processing instructions

The sensitivity changes in dependence on the acceleration voltage. While 1300 µC/cm² is sufficient at 30 kV, this value increases to 4000 µC/cm2 at 100 kV. Figure 1 shows the corresponding dose scale (90 s AR 300-44, 23 ˚C). Recommended are development times of 60-90 s.

Medusa 82的敏感度會隨著使用的加速電壓改變. 加速電壓在30kV時只需約1,300 uC/cm²的劑量; 在100kV時則需增加到4,000 uC/cm². 左下圖1為不同曝光劑量下顯影的結果(顯影劑AR 300-44, 23°C, 顯影時間 60-90 sec)

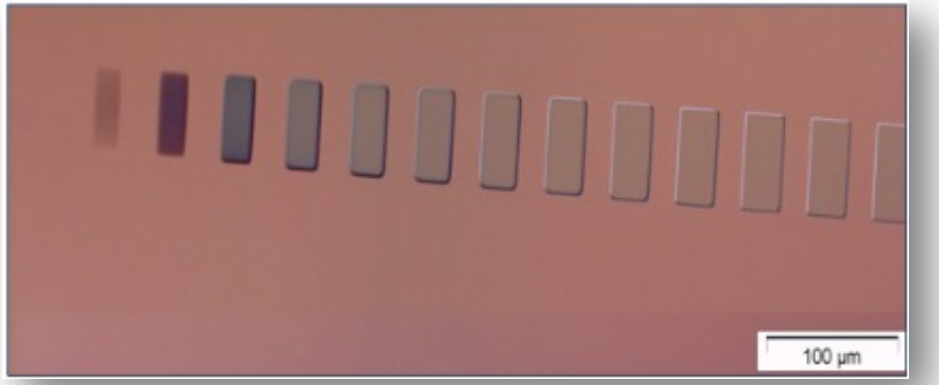



Figure 1: Dose scale (400 – 5000 µC/cm2) Medusa 82. Resist: SX AR-N 8200.06/1 - 100 nm; coating: 60 s 4000 rpm; soft-bake: 15 min @ 120 ˚C; exposure: Raith Pioneer, 30 kV; development: 90 s AR 300-44; 23 ˚C; stopping: 30 s DI water

Also, AR 300-46, AR 300-47 and AR 300-73 can be used for development, but the different developer concentrations affect the required development time and the dose. AR 300-44 results in a contrast of 4.7 at a required dose of 690 µC/cm2, while AR 300-73 results in a contrast of 4.6 at a required dose of 785 µC/cm2 under otherwise equal condition

顯影劑AR 300-46, AR 300-47及AR 300-73皆適用,但濃度不同, 所需顯影時間及曝光劑量也隨著改變. 右圖2顯示,以AR 300-44顯影,在曝光劑量690uC/cm²時,對比度達4.7. 在其它參數一樣下,以AR 300-73顯影,要達4.6對比度則需785 uC/cm²的曝光劑量

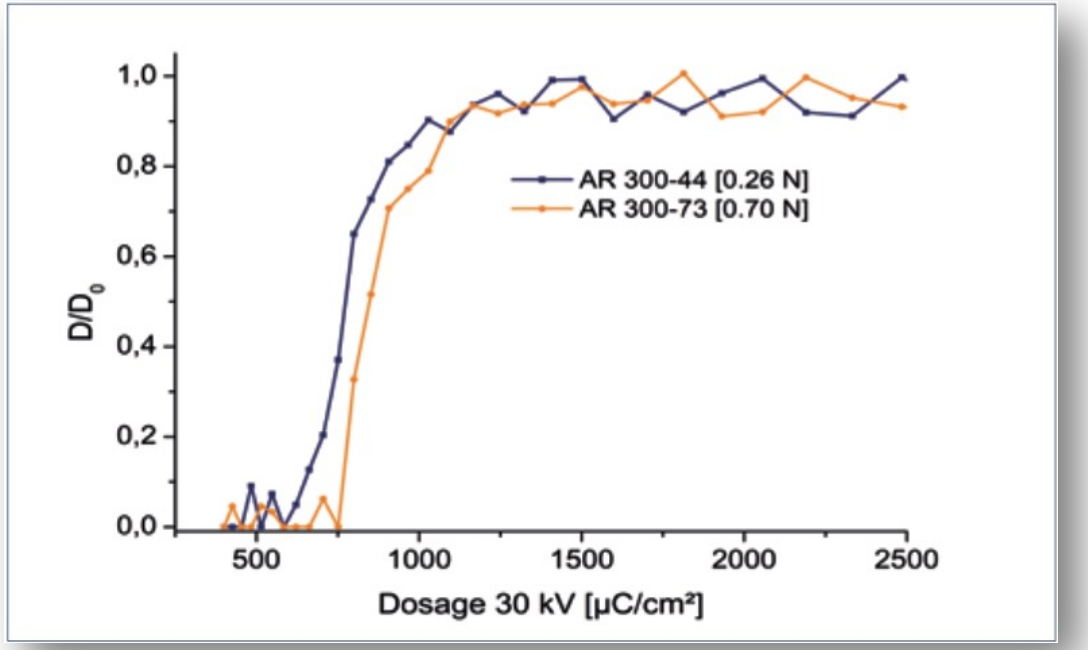



Figure 2: Influence of developer concentration on contrast and dose

# Medusa 82 silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, HSQ compatible resist



To increase sensitivity, a post exposure bake may be required after irradiation, which increases the sensitivity the increases by a factor of 8 at 100 kV and even by a factor of 20 at 30 kV. In addition, also the contrast is increased.

增加曝後烤步驟可增加Medusa 82的敏感度. 在100kV加速電壓,曝光後加以曝後烤可使敏感度增約8倍; 在30kV則增加約20倍. 下圖3為不同曝後烤條件下敏感度的變化.

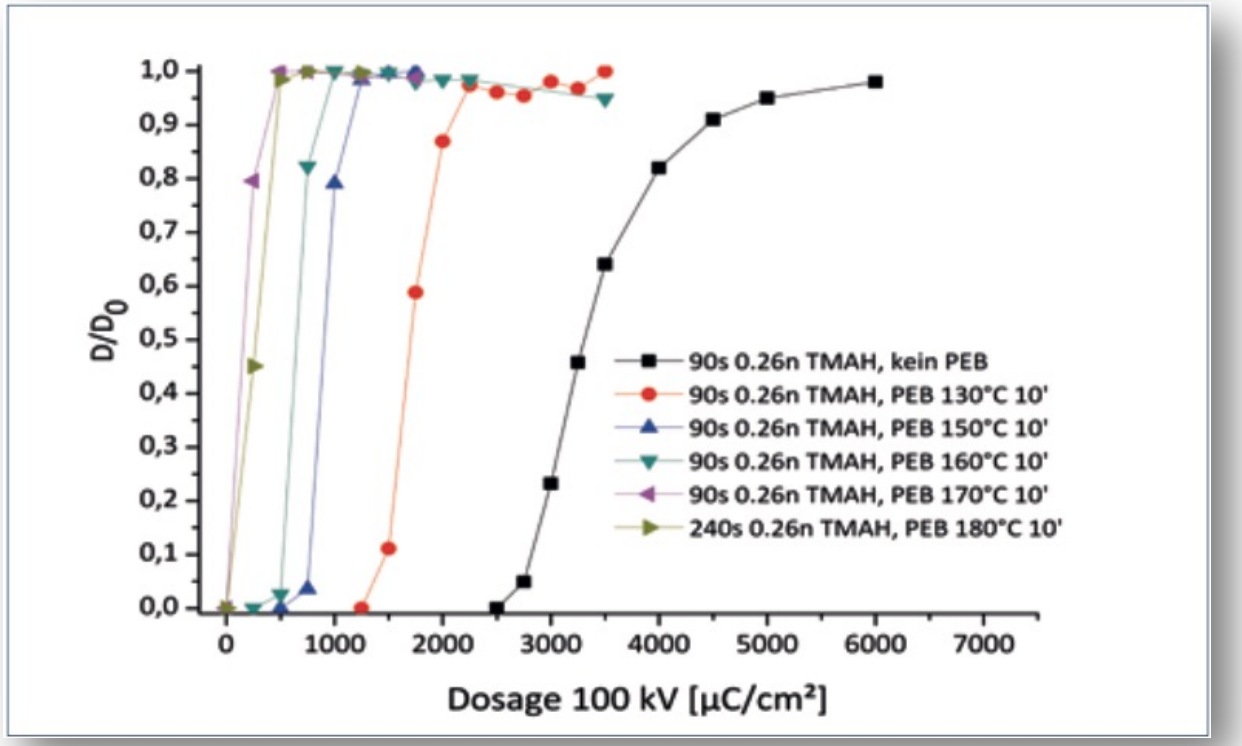



Figure 3: Influence of post exposure bake temperature on the dose. Resist: SX AR-N 8200.06/1; coating: 60 s 4000 rpm; soft- bake: 10 min; exposure: 100 kV; post exposure bake 10 min; development: 90 s AR 300-44; 23°C; stopping: 30 s DI water

# Medusa 82 UV silsesquioxane based e-Beam Resist

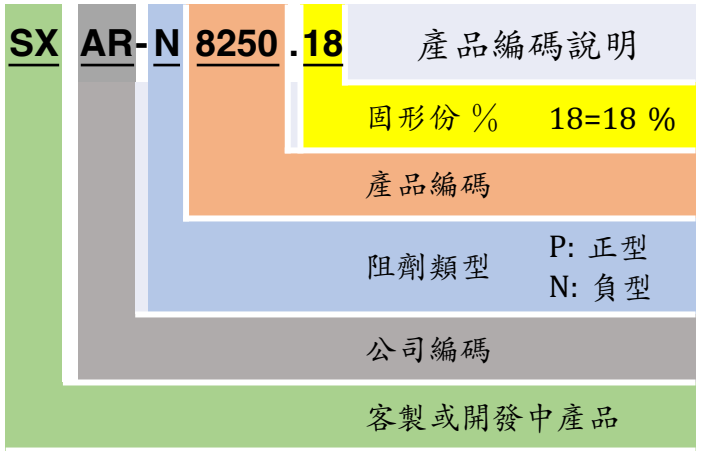
## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible

### 產品簡介:

AR-P 8250系列, 實驗代號Medusa 82 UV, 為矽倍半氧烷類(silsesquioxane)負型電子束微影阻劑. 可於電子束(EBL), 極紫外線(EUV)及深紫外線(DUV)下曝光. 與傳統HSQ resist相較, Medusa 82具有較佳製程穩定度, 較容易去除及較長的使用壽命等優點.

產品系列目前有:

| | | SX AR-N 8250.03 | SX AR-N 8250.06 | SX AR-N 8250.18 |
|---|---|---|---|---|
| Film thickness@4000rpm | nm | 50 | 100 | 400 |
| Resolution best value | nm | 15 | 15 | 20 |
| Contrast | | 8 | | |
| Flash point | °C | 38 | | |
| Storage 6 months | °C | 8 - 12 | | |




### 產品包裝：

100 ml /瓶

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

# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



## Characterization

- high-resolution e-beam resist, also sensitive in EUV (13.5 nm) and DUV (250 nm) range
  高解析度電子束微影阻劑,亦可於極紫外線(EUV 13.5 nm),深紫外線(DUV 250 nm)下曝光.
- comparable to HSQ, but with by a factor of 20 higher sensitivity, easier to remove
  類似於HSQ,但敏感度高約20倍,也較容易去除
- considerably higher shelf life
  較長的有效期限
- silsesquioxane and acid generator dissolved in 1-methoxy-2-propanol
  主要成份為矽倍半氧烷及光酸產生劑溶於丙二醇甲醚(PGME)

# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



| Properties I | | | | |
|---|---|---|---|---|
| Parameter | | AR-P 8250.03 | AR-P 8250.06 | AR-P 8250.18 |
| Solids content 固型份 | % | 3.0 | 6.0 | 18.0 |
| Viscosity@25°C 黏度 | mPa.s | 2.3 | 2.5 | 3.2 |
| Film thickness@4000 rpm膜厚 | nm | 50 | 100 | 400 |
| Resolution 解析度 | nm | 15 | 15 | 20 |
| Contrast 對比 | | 8 | 8 | 8 |
| Flash point 閃火點 | °C | 38 | | |
| Storage 6 months<br>儲存溫度/有效期限 | °C | 8 - 12 | | |

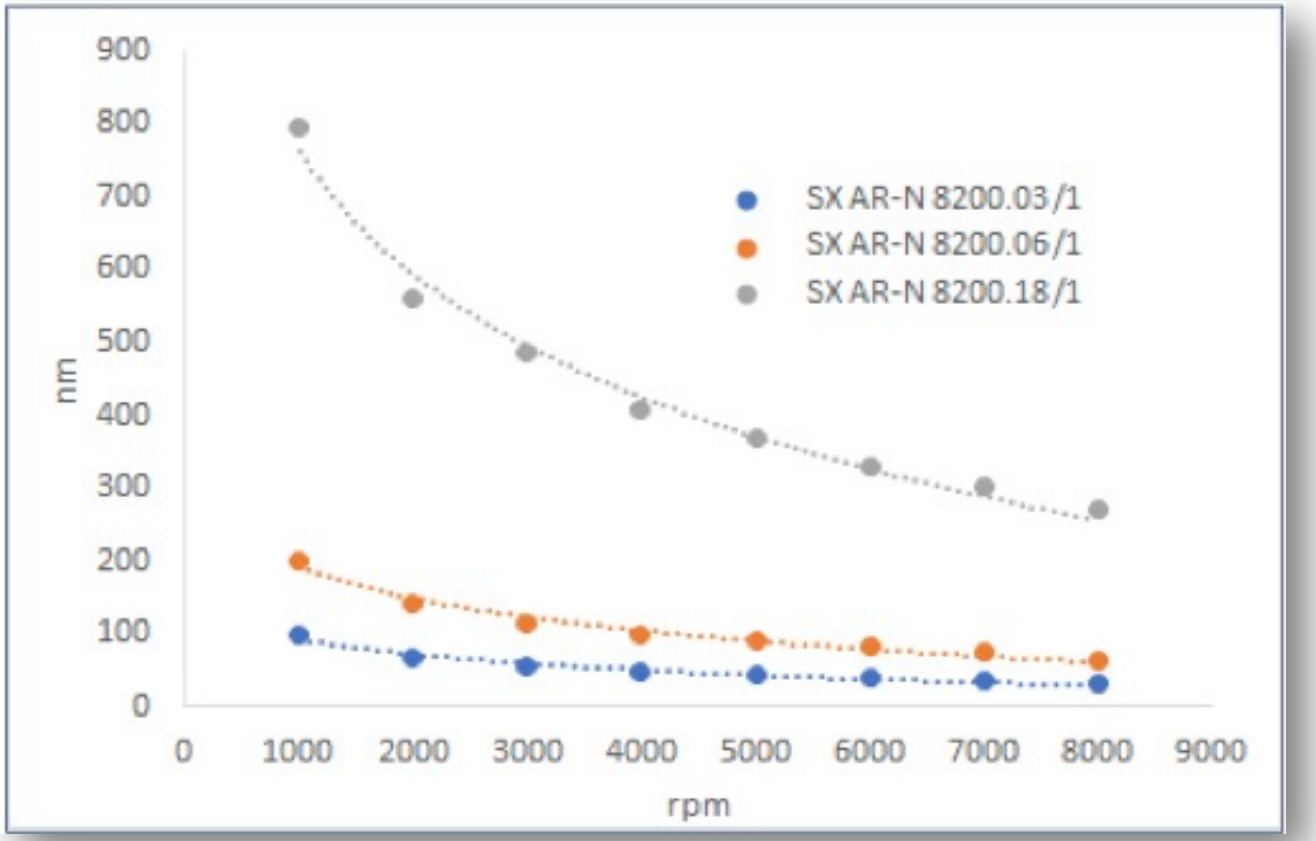
| Property II | | | |
|---|---|---|---|
| Glass transition temperature | °C | - - | |
| Dielectric constant | | - - | |
| Cauchy coefficients | $N_0$ | 1.461 | |
| | $N_1$ | 72 | |
| | $N_2$ | 0 | |
| Plasma etching rates<br>1 Pa, 240 - 250 V Bias | nm/min | Ar sputtering | |
| | | $O_2$ | 7 |
| | | $CF_4$ | |
| | | 30 $CF_4$ + 5 $O_2$ | 240 |

# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



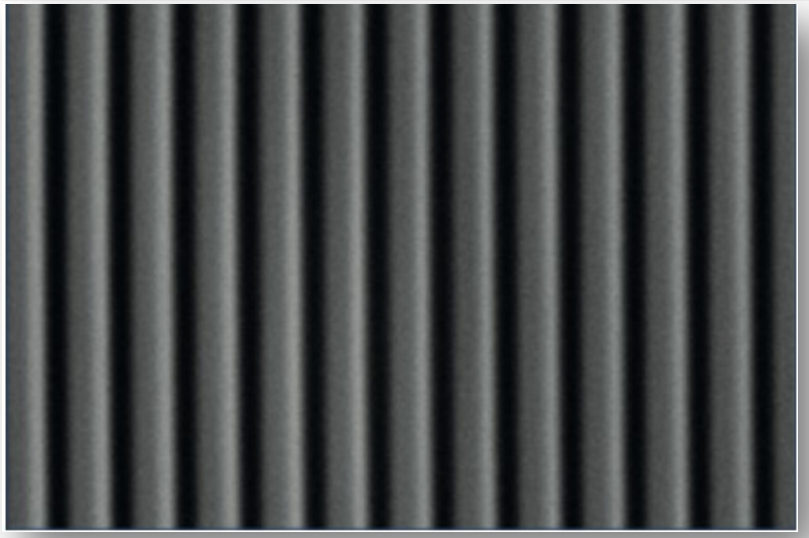
### SX AR-N 8200 series spin curve



# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible

### Structure resolution



200 nm bars, written at 100 kV with SX AR-N 8200.03/1

### Resist structures

Medusa 82 UV structure with higher sensitivity

### Process parameters

| | |
|---|---|
| Substrate | Si 4” wafer |
| Soft-bake | 150 ˚C x 10 min, hot plate |
| Exposure | Raith Pioneer 30 KV |
| Development | AR 300-44 x 90 sec, 23 ˚C |

### Process chemicals

| | |
|---|---|
| Developer | AR 300-44 |
| Thinner | AR 600-07 |
| Stopper | DI water |
| Remover | 2n NaOH, BOE |

# Medusa 82 UV silsesquioxane based e-Beam Resist

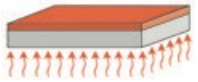
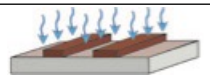
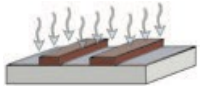
## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



## Process conditions

This diagram shows exemplary process steps for resists of SX AR-N 8250 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 SX AR-N 8250 series 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  | SX AR-N 8250.03 | SX AR-N 8250.06 | SX AR-N 8250.18 |
| | 50 nm@4000 rpm | 100nm@4000 rpm | 400 nm@4000 rpm |
| Soft bake (± 1°C)  | 150 °C x 10 min hot plate | | |
| e-Bean exposure dose ($E_0$):  | Raith Pioneer, 30 kV | | |
| | 60 µC/cm² | 85 µC/cm² | |
| Post exposure bake (optional)  | Post exposure bake can be omitted since no further sensitivity increase is achieved. | | |
| Development (21-23±0.5°C) puddle  | AR 300-44, 90 sec | | |
| Rinse | DI water, 30 sec | | |
| Customer specific technology  | | | |
| Removal  | 2n NaOH | | |

**Note on stability:** Liquid Medusa resists are stable for up to 6 months if kept refrigerated at least 8 - 12 ˚C. Coated substrates can be stored under normal conditions and processed without any loss of sensitivity or resolution even after several weeks. Current studies show that irradiated substrates can be processed even after 21 days without significant loss of sensitivity.

穩定性: Medusa 82阻劑保存在8-12°C環境下,有效期限為6個月. 阻劑已塗佈在基板上,在正常情況下仍可維持其敏感度或解析度至數週. 目前研究顯示,已曝光的基板在21天後顯影,其敏感度幾乎不變.

# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



## Processing instructions

Medusa 82 and Medusa 82 UV can both be processed under similar conditions (annealing, development, removal), but they differ with respect to their sensitivity. Resist Medusa 82 UV contains a photoacid generator to increase the sensitivity and is already 20 times more sensitive if normal process conditions (without post exposure bake) are used. This is especially important für sensitive substrates which might be damaged by an additional heat treatment. Fig. 4 shows a comparison of both resists at different acceleration voltages without post exposure bake:

Medusa 82與Medusa 82 UV製程參數類似,如烘烤,顯影,去除等. 差異主要在於敏感度. Medusa 82 UV的配方含光酸產生劑,在無曝後烤的一般製程,其敏感度已高出20倍. 這個特性對溫度敏感的基板非常重要,可避免因曝後烤的高溫造成異常. 下圖4為兩種阻劑在無曝後烤及不同加速電壓的比較. Medusa 82為藍色,Medusa 82 UV為橘色. 左下圖加速電壓為30kV;右下圖為100kV.

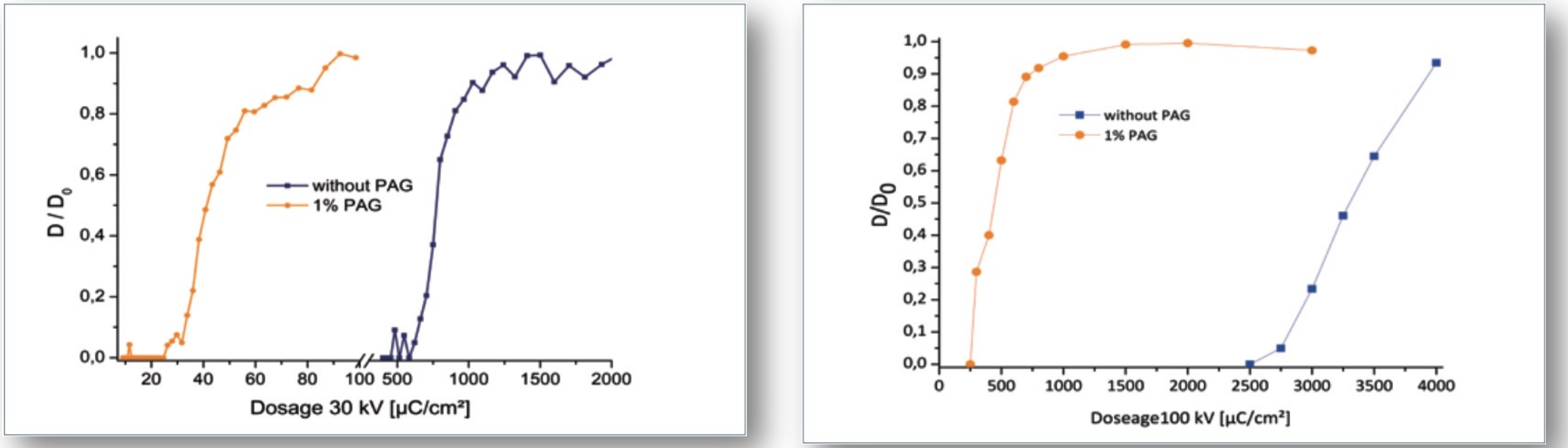



Figure 4: Comparison of the sensitivity of SX AR-N 8200.06/1 (blue) and SX AR-N 8250.06/2 (orange); on the left side at 30 kV, on the right at 100 kV acceleration voltage. Development was performed in AR 300-44, 90 s, 23 °C and without post exposure bake.

# Medusa 82 UV silsesquioxane based e-Beam Resist

## High-resolution, etch-stable, negative tone, for EBL EUV & DUV, HSQ compatible



For Medusa 82 UV, an additional tempering step after exposure does not result in a further increase in sensitivity:
增加曝後烤不會提高Medusa 82 UV的敏感度, 如下圖5

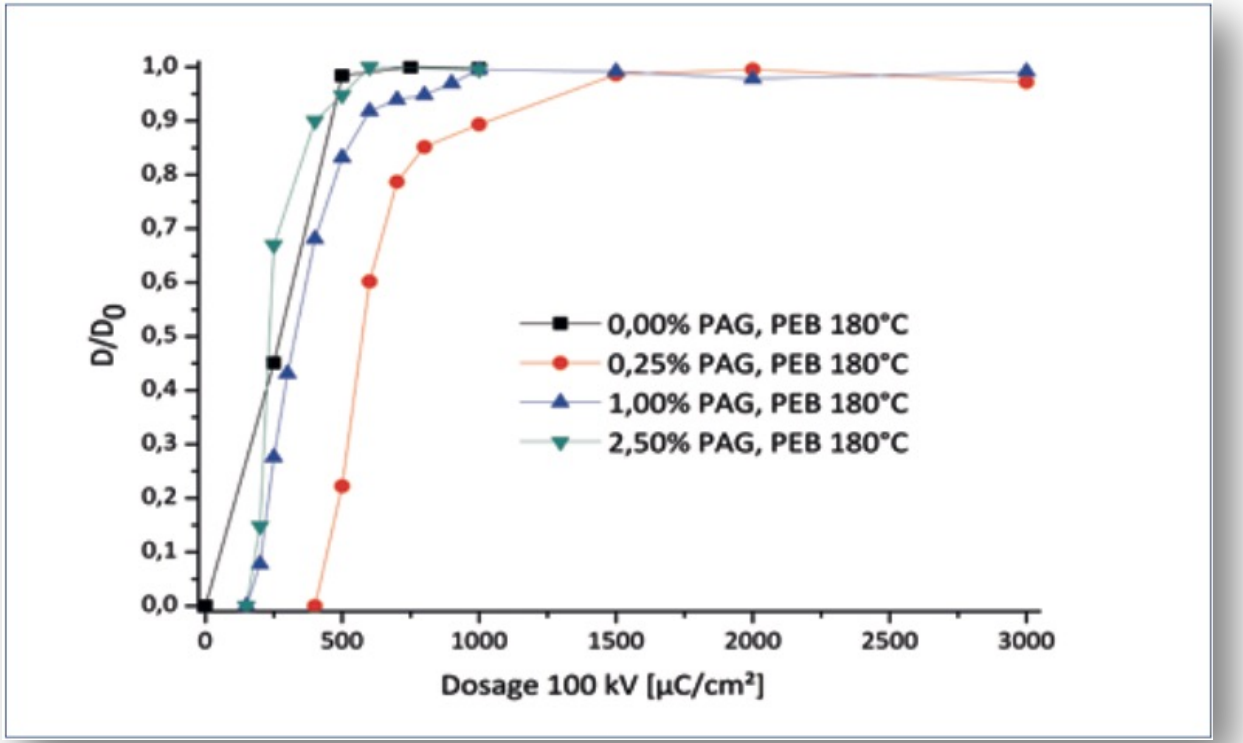



Figure 5: Combination of post exposure bake and photoacid addition