CD Reduction Through Annular Illumination and Sidewall Spacers

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Planned Procedure

Exposure

ARC I-con 16 Etch

Oxide Etch

Resist Ash

Nitride Deposition

Nitride Strip

Polysilicon Etch

Pattern Transfer

BOE - Oxide Strip

Nitride Etch

Future Processing to transfer pattern to a Polysilicon Gate
ARC i-CON 16 Minimum reflectance at 1600A film thickness.

OiR 620 film thickness is 2600A.
OiR 620 is diluted with PGMEA at a 1:1 ratio to achieve a film thickness below production standards.

Swing curve confirms the influence of a BARC layer.
Depth of Focus Plots

CONVENTIONAL ILLUMINATION

NA = 0.6, $\sigma = 0.613$

ANNULAR ILLUMINATION

NA = 0.6, $\sigma_O = 0.434$, $\sigma_I = 0.21$
Etch Recipes

**I-Con 16 Etch:** Pressure: 70mT, Power: 200 W, O2: 5 sccm
- BARC Etch Rate = 2500 A/min,
- OiR 620 = 1800 A/min
- Oxide Etch Rate = 32 A/min

**Oxide Etch:** Pressure: 70mT, Power: 250 W, O2: 5 sccm, CHF3: 30 sccm, Ar: 100 sccm.
- Oxide Etch Rate = 638 A/min,
- OiR 620 = 360 A/min

**Nitride Etch:** Pressure: 70mT, Power: 250 W, O2: 0 sccm, CHF3: 30 sccm, SF6: 30 sccm, Ar: 100 sccm
- Nitride Etch rate = 757 A/min
Exposure and Etch of i-CON 16

ANNULAR ILLUMINATION

$NA = 0.6$, $\sigma_O = 0.613$, $\sigma_I = 0.37$

Resolution at 350 and 325 nm L/S, possibly 300nm
Thermal Oxide Etch and Nitride Deposition

HARD MASK

NITRIDE DEPOSITION WITH LPCVD
Nitride Etch and BOE - Issues

NITRIDE ETCH

BOE

ETCHED SILICON
Sidewall Spacer Formation – 2000A

2000A NITRIDE THICKNESS

500 NM MASK FEATURES

263 NM SIDE WALL SPACER.
Sidewall Spacer Formation – 1500A

1500A NITRIDE THICKNESS

500NM – MASK LINES
SIDEWALL SPACER – 192 NM
Sidewall Spacer Formation – 1200A

1200A NITRIDE THICKNESS
250 – 350 NM MASK FEATURES

500 NM MASK LINES
205 NM SIDEWALL SPACERS
Future Work

1. Future Processing to transfer pattern to a Polysilicon Gate
2. Optimize nitride thickness for sidewall spacers at <350nm
3. Industry uses a second litho step to image and etch horizontally to remove SWS ends.
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