Reliability report of high power injection lock laser light source for double exposure and double patterning ArF immersion lithography

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  - ArF Roadmap
  - GigaTwin advantage
  - ArF Specifications
- FEATURES OF GT62A-1S xE
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  - Other Features
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  ✓ Other Features

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INTRODUCTION

➢ 193nm ArF light sources are widely used in semiconductor mass production from the 90 nm node and beyond.

➢ The ArF immersion technology is even spotlighted as the enabling technology for the 45nm node and beyond.

➢ Beyond that, double patterning is considered to be most promising technology to meet the requirement of the next generation 32nm node.

➢ To achieve this, market demands for ArF light source are getting more severe.

For Example:

    Higher throughput / Higher reliability / Less running cost
ArF Roadmap

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<tr>
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<td>double patterning higher throughput</td>
<td>6kHz/90W/0.35pm(E95)</td>
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<td>6kHz/80W/0.35pm(E95)</td>
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</table>

* 1st laser delivery timing to scanner manufacture

* GTxxA

End customer installation timing (Estimation)

* TBD
GigaTwin advantage

- Performance improvement
  - Develop new technology quickly
- Inherited Reliability
  - Smoothly introduced to a mass-production after installation

- Introduction of new Technologies to current model
  - EcoPhoton roadmap
  - BCM

Flexibility

- **GT62A-1S xE**
  - 90W 0.3pm
  - 60W 0.3pm
  - 60W <0.5pm
  - 40W <0.5pm

GT62A
GT61A
GT60A
GT40A

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## ArF Specifications

<table>
<thead>
<tr>
<th>ArF model</th>
<th>GT40A</th>
<th>GT60A</th>
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### Durability (Expected)

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<tr>
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<td>Bpls</td>
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* GRYCOS technology
** MPL (Multi Positioning LNM)
*** Durability extension @ <90W

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GT62A-1S xE is the laser matching the enhancement technology of advanced Exposure Systems. It has the capability of power extension from 60W to 90W.

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FEATURES OF GT62A-1S xE

- Approach to the advanced exposure technology
  - Extendable Power
  - Long pulse duration

- Other Features
  - Running cost reduction
    - Chamber lifetime extension (GRYCOS)
    - LNM lifetime extension (MPL)
    - Gas lifetime extension (TGM)
  - Reliability
FEATURES OF GT62A-1S xE

- Approach to the advanced exposure technology
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    - Gas lifetime extension (TGM)
  - Reliability
Extendable Power

- Illumination Power optimum for Resist Sensitivity is provided.
- Power extension from 60W to 90W

Feed-back the various technologies of 90W in the 60W laser.

Flexibility of the lithography processes can be increased.
Extendable Power

- Beam Quality related to CD variation is kept stable in Power extension.

**Beam Quality - 60W**

- Dose Stability
- Wavelength Stability
- Spectrum Stability

**Beam Quality - 90W**

- Dose Stability
- Wavelength Stability
- Spectrum Stability
Long pulse duration

- GT62A-1S xE contributes optics durability and is able to reduce LER.

- New OPS (Optical Pulse Stretcher) developed for >60W operation
  - 2 stage pulse stretch: $T_{is} = 130\text{ns}$

- Advantage of New OPS
  - Lower peak power slows down optics deterioration
  - Reduce Spatial / Temporal coherence

**Temporal pulse shape**

**Spatial coherence**

*Measured by Shearing interferometer*
FEATURES OF GT62A-1S xE

➢ Approach to the advanced exposure technology
   - Extendable Power
   - Long pulse duration

➢ Other Features
   - Running cost reduction
     - Chamber lifetime extension (GRYCOS)
     - LNM lifetime extension (MPL)
     - Gas lifetime extension (TGM)
   - Reliability
Running cost reduction

- Inheriting the GigaTwin platform, GT62A-1S xE features the reduced running costs.
  - Three technologies for running cost reduction are equipped.

Technologies for running cost reduction:

- Chamber lifetime extension (Gigaphoton Recycled Chamber Operation System)
- LNM lifetime extension (Multi Positioning LNM technology)
- Gas lifetime extension (Total Gas Manager)
Chamber lifetime extension (GRYCOS):

- Each laser chamber can be used up to 40Bpls.

By using a chamber as an oscillator and then an amplifier

- No impact to Beam Quality
- Beam Quality

**Chamber lifetime extension (GRYCOS):**

**Wavelength Stability**

**Spectrum Stability**

**Dose Stability**

By using a chamber as an oscillator and then an amplifier.
**LNM lifetime extension (MPL):**

- LNM lifetime extends to double (30Bpl ≡ 60Bpl).

**By changing optical path efficiently**

- If this part of the surface is not irradiated, the optics efficiency remains unchanged.
- If this part of the surface is irradiated, the optics efficiency deteriorates.

By changing the optical path, the LNM position can also be altered, ensuring improved efficiency and longevity.
Gas lifetime extension (TGM):

- Gas refill interval extends remarkably (3 days ⇒ 15 days: 24 times/year).

**By Improving Gas Control**
- Stabilization of fluorine partial pressure
- Reduction of the amount of impurity

**Beam Quality is stable during extended gas lifetime.**

---

**Pulse count (Mpls)**

0 200 400 600 800 1000 1200 1400 1600 1800 2000

---

**Beam Quality (TGM)**

- Energy Stability (%)
- Wavelength Stability (pm)
- Spectrum Stability (pm)

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**Without E95 control**
Reliability

- Inheriting the GigaTwin platform, GT62A-1S xE features proven reliability.

Reliability > 99.5%

same as matured KrF lasers

Availability

<table>
<thead>
<tr>
<th>Year</th>
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CONCLUSION

- GT62A-1S xE designed to support the requirement of process parameter flexibility of exposure tool and end customer.
  - Fit to Advanced Exposure Systems like a new illumination system.
  - Provide Illumination Power optimum for Resist Sensitivity
  - Maintain CD variation well in Power extension
  - Contribute to optics durability and is able to reduce LER.

- Inheriting the GigaTwin platform, it features the reduced running costs and proven reliability by GRYCOS, MPL, TGM.