Mask Supply Workshop - Cleaning -

February 4th 2004

DuPont Photomasks, Inc

Perfectly Focused.

Outline

- Today's Clean Requirements
  - Requirements / Industry Survey
- DPI Activities
  - Solutions for advanced 193nm Applications
  - Phase&%T control
  - Residuals control
- Tomorrow's Clean requirements
- Conclusion
- Thanks

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Today's Clean Requirements

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Clean Industry Survey

- Still standard - moving slowly
  - Acid / Base / Rinse platform
- Residue Control
  - Process adjustments
- Reading material / Supplier management
  - Alternative solutions
    - UV - DiO3 - H2 Water - dry/wet processes - Use of surfactant - Snow Clean - IPA - Solvents -
  - smaller defects control
  - Optical Properties control
  - Residue control

- The reading material : Good summary of what people believe will be critical (see above)

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Clean Requirements

- #1: Addressing defects control
  - 1-1 On Clear
  - 1-2 On Dark
  - Defects are #1 cause of Mask Yield Loss in Mature process
- #2 : Addressing Phase&%T control
  - 2-1 shipped
  - 2-2 Re-clean
- So what's number 3, 4, … ?
  - Inorganic residual of known compounds ?
  - Organic residuals ?
- Interestingly only #1 is in the Customer specs and the ITRS RM

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DPI Activities

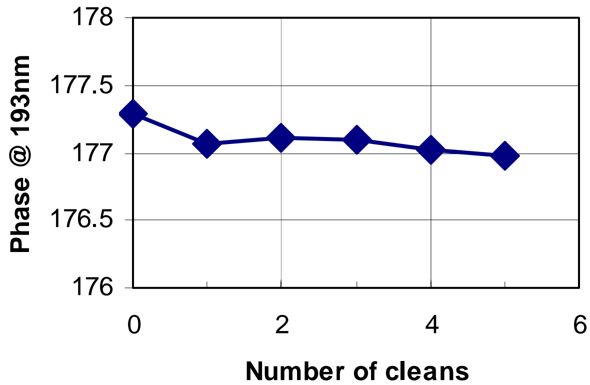
- Defect Control
  - Clean starts at Strip - effects can be cumulative
    - Both Modules need to be addressed and optimized
- Residue control
- In both cases
  - No optical change - No AR Loss - Low residue

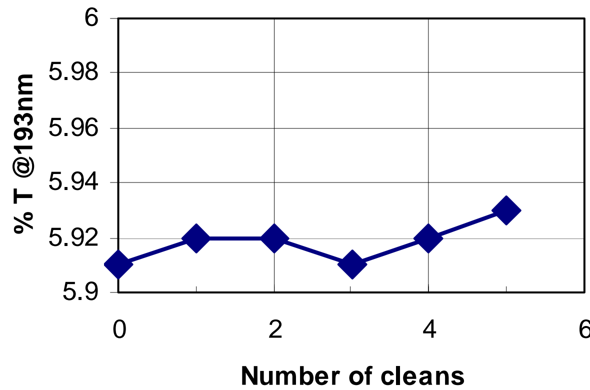
- Shipped Reticle has a package
  - Focus on reliability
  - Strong Internal understanding
  - Internal testing / Exposure testing
    - Reticle - Pell - Shipping compact
      - Has been critical in recent key progress - QA Monitoring -

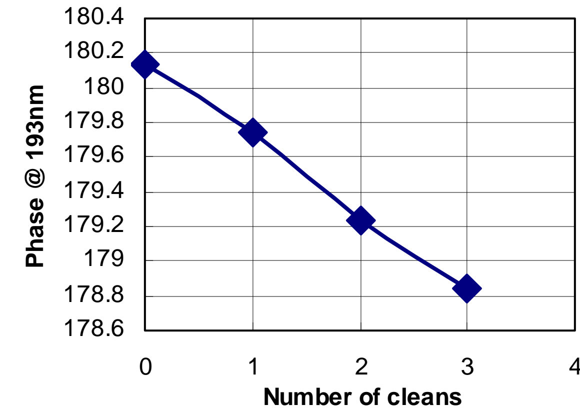
Cleaning Effects on EAPSM

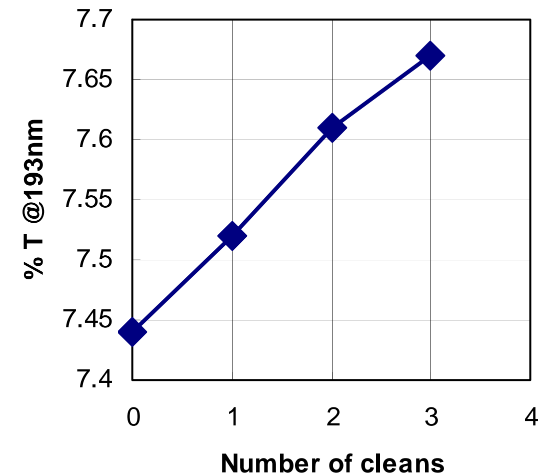
- EAPSM Clean
- Std Clean

193 MoSi Type





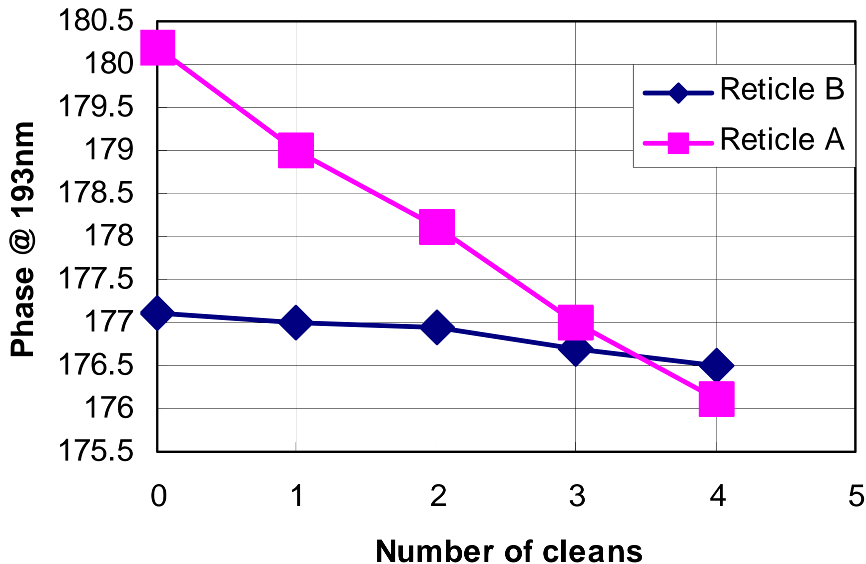


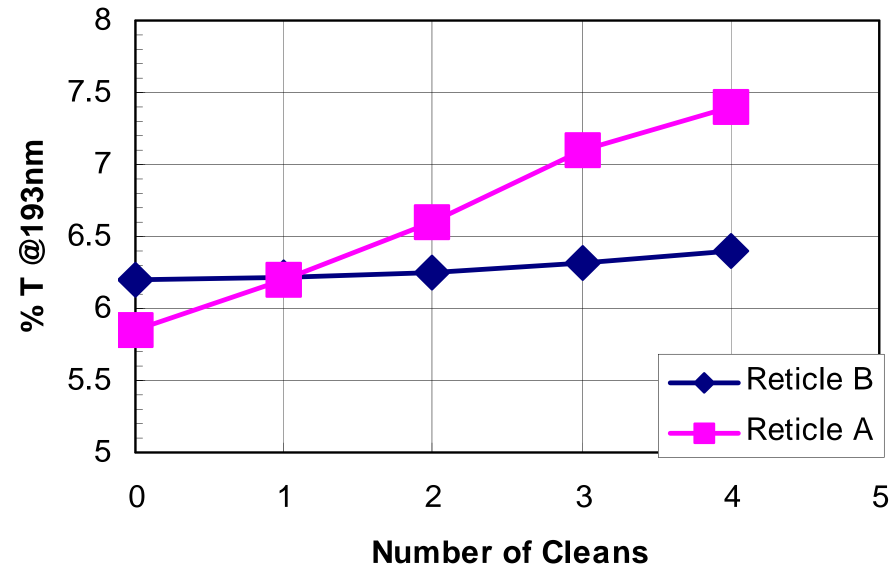


Untreated vs. Treated EAPSM

Std Clean Chemistry

Reticle A: Untreated
Reticle B: UV Treated





- Phase & %T control can be achieved with Passivation implementation

* Passivation IP is a Patent Pending

Haze concerns

- Broad Ind. Concerns / numerous reports
- Use of low k1 reticle solution minimize the process window
  - Sub resolution defects (Print - affect CDs) (Front)
  - Change in %T could impact as well (Back)
- At 193nm
  - All Ions need to be controlled
    - A-Carbonate, A sulfate (bisulfate),
    - Brian referred to some unknown compound
  - It's not mask process related only
    - DPI - Bacus 2003 - separation of the effects (Env. Contribution)
    - How are we going to control it ?
    - Shared responsibilities? Working together?
  - Some components cannot be removed - Some can be controlled
    - Material, Exposure wavelength, Pell
    - Mask Process - Compact / Glues - Storage - environment

193nm Radiation Test (2.5KJ)

Reticle Glass Side View

Reticle Residual window at 248nm / 193nm

193nm Residuals - A new requirement window

SO4 Levels
ppb

248nm
Haze

248nm Process
Window

Current
248nm
Process

193nm Program

193nm Process
Window

NH4 Levels
ppb

What can be achieved today

- Use a known process - Based on particle removal efficiency!
  - Understand each step -
  - Adjust them -
  - Implement new process recipe BUT
    - Still meeting / exceeding particle specs
    - Respecting EAPSM optical specs

- Start over without use of the compound -
  - mechanical - optical energy - vibration energy - new Chemistries
  - Need to be a clean process
    - removing what you don't want

Ultra-Clean Mask Surface: Absorber Side

Reduction
NH_4 : 75%
SO_4 : 98%

Absorber Side

Strip A & Clean

Strip A Only

Strip A + Test B & Test C

Strip A + Test B

Strip A + Test C

Strip A + Test D

Strip A + Test D

Clean A + Test D

0

Sulfate Levels (ppb)

Ammonium Levels (ppb)

Ultra-Clean Mask Surface: Glass Side

Haze Free (5kJ - ArF)

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Tomorrow’s Clean Requirements

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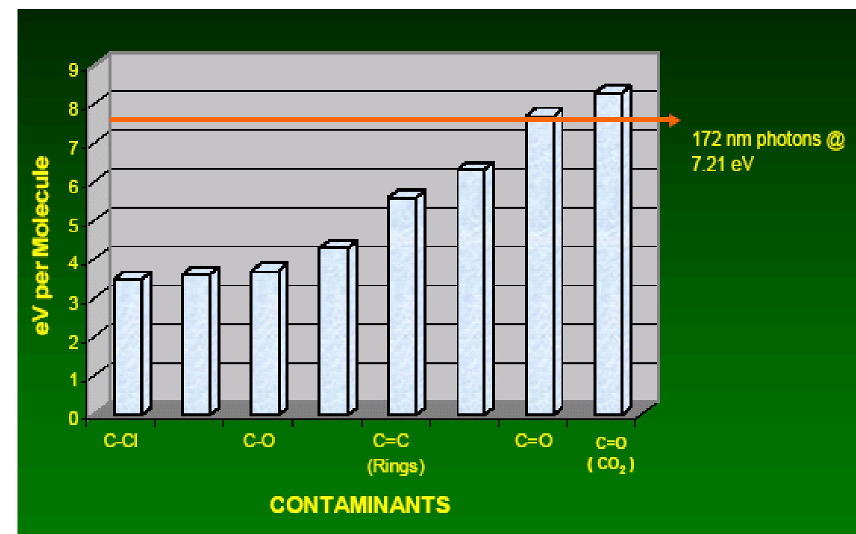
157nm … NGL

- 157nm will be a repeat of 193nm - expect to be worst
  - Organic effects added to existing Inorganic Ones
- Stepper Lens cleaning strategy is working and was demo'd to Qtz clean (Intel paper)
  - Repeatable
  - 172nm breaks all bonds
- Final Clean + Pell Mounting time



- EUV - Trouble ahead !
  - Even water is a contaminant
  - Lot's of work ahead for the back end Modules

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Conclusion

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Summary - Conclusion

- It's getting worst - Requires multiple understanding
  - The Clean Module is getting more critical
- DPI Adv. Group is working to meet all new Clean requirements
  - Defect - EAPSM (Phase, %T) and residual Controls
  - Alternative combinations in the process
    - All wet vs. Hybrid cleans
  - demonstrated solutions (Passivation - Residue Control)
  - Heading for a shipped reticle solution
    - Mask - Pell - shipping compact
  - Started discussions to overcome Haze
    - Industry Survey shows that it is a complex to solve
- 157 & EUV work is already started in the European advanced R&D Center (A.M.T.C)

Thanks

- RR R&D Team
  - Eric Johnstone (IED Assignee), Christian Chovino, Julio Reyes
- ISMT for setting up this meeting
  - Pat Marmillion, Marylyn Bennett