Comparison of Cleaning Methods for Thin Film Surfaces

Lena Johnson, Mitch Challis, Ross Robinson, Richard Sandberg

Group 4

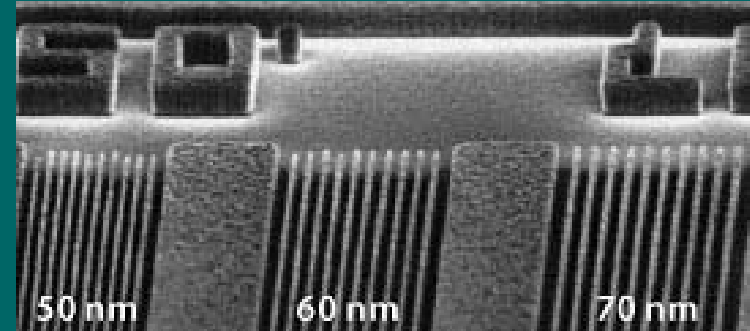
English 316 Oral Report

June 16, 2003

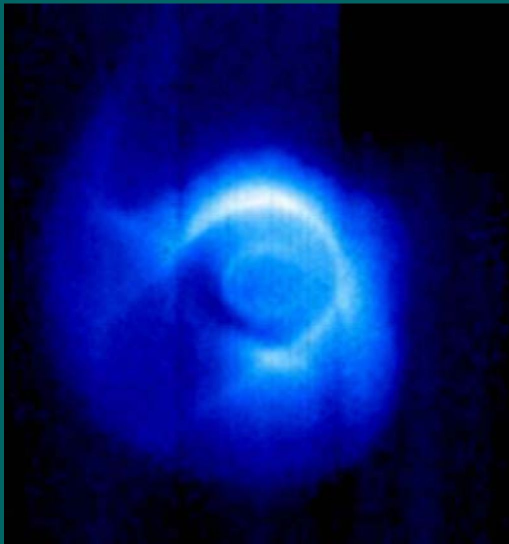
Applications for EUV Light Research

Multilayer Mirrors

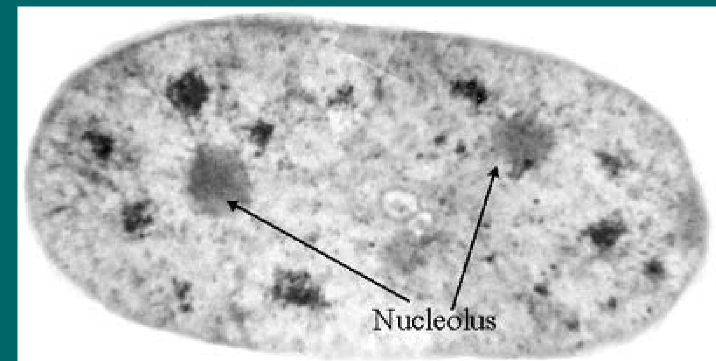
EUV Lithography



EUV Astronomy



EUV Microscopes



www.lbl.gov/Science-Articles/Archive/xray-inside-cells.html

Images from www.schott.com/magazine/english/info99/

How small is that?

- Want to reflect EUV (extreme ultraviolet) light (50-5 nm or 10^{-7} cm)

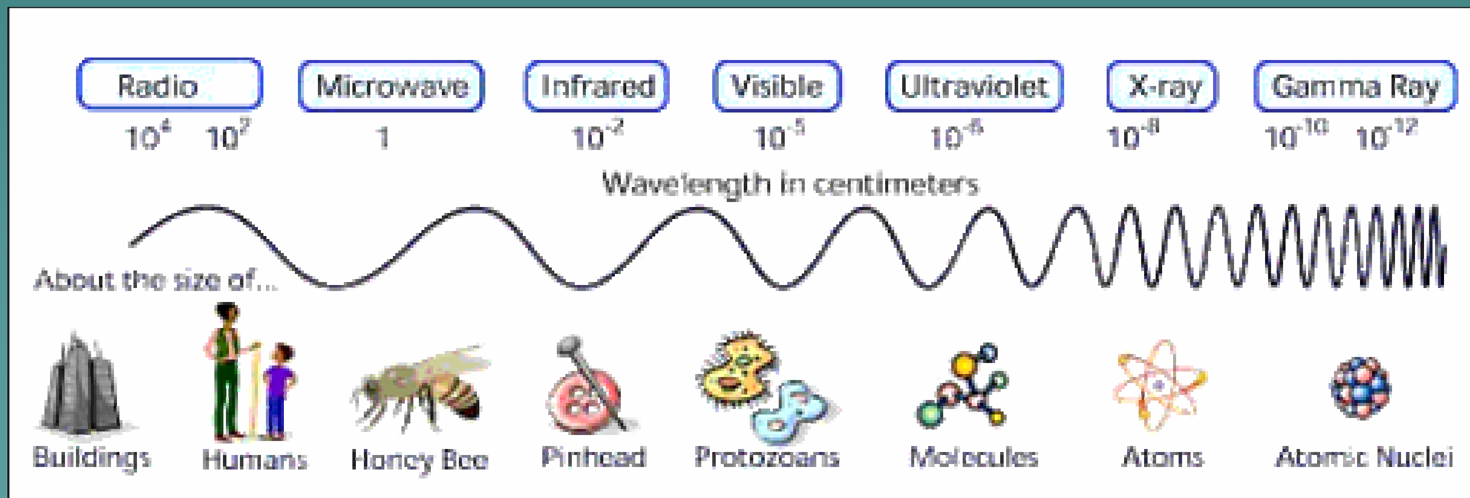


Image from http://imagers.gsfc.nasa.gov/ems/waves3.html

The Problem

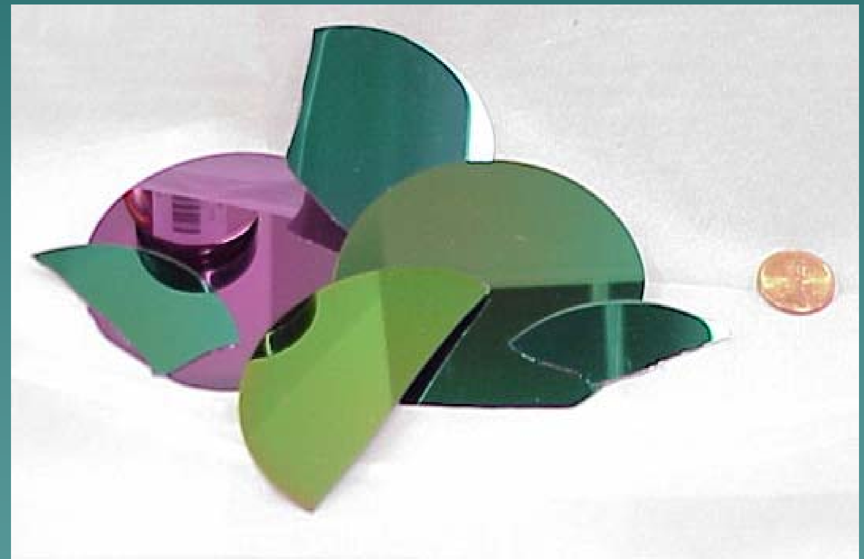
- Organic contaminants collect on the surface (Junk).
  - Interferes with measuring optical constants
- Example with visible light

Question:

How do we effectively remove contaminants?

Outline

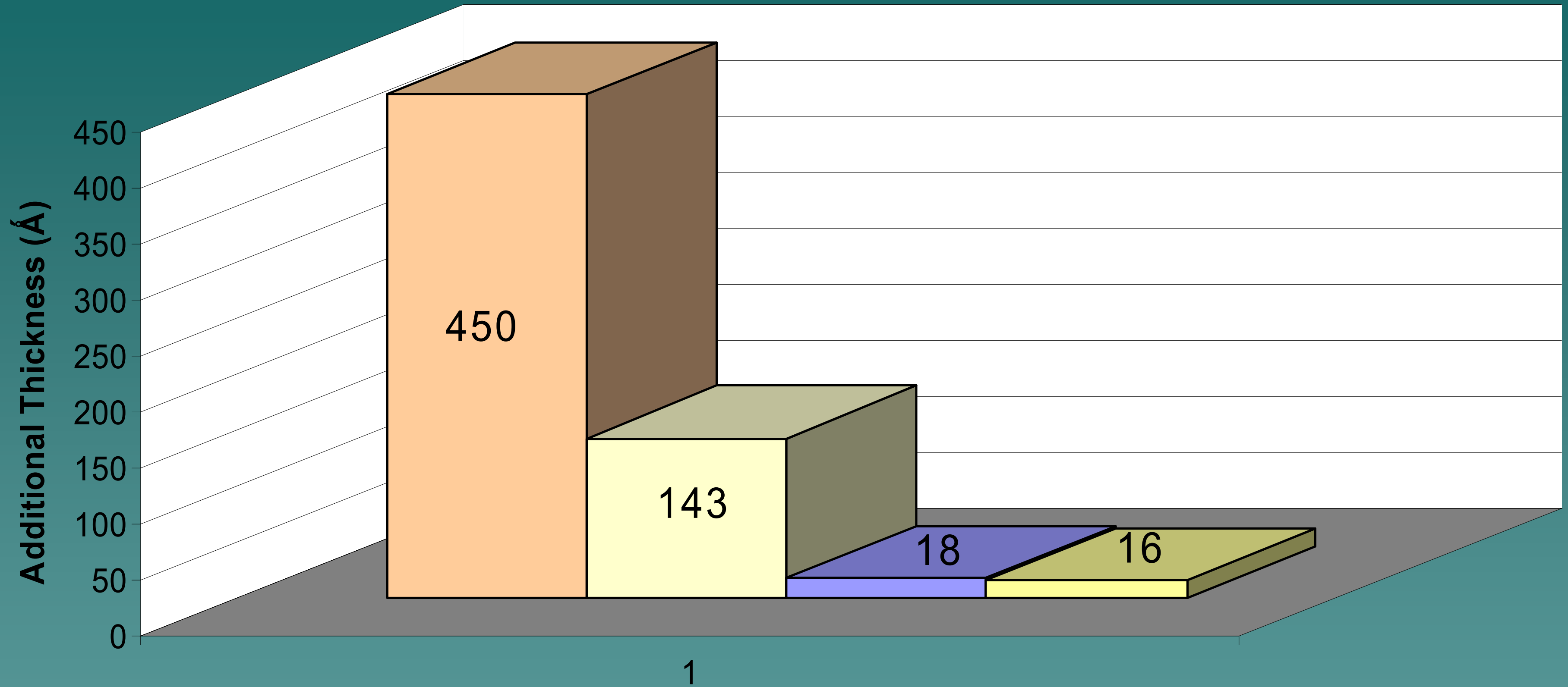
1. Measurement methods
2. Cleaning methods
   -Opticlean®
   -Plasma Etch
   -UV lamp
3. Conclusions



Video

- Measurement method
  - Ellipsometry
- Cleaning methods tested
  - Opticlean
  - UV Lamp
  - Plasma Etch

Short Exposure Contamination Experiment (10 sec)



Spit on

Touched with bare fingers (10s)

Dipped in Deionized Water

Touched and rubbed with latex glove (10s)

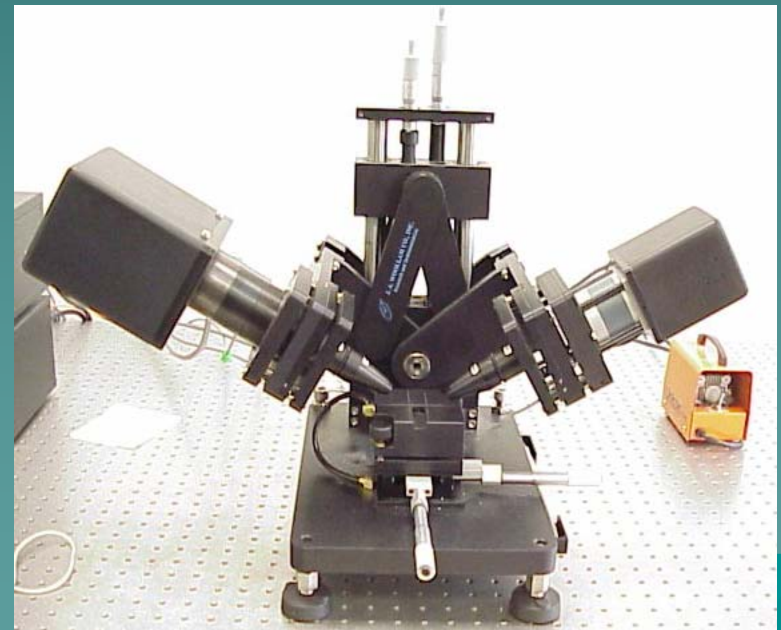
Opticlean® Process leaves hydrocarbon residue

- *Opticlean®* significantly removes contaminants, but leaves a residue

- <u>Ellipsometric Results</u>
  Opticlean® residue thickness on two runs:
  1) 17 Ångstroms
  2) 22 Ångstroms

- *Opticlean® made by* Dantronix Research and Technologies, LLC
- Ellipsometer Type: J.A. Woollam Co., Inc Multi-Wavelength Ellipsometer (EC110)

http://www.dantronix.com



http://www.jawoollam.com/

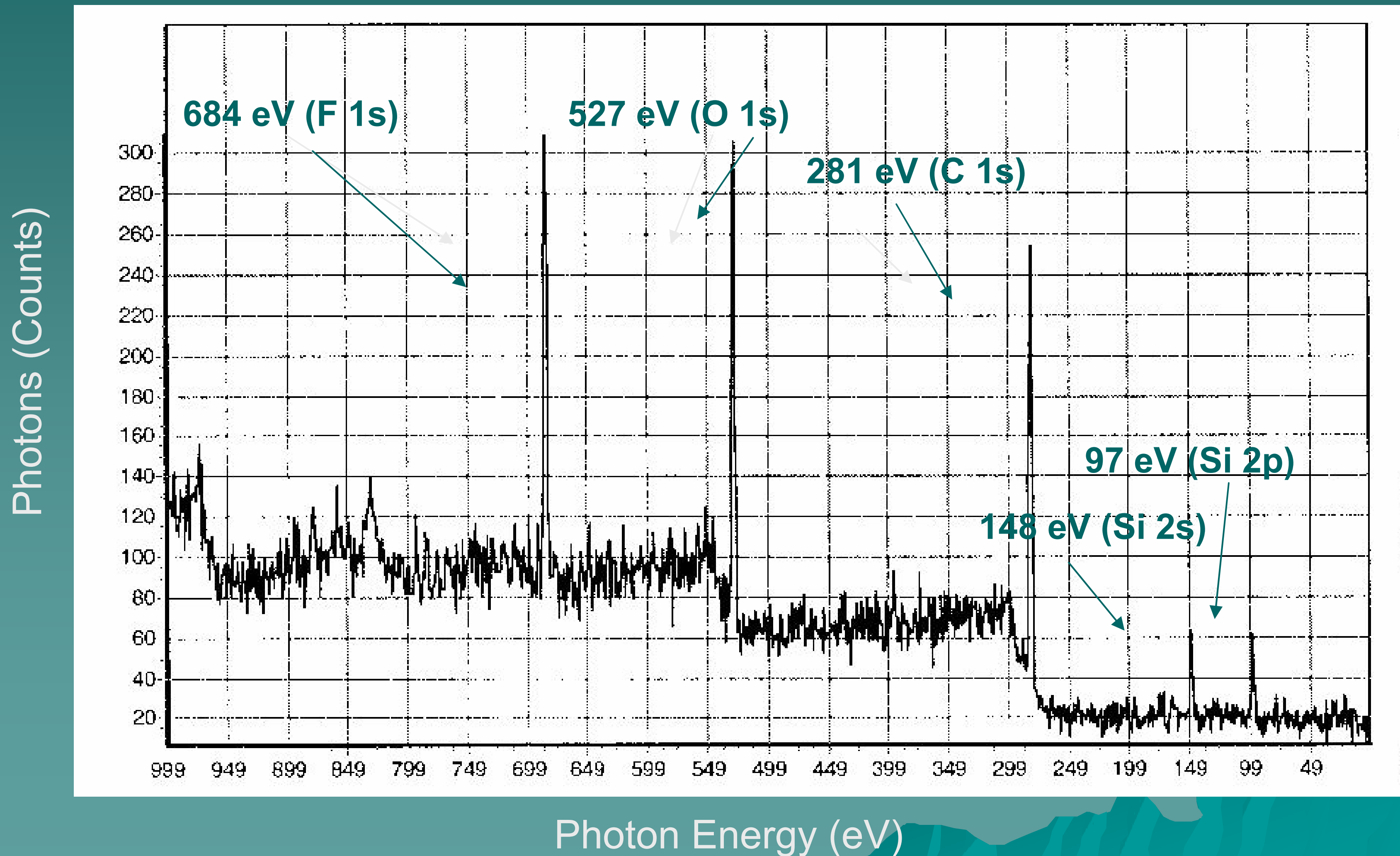
Does the Opticlean® process damage thin films?

- Scanning Electron Microscope showed no thin film damage, nor trace of materials used in thin films on pulled of *Opticlean® films (U, Sc, Va).*

- X-Ray Photoelectron Spectroscopy found no trace of materials used in thin films on pulled of *Opticlean®* .

XPS revealed components of Opticlean®, but not heavier metals used in thin films.

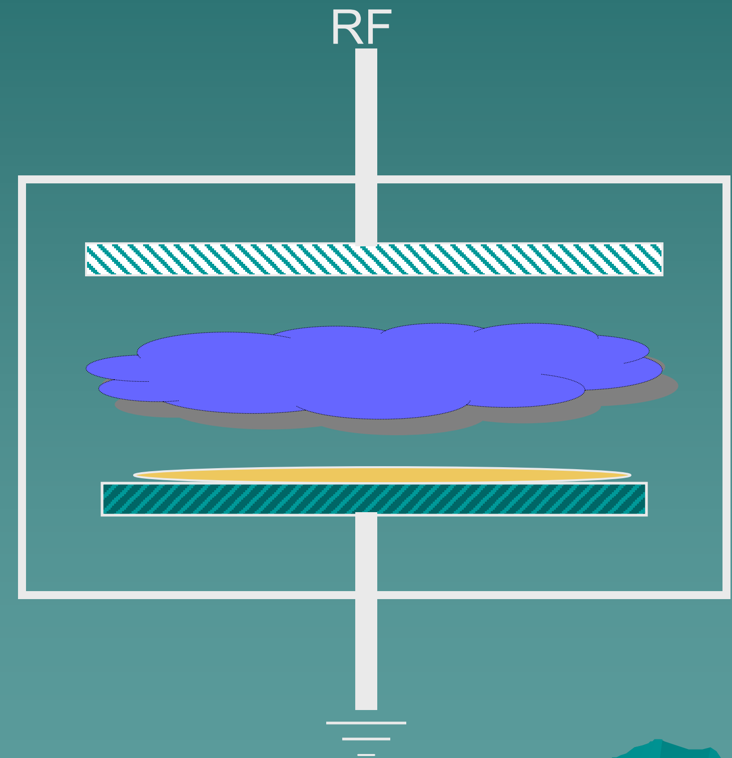
Prominent thin-film lines: U-380 eV, V-515 eV, Sc-400 eV



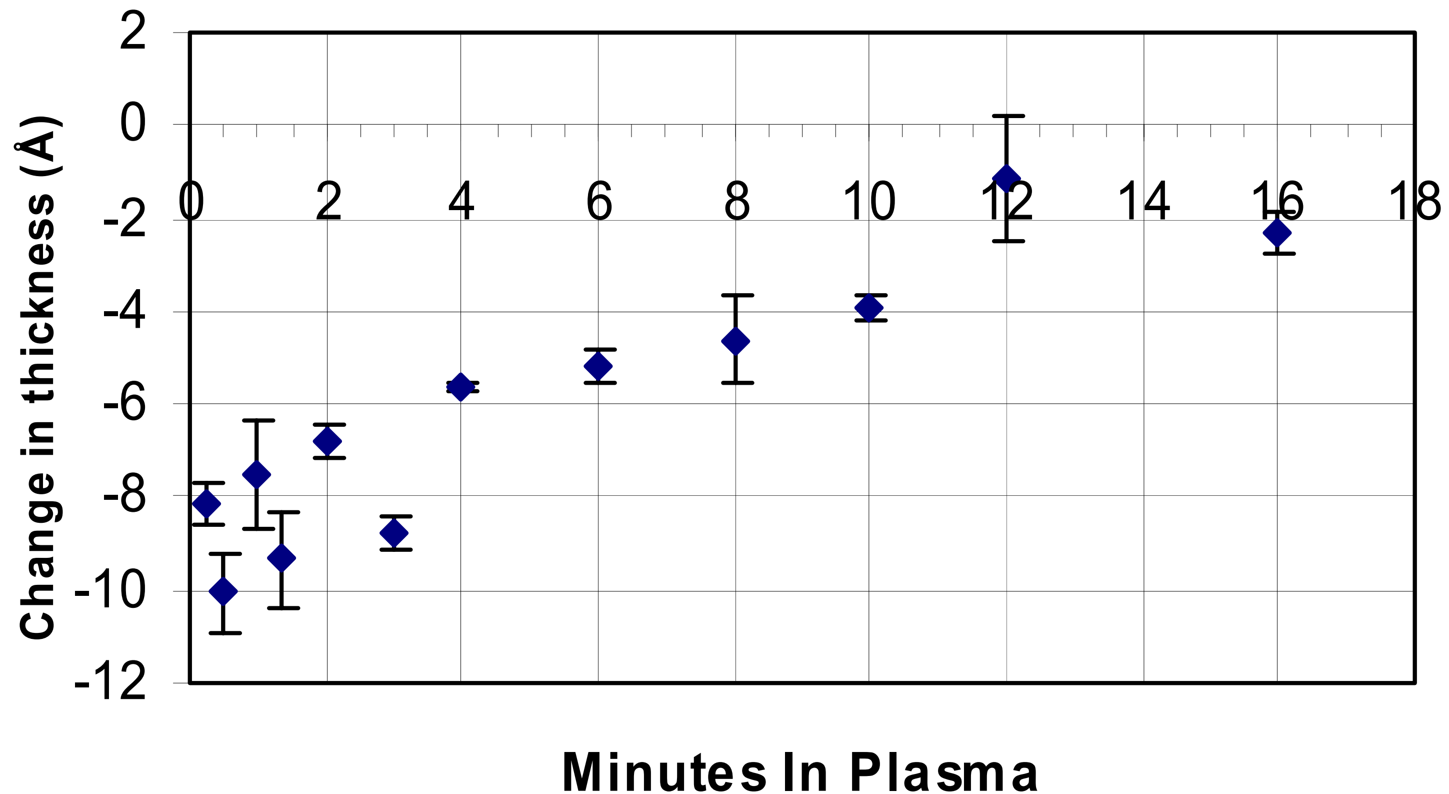
Photon Energy (eV)

Cleaning residue with “Matrix” Plasma Etch

- RF Plasma Etching with O_2 Plasma
  - 0.120 Torr Pressure
  - 250W RF (max 350)
  - 0.75 SCCM O_2 flow
  - No extra heat applied
- Good for removing polymers, but not bulk contaminants (i.e. Dust)
- Oxygen plasma plus mechanical sputtering removes surface layers

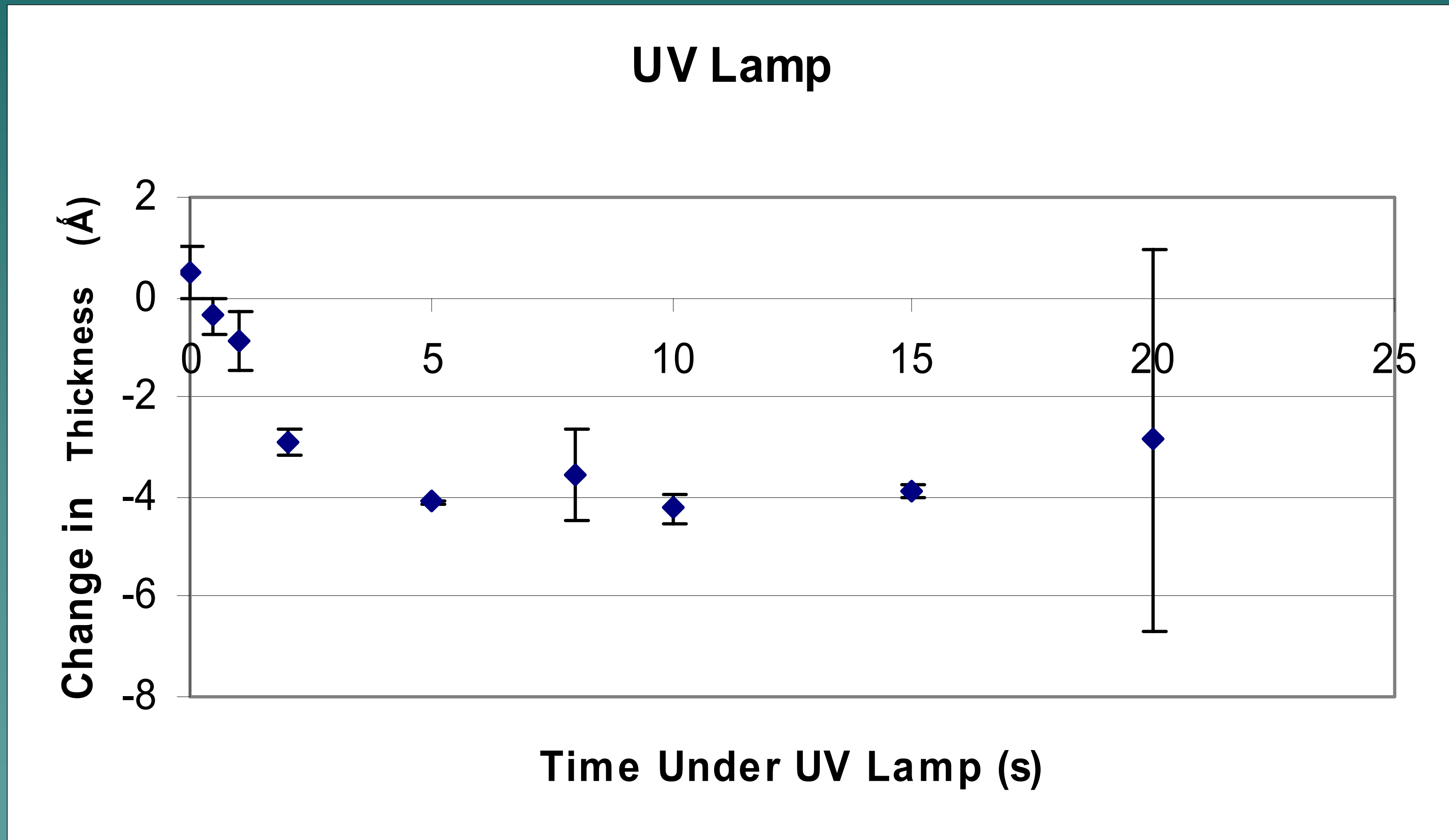


Plasma Results



UV Lamp

UV Results



Conclusion

Method	Effectiveness	Cleaning Time	Ease of Use	Notes
Opticlean®	Left residue	Must wait for polymer to cure	Can be difficult to peel off.	Good for dust etc..
Oxygen Plasma	Effective. Cl not completely removed	Setup takes a few minutes. Clean under a minute	Equipment in clean room. Complex to setup.	Builds up silicon dioxide
Eximer UV Lamp	Effective	1 to 5 minutes	Very easy	Less silicon dioxide buildup then plasma.
Opticlean® + Oxygen Plasma	Effective Possible 1 Å residue or oxide	Long, plasma setup and polymer cure time.	Complex clean room equipment and skill needed to peel	

- Recommended Procedure:
  - UV lamp for 5 minutes

Conclusion

Method	Effectiveness	Cleaning Time	Ease of Use	Notes
Opticlean®	Left residue	Must wait for polymer to cure	Can be difficult to peel off.	Good for dust etc..
Oxygen Plasma	Effective. Cl not completely removed	Setup takes a few minutes. Clean under a minute	Equipment in clean room. Complex to setup.	Builds up silicon dioxide
Eximer UV Lamp	Effective	1 to 5 minutes	Very easy	Less silicon dioxide buildup then plasma.
Opticlean® + Oxygen Plasma	Effective Possible 1 Å residue or oxide	Long, plasma setup and polymer cure time.	Complex clean room equipment and skill needed to peel	

- Recommended Procedure:
  - UV lamp for 5 minutes