Study of the Initial Oxidation of H-Si using XPS, STM and IR

Student: Kathleen Morse
Advisor: Prof. Chris Chidsey

Outline

- **Project Objectives**
- **ESH Impact**
- **Earlier Observation**
- **H-Si Surface Description**
- **Current Research**
- **Conclusion**
- **Future Plans**

Project Objectives

Observe changes in oxygen coverage, surface morphology and structure of H_x-Si(100) and model surfaces H-Si(111)(1X1) and H-Si(100)(2X1) using XPS, STM and ATR-IR for each of the following:

- **UV light**
- **dopant concentration**
- **humidity**
- **dopant type**

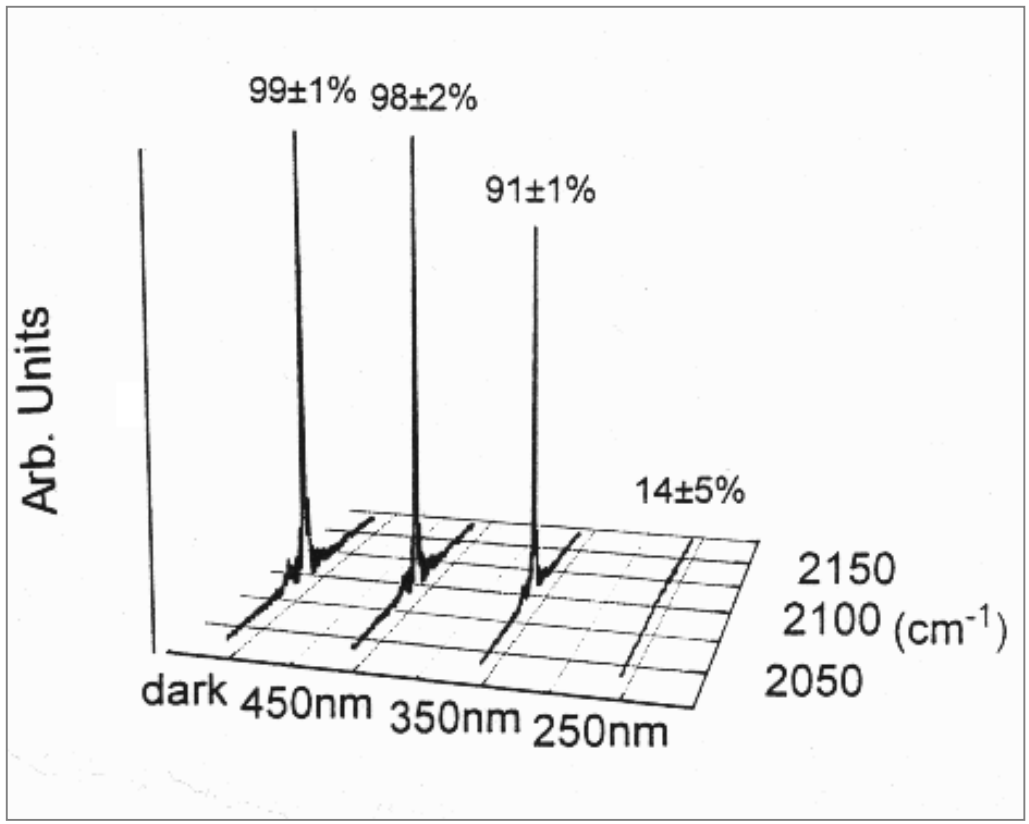
After investigating factors affecting oxidation, propose possible mechanisms to explain the oxidation behavior.

ESH Impact

Optimization of Front-end Cleaning Processing requires understanding how cleanroom ambient oxidizes/ contaminates H-Si surface.

Our study focuses on how cleanroom lighting conditions affect the wafer surface.

Earlier Observation: Presence of UV Light Promotes the Oxidation H-Si(111)(1X1)



M. Linford, *Thesis*, Stanford University, 1996.

Hydrogen Terminated Silicon Surface

Complication:

H_x-Si(100)

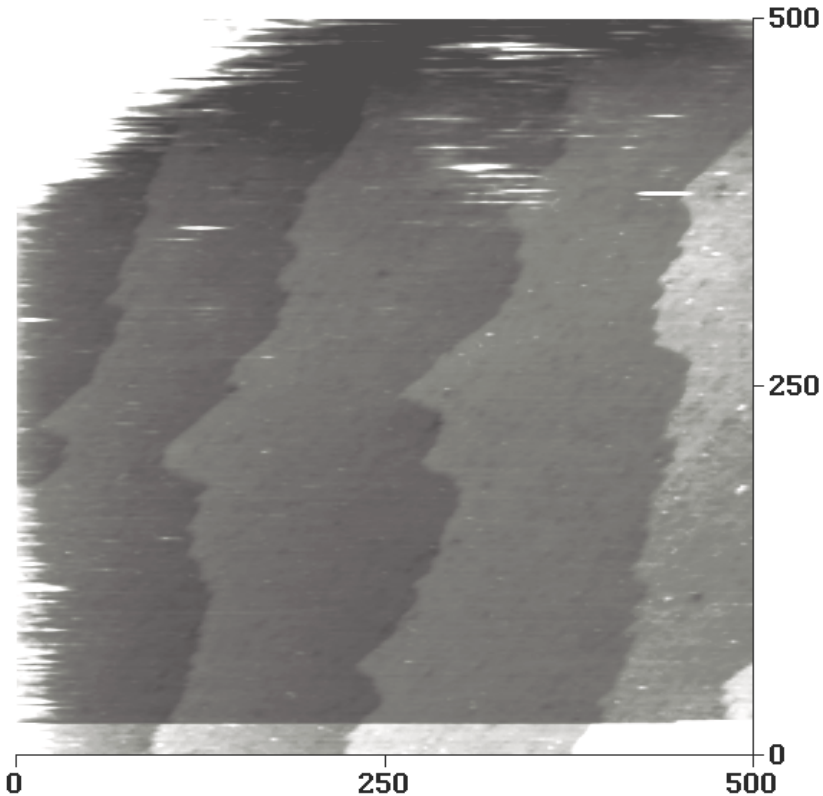
- Surface of current technological relevance is rough

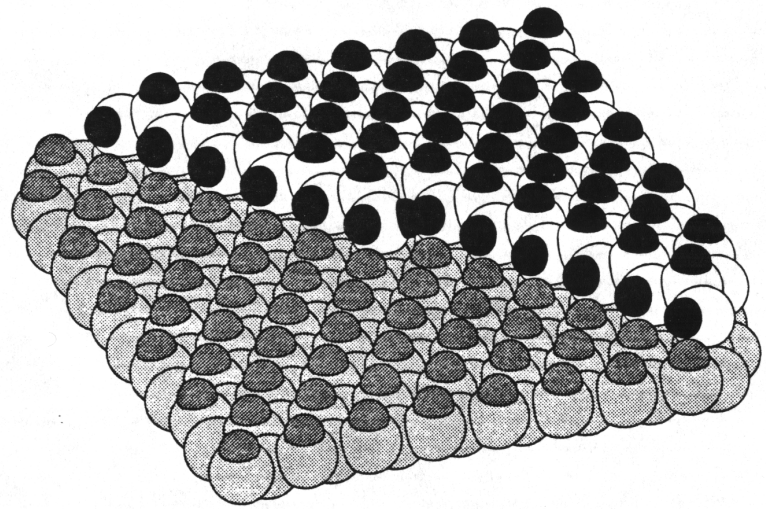
Simplification:

Model Surfaces

- H-Si(111)(1X1) is predominantly perpendicular monohydride.
- H-Si(100)(2X1) is predominantly tilted monohydride.

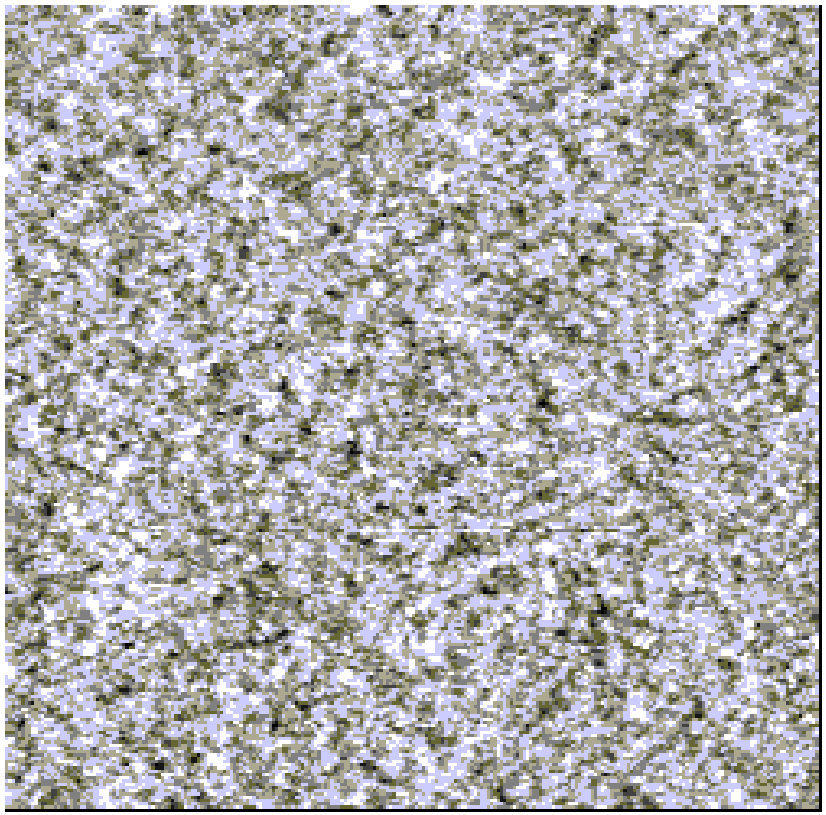
H-Si(111)(1X1)

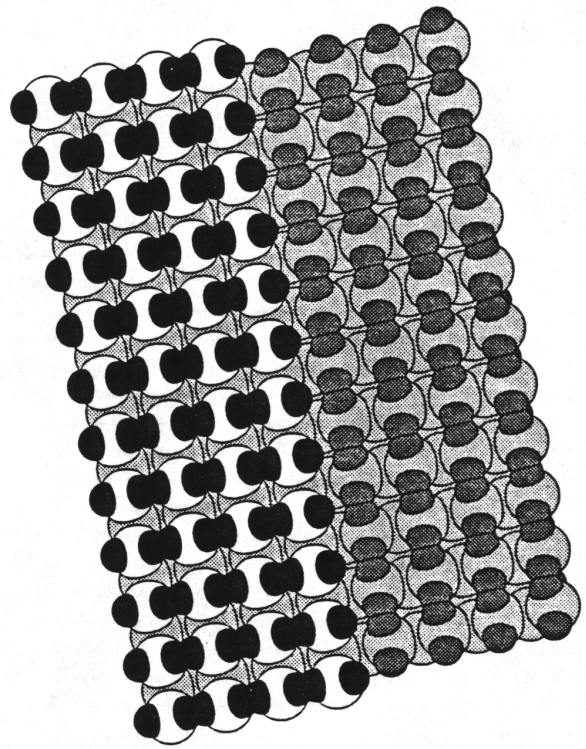




K.Morse, Stanford University, 1999.

H_x-Si(100)





C. Wade, Thesis, Stanford University, 1997.

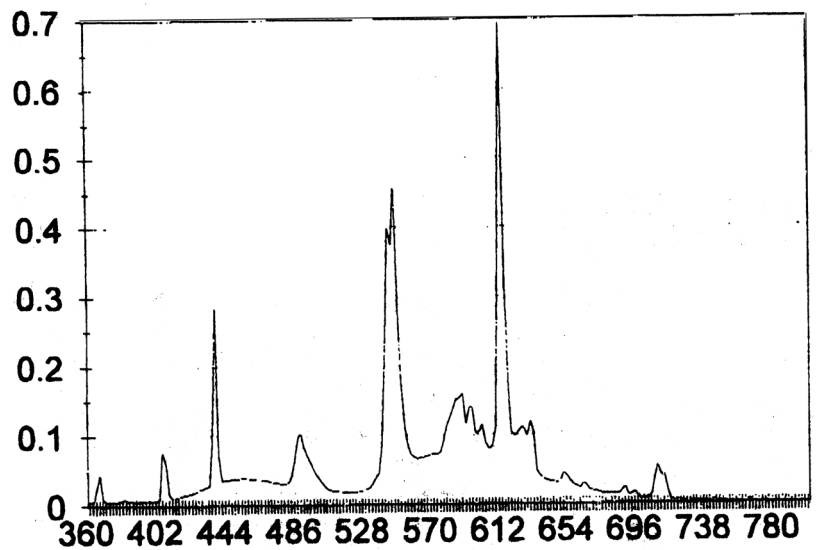
Current Research

- **Determine the affect of lamp type on oxidation of H_x-Si(100) and H-Si(111)**

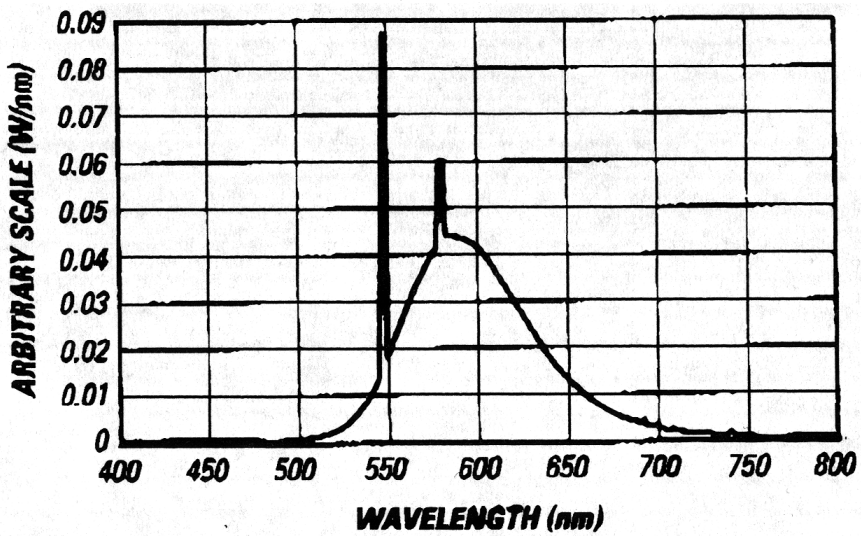
- **Investigate the relationship between energy density and oxidation**

Lamp Light Spectrums

Model: TL730
Room Light
Manufacture: Philips

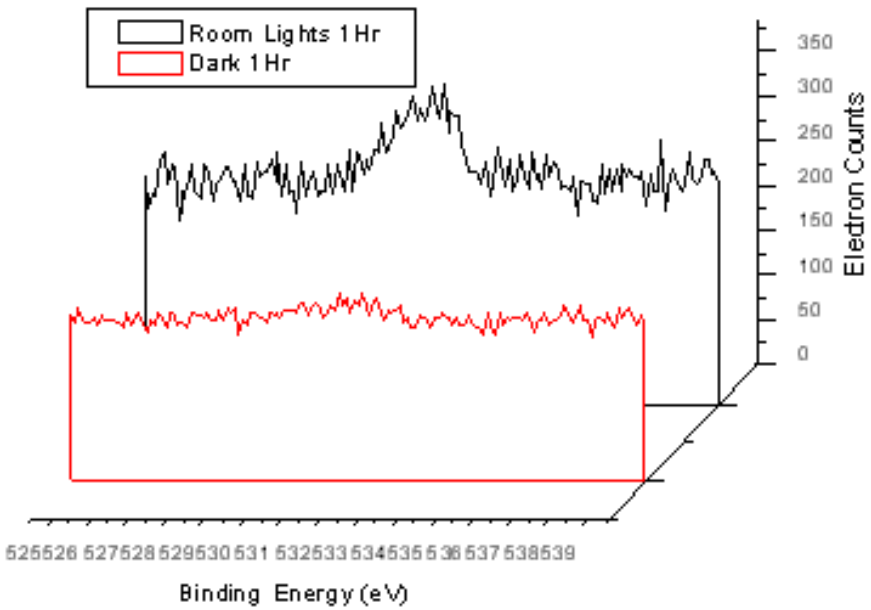


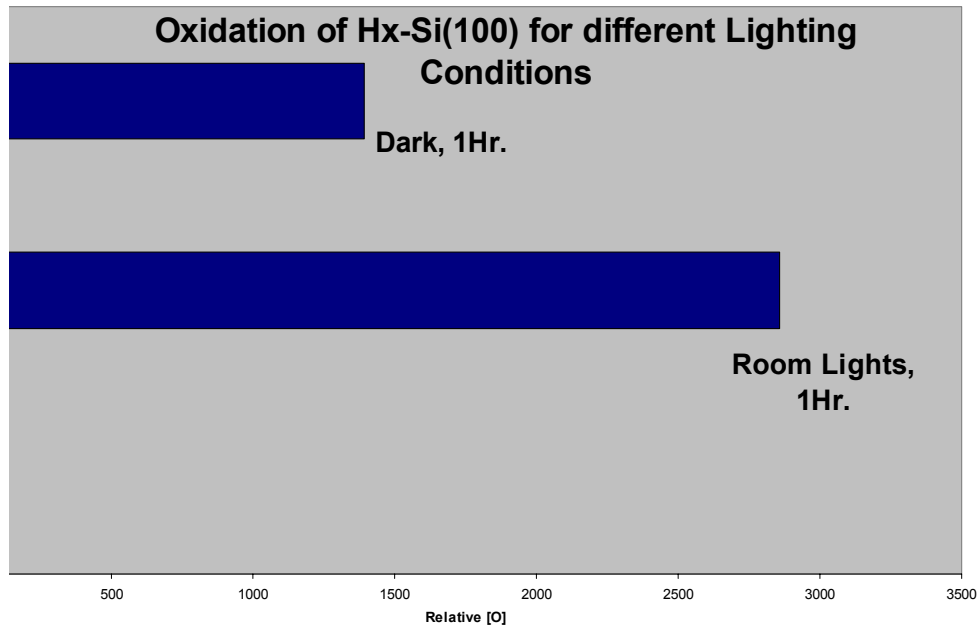
Model: Trimeline T8
Gold Light
Manufacture: General Electric Lighting



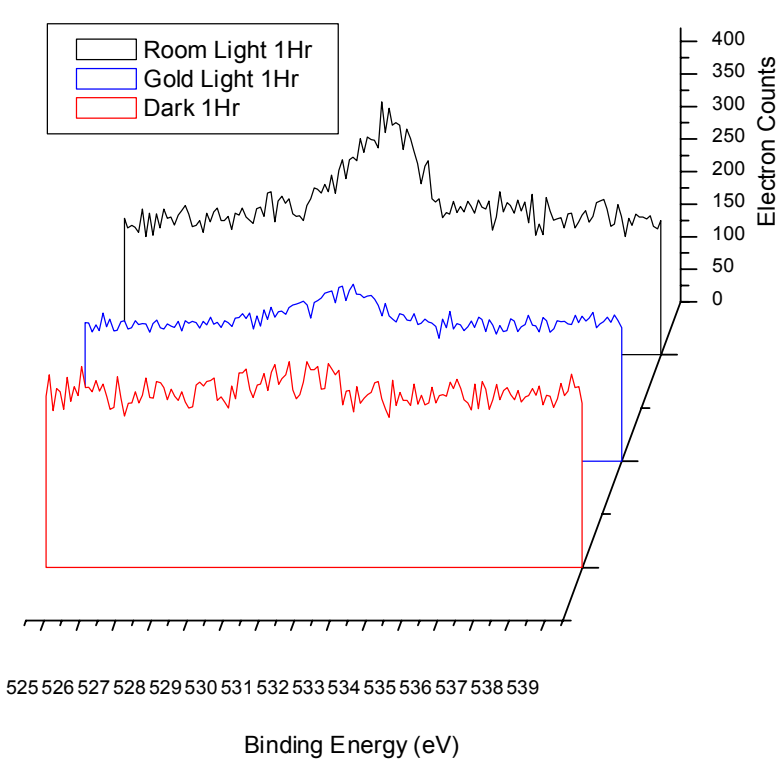
Note: no light emitted less than 500nm.

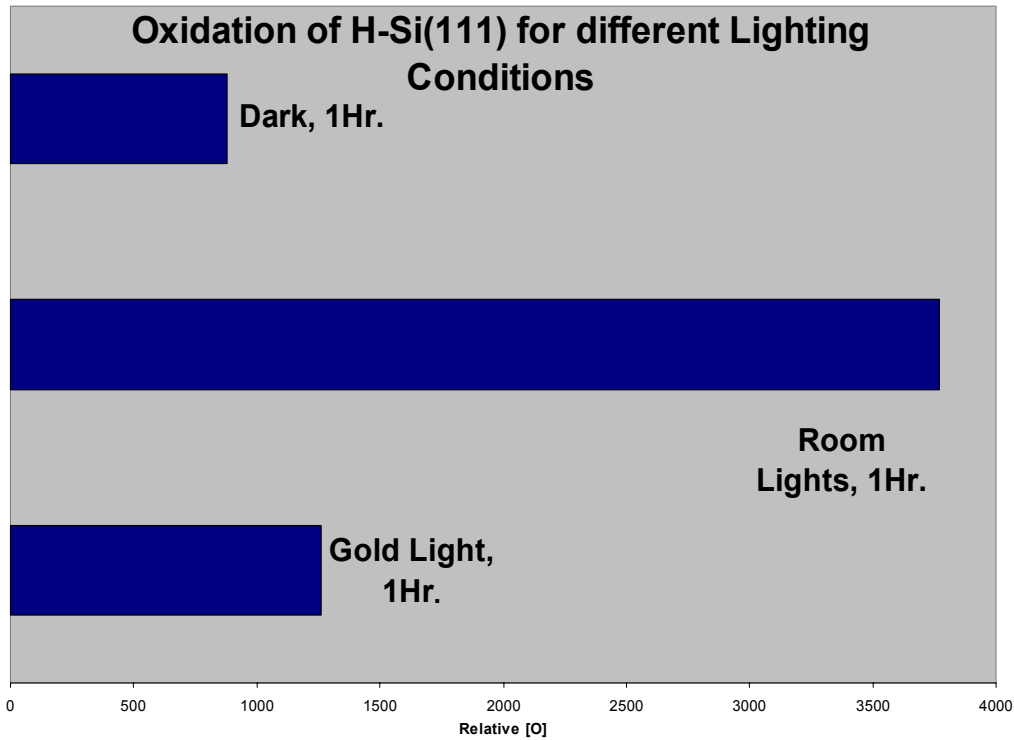
Sensitivity of Oxidation of H_x-Si(100) to Light



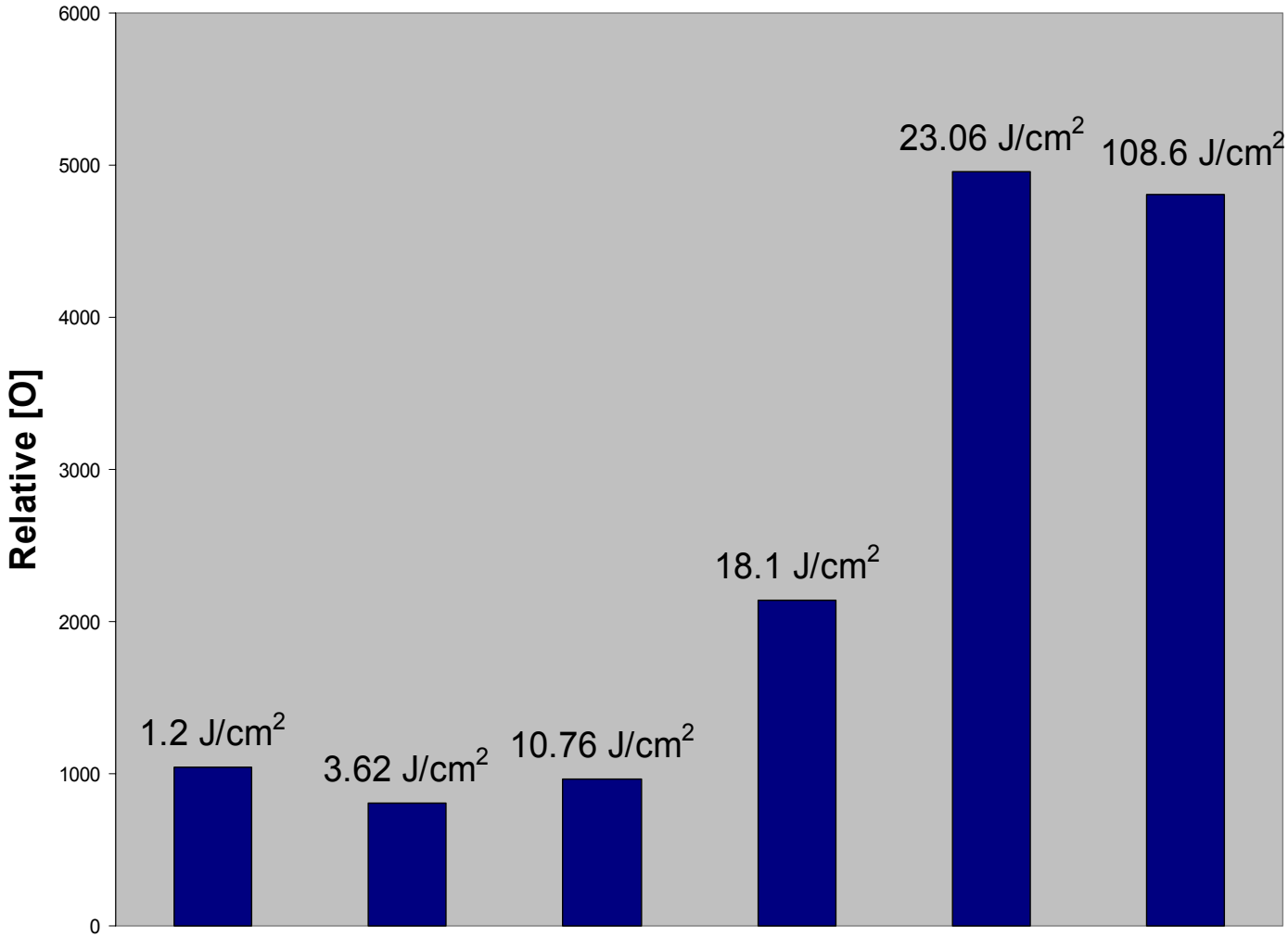


Sensitivity of Oxidation of H-Si(111) to type of lamp





Light Oxidation of H-Si(111) at Various Energy Densities with λ=350nm



Conclusions

- **H_x-Si(100) and H-Si(111) oxidizes when exposed to room light**

- **As light energy density increases, so does the concentration of oxide.**

Future Plans

- **Investigate the model surface H-Si(100)(2X1) for light initiated oxidation.**
- **Determine at which photon energy does oxidation start for each of these H-Si surfaces.**
- **Investigate the roles surface morphology, humidity and doping type and concentration play in the light initiated oxidation of the surface.**