Characterization Of Plasma Process Induced Damage Near $SiN/SiO_2/Si$ Interface By Room Temperature Photoluminescence

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Objective:

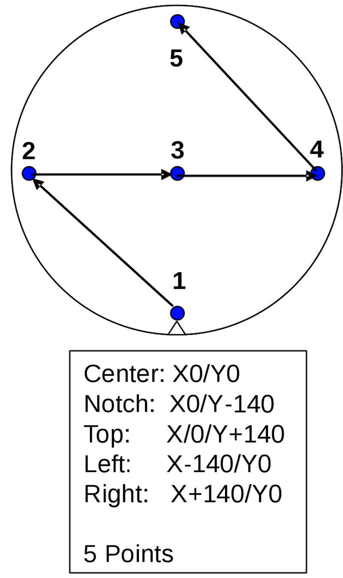
- Development of nondestructive optical plasma induced damage (PID) characterization technique for dielectrics/Si interface quality towards in-line process and equipment monitoring

Sample Preparation:

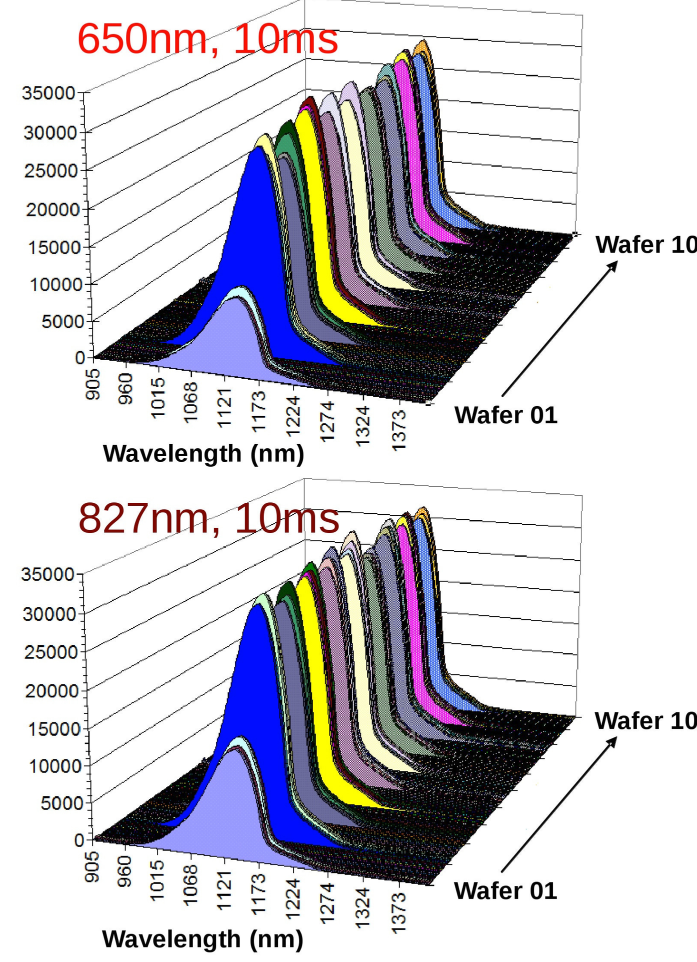
- Reference Wafers: $SiN/SiO_2/Si$ (LPCVD)
- PID Characterization Wafers:
  500 nm-thick HDP-CVD SiO_2 on reference wafers
  HDP-CVD Process conditions were varied.
  - Process chamber (Chamber-to-Chamber Variation)
  - Gas flow
  - RF power
  - Deposition rate
  - Deposition time
  - Wafer temperature

Wafer Description

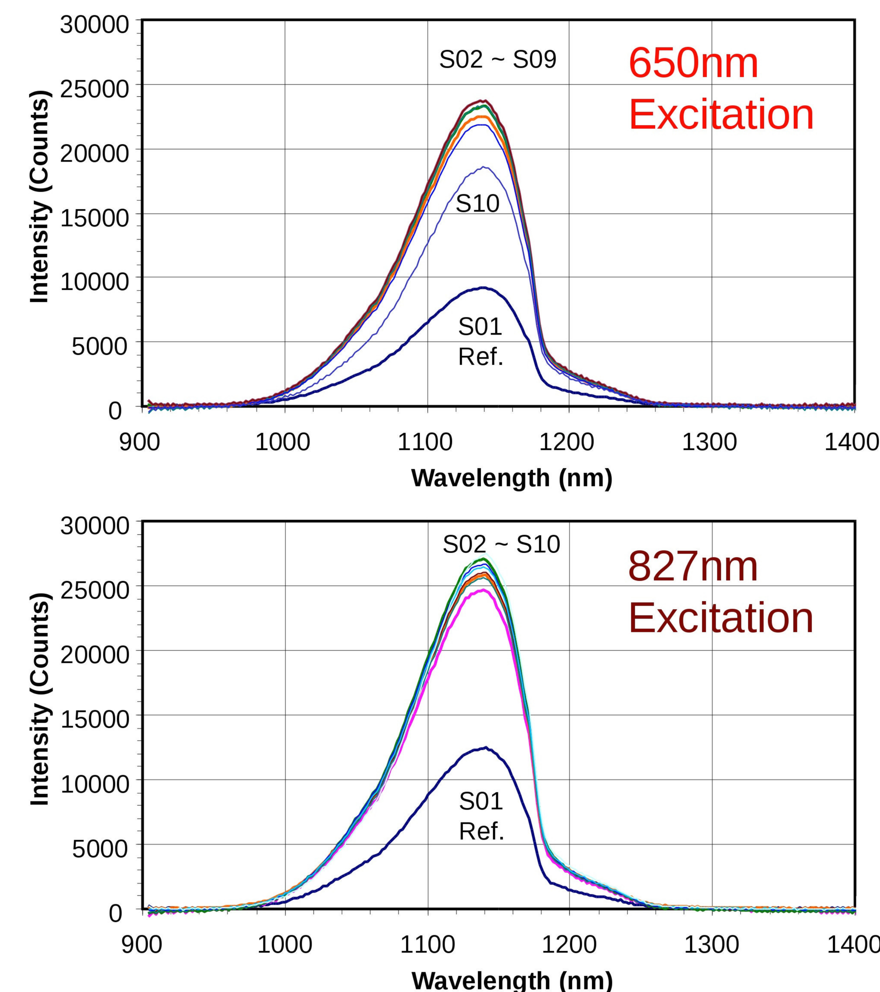
Wafer 01 Reference	Wafer 02 ~10
	HDP SiO_2 (4600~5000A)
SiN (200A)	SiN (200A)
SiO_2 (500A)	SiO_2 (500A)
Si Wafer	Si Wafer
SiO_2 (500A)	SiO_2 (500A)
SiN (200A)	SiN (200A)



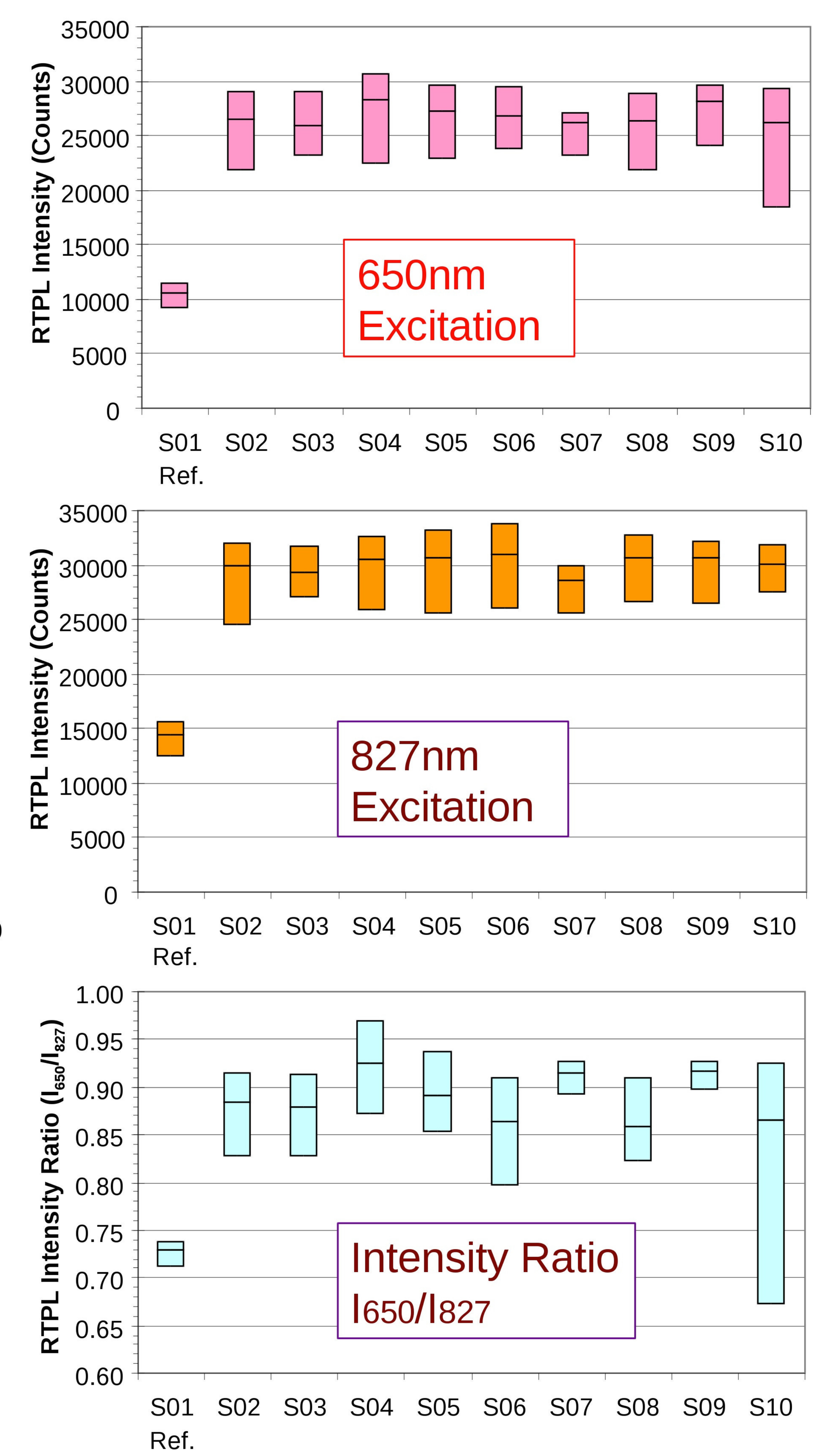
RTPL Spectra 5 Points/Wafer



RTPL Spectra Measured at Wafer Center



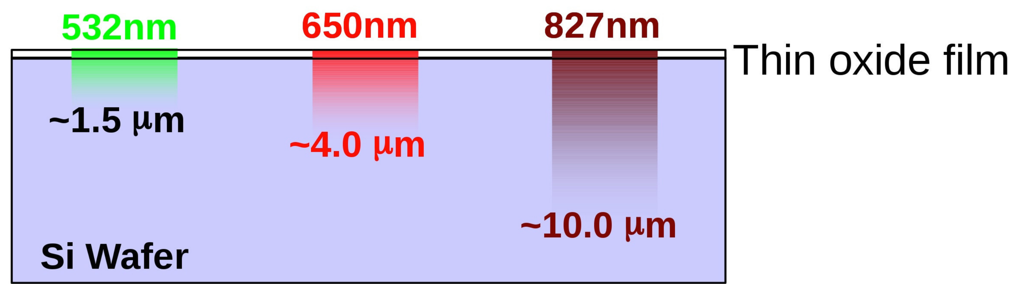
5 Point Measurement Summary



Characterization Technique:

- Multiwavelength Room Temperature Photoluminescence (RTPL)
  - 532 nm
  - 650 nm
  - 827 nm

Excitation Wavelength vs. Probing Depth

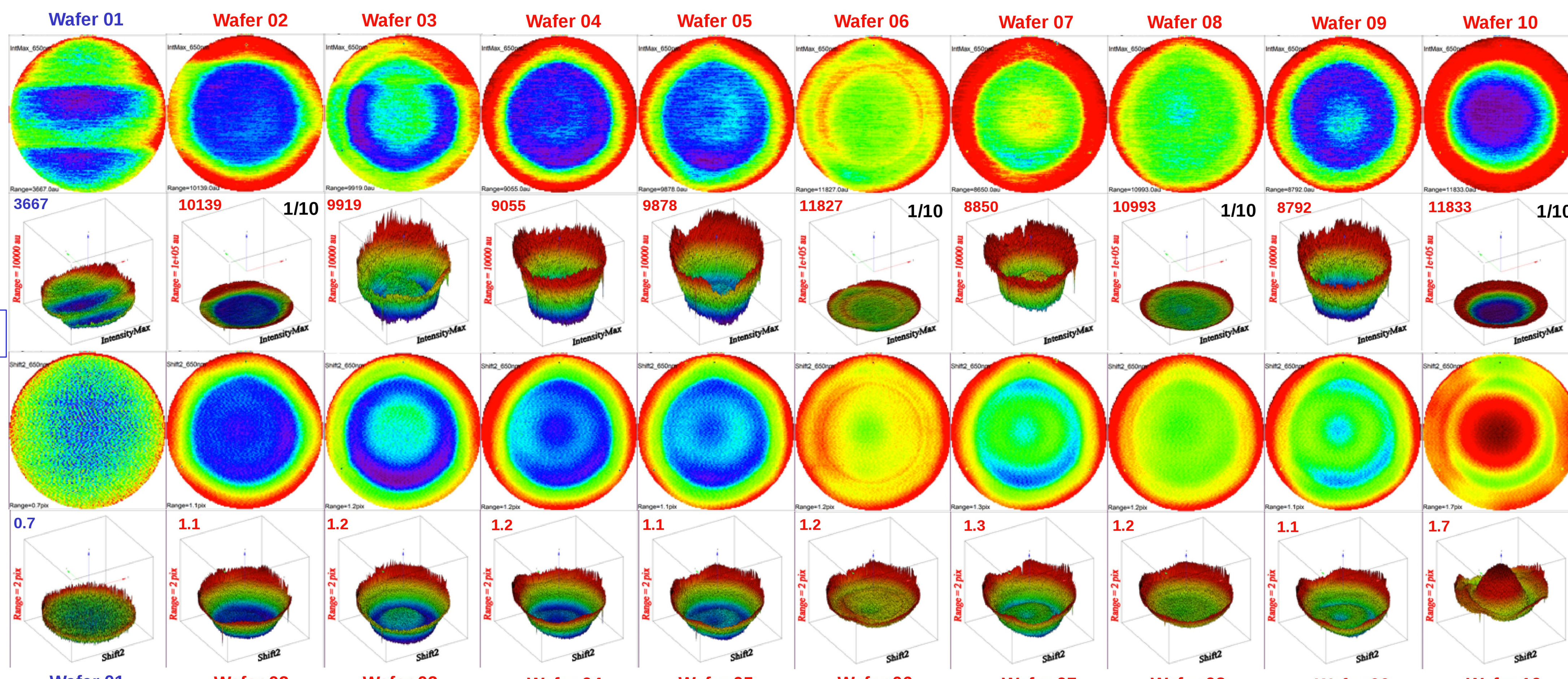


650nm Excitation 10ms
15,101 Pts 2mm intervals

Max PL Intensity

PL from Front Side

Band Tail PL Center Freq.

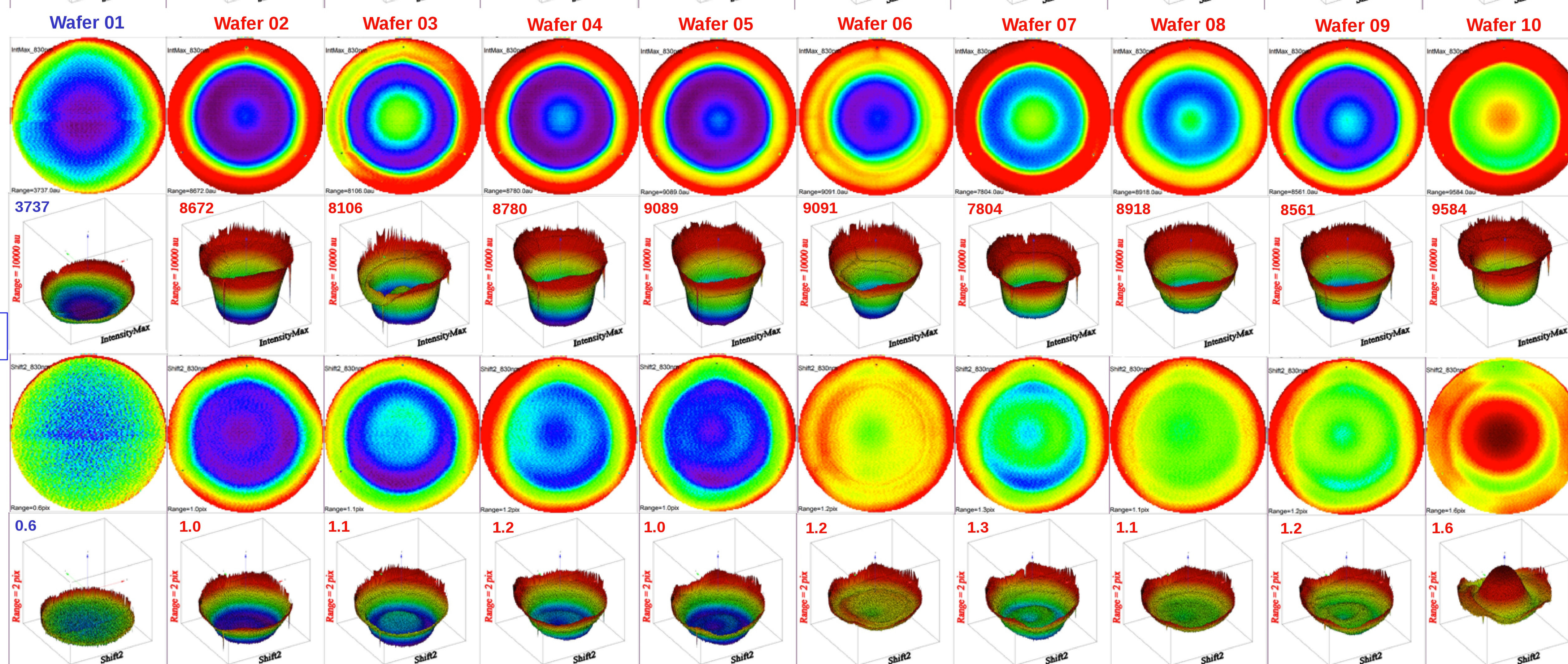


827nm Excitation 10ms
15,101 Pts 2mm intervals

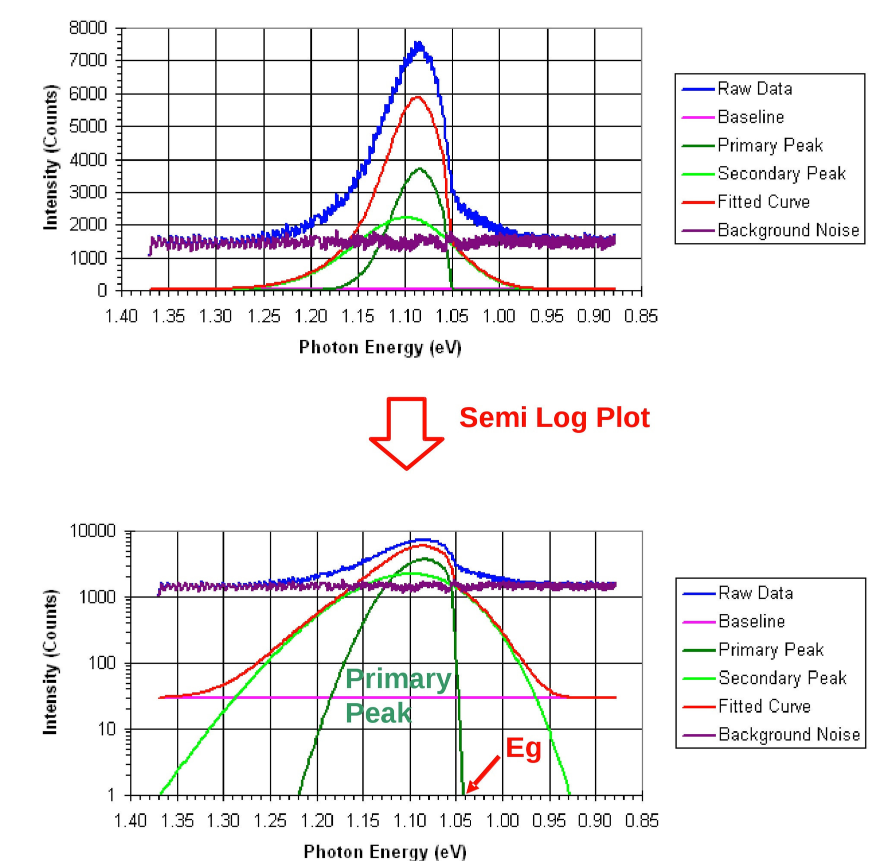
Max PL Intensity

PL from Front Side

Band Tail PL Center Freq.



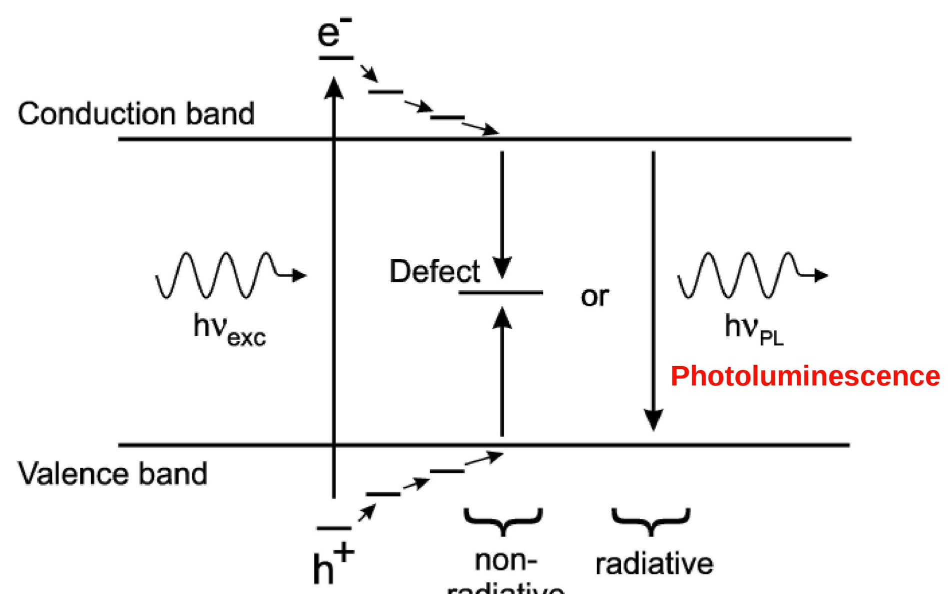
Deconvolution of RTPL Spectra into Interband and Band Tail Components



For characterization of
- bandgap variation
- passivation
- interface quality
- dopant activation
- lattice damage
- defects
- band bending

PL spectra measurement and deconvolution are required.

Radiative and Non-Radiative Recombinations



Good Crystallinity, Good Passivation, Low Dopant Concentration	Strong PL
Defects, Poor Passivation →	Weak PL
Dopant Variations →	PL Intensity & Peak Position Variation

Summary

Multiwavelength RTPL measurements were performed to visualize and monitor HDP-CVD conditions on the integrity of stacked gate dielectrics/Si interface. RTPL can be very useful for in-line monitoring of PPID as well as gate dielectric integrity compromised during subsequent plasma process steps.